

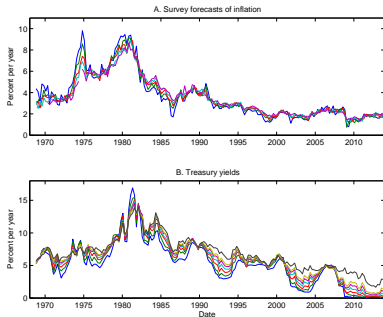
Expected inflation and other determinants of Treasury yields

Greg Duffee
Johns Hopkins University

Q Group Fall Seminar, October 2018

A plot

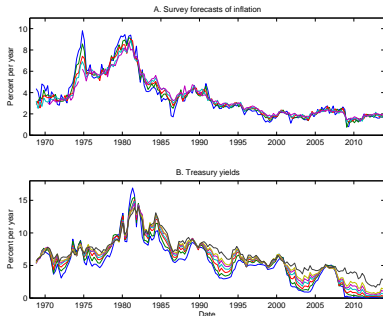
Inflation expectations and Treasury bond yields move widely over time and sort of together



- Consensus forecasts of GDP index quarter-to-quarter inflation, zero to four quarters ahead
- Yields on nominal Treasury bonds, maturities 3 months to ten years

A plot

Inflation expectations and Treasury bond yields move widely over time and sort of together

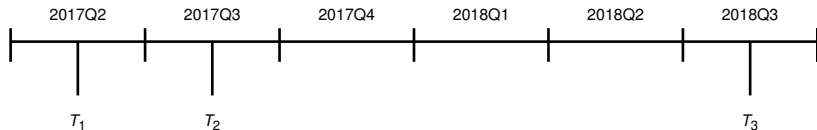


- Consensus forecasts of GDP index quarter-to-quarter inflation, zero to four quarters ahead
- Yields on nominal Treasury bonds, maturities 3 months to ten years

This paper is **not** about covariation of their levels

The question

How much of the short-horizon innovation in yields is attributable to news about expected future inflation?



inflation variance ratio of a bond over a quarter \equiv

$$\frac{\text{Var}(\text{news about expected average inflation to maturity})}{\text{Var}(\text{yield innovation})}$$

Why should we care about this number?

- What are the dominant risks investors face when holding long-term default-free nominal claims?
- What are the macroeconomic drivers of uncertainty in a portfolio of stocks and nominal bonds?
 - Why has the correlation between stock returns and nominal Treasury bond returns changed sign over time?

Results

- 10-20% of var of quarterly shocks to nominal Treasury yields is news about average expected inflation over life of bond

Robust statistically, varies over time

- What accounts for remaining variation? Data do not speak clearly

News about real rates? Changes in risk premia?

Bond math

- Excess return definition (will apply to nominal bonds)

excess return from t to $t + 1 \equiv$ raw return –
 $\frac{1}{4} \times$ (one-quarter nominal yield at t)

- Ex-post accounting identity, yield on m -quarter bond at quarter t is $y_t^{(m)}$

$$y_t^{(m)} = \frac{1}{m} \sum_1^m \text{current, future one-quarter nominal rates} \\ + \frac{4}{m} \sum_1^m \text{future excess returns to bond}$$

More bond math

- Shorthand notation: expectation at quarter t of inflation from quarter t to quarter $t + 1$ is π_t^e
- Definition of ex-ante one-quarter real rate

$$r_t \equiv \text{one-quarter nominal rate}_t - \pi_t^e$$

- Ex-post accounting identity, real rate version (excess returns denoted ex)

$$y_t^{(m)} = \frac{1}{m} \sum_{i=1}^m \pi_{t+i-1}^e + \frac{1}{m} \sum_{i=1}^m r_{t+i-1} + \frac{4}{m} \sum_{i=1}^m ex_{t+i}^{(m-i+1)}$$

Expectations

- An expectation (E) of an identity is an identity

$$y_t^{(m)} = \frac{1}{m} \sum_{i=1}^m E_t(\pi_{t+i-1}^e) + \frac{1}{m} \sum_{i=1}^m E_t(r_{t+i-1}) + \frac{4}{m} \sum_{i=1}^m E_t(\text{ex}_{t+i}^{(m-i+1)})$$

- An earlier expectation of an expectation is an identity

$$E_{t-1}(y_t^{(m)}) = \frac{1}{m} \sum_{i=1}^m E_{t-1}(\pi_{t+i-1}^e) + \frac{1}{m} \sum_{i=1}^m E_{t-1}(r_{t+i-1}) + \frac{4}{m} \sum_{i=1}^m E_{t-1}(\text{ex}_{t+i}^{(m-i+1)})$$

- Subtract latter from the former ...

Innovations and news

innovation in nominal yield \equiv news about expected inflation
+ news about expected real rates
+ news about expected excess returns

- Variance version

$$\begin{aligned} \text{Var}(\text{innovation in nominal yield}) &= \sum_{i=1}^3 \text{Var}(\text{news type } i) \\ &+ \sum_{i=1}^3 \sum_{j=i+1}^3 \text{Cov}(\text{news type } i, \text{news type } j) \end{aligned}$$

Defining “inflation variance ratio”

$$1 = \frac{\text{Var}(\text{news about expected inflation})}{\text{Var}(\text{innovation in nominal yield})} + \sum_{i=2}^3 \frac{\text{Var}(\text{news type } i)}{\text{Var}(\text{innovation in nominal yield})} + \sum_{i=1}^3 \sum_{j=i+1}^3 \frac{\text{Cov}(\text{news type } i, \text{news type } j)}{\text{Var}(\text{innovation in nominal yield})}$$

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- The definition

Inflation variance ratio

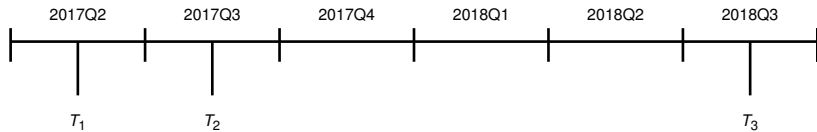
- What it is not
 - Conditional
 - Orthogonal
 - Fundamental (exogenous shocks)
- What it is
 - Straightforward to calculate

Constructing news about expected future inflation

Consensus forecasts from Blue Chip, Survey of Professional Forecasters

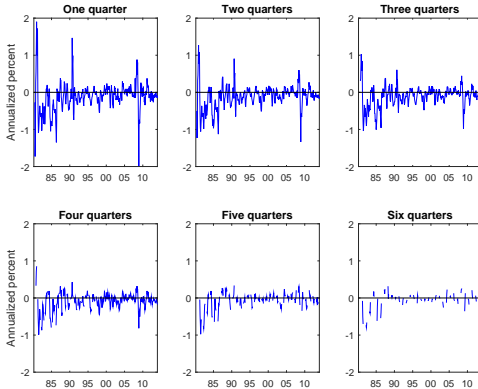
- Substantial academic evidence: econometric models cannot beat survey forecasts
“... purely judgmental forecasts of inflation are right at the frontier of our forecasting ability”
- Forecasts horizons do not extend much beyond a year
Need a mathematical model model to extrapolate long-horizon forecasts from short-horizon forecasts

Short-horizon measures



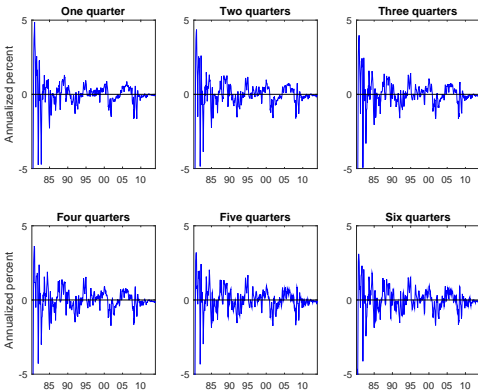
- News about expected future inflation constructed from surveys – model-free
- Yield innovations from T_1 to T_2 constructed by projecting on lagged term structure

Short-maturity inflation news



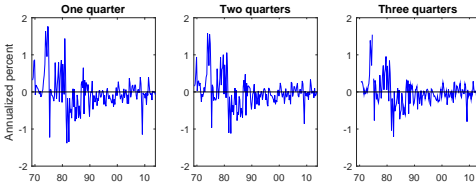
- News about average expected CPI inflation from Blue Chip consensus forecasts
- Quarterly news, observed monthly

Short-maturity yield shocks



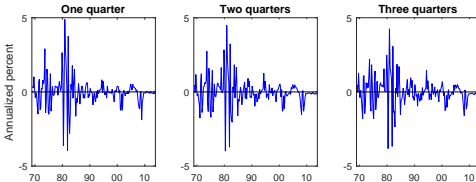
- Shocks are residuals from OLS forecasting regressions, projecting on 1-q, 4-q, 6-q yields
- Quarterly innovations, observed monthly

Short-maturity inflation news



- News about average expected CPI inflation from Survey of Professional Forecasters consensus forecasts
- Quarterly news, observed quarterly

Short-maturity yield shocks



- Shocks are residuals from OLS forecasting regressions, projecting on 1-q, 4-q, 6-q yields
- Quarterly innovations, observed quarterly

Blue Chip, with monetary policy regime subperiods

Statistic	Maturity (quarters)			
	1	2	3	4
1980Q1–2013Q4				
SD of news about expected infl	0.45	0.35	0.31	0.26
Variance ratio	0.20	0.12	0.10	0.07
1980Q1–1982Q4				
SD of news about expected infl	0.98	0.77	0.73	0.70
Variance ratio	0.09	0.06	0.06	0.06
1983Q1–2008Q2				
SD of news about expected infl	0.33	0.27	0.24	0.19
Variance ratio	0.33	0.20	0.15	0.09
2008Q3–2013Q4				
SD of news about expected infl	0.50	0.35	0.27	0.14
Variance ratio	1.77	1.23	0.85	0.63

Survey of Professional Forecasters, also with subperiods

Statistic	Maturity (quarters)		
	1	2	3
1968Q4–2013Q4			
SD of news about expected infl	0.46	0.40	0.35
Variance ratio	0.23	0.19	0.15
1968Q4–1979Q2			
SD of news about expected infl	0.67	0.59	0.51
Variance ratio	0.50	0.38	0.28
1979Q3–1982Q4			
SD of news about expected infl	0.81	0.66	0.61
Variance ratio	0.08	0.06	0.06
1983Q1–2008Q2			
SD of news about expected infl	0.29	0.26	0.24
Variance ratio	0.29	0.22	0.17
2008Q3–2013Q4			
SD of news about expected infl	0.30	0.23	0.22
Variance ratio	0.65	0.74	0.73

Long-maturity inflation variance ratios

- Expected inflation: Use existing academic literature
 - Best forecast of distant inflation is extrapolating glide path embedded in short-term forecasts
- Forecasts of future long-term yields: Use existing academic literature

Changes in long-term bond yields are essentially unpredictable

Key assumptions

- Standard academic setup

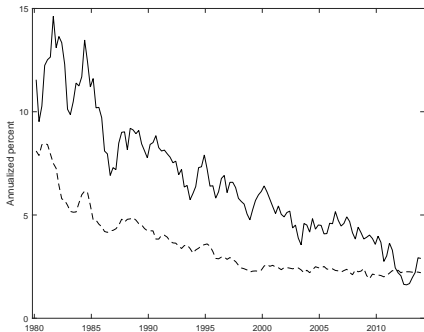
Inflation is the sum of a permanent component—very long-run swings—and a transitory component driving short-run fluctuations

- Do we assume that in the long run, inflation and nominal yields move one-for-one? (academic term: cointegrated, cointegration vector of $1, -1$)
 - If, 50 years from now, long-run inflation forecasts are 20% rather than 2%, will long-run yield forecasts be 18% higher than today?
 - Common assumption that I do *not* adopt because it seems to be at odds with the data

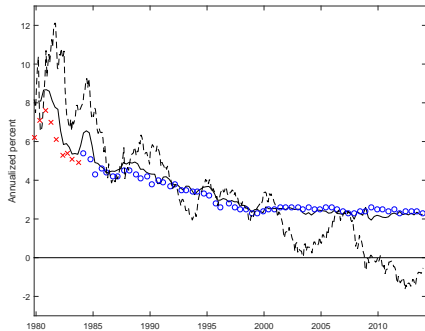
Results for 10-year bond yield, with subperiods

Survey	Sample Period	SD of inflation news	SD of yield shocks	Variance Ratio
Blue Chip	1980Q1–2013Q4	0.21	0.64	0.11
	1980Q1–1982Q4	0.47	1.31	0.13
	1983Q1–2008Q2	0.19	0.55	0.12
	2008Q3–2013Q4	0.10	0.38	0.07
Survey of Prof Forecasters	1968Q4–2013Q4	0.21	0.56	0.14
	1968Q4–1979Q2	0.25	0.42	0.35
	1979Q3–1982Q4	0.25	1.24	0.04
	1983Q1–2008Q2	0.16	0.49	0.11
	2008Q3–2013Q4	0.07	0.44	0.03

Long-run inflation expectations



Ten-year bond yield and model-implied expected average inflation over next ten years



Survey forecasts of inflation in [5-10] yrs, my model forecast (solid), forecast assuming cointegrated yields and inflation (dashed)

Summary of evidence

- Estimates of unconditional variance ratios no higher than 0.2 for all examined maturities
- Noticeable variation across subperiods with different monetary policy regimes

For long maturity bonds, ratios never exceed 0.4

What drives yield shocks?

Remember the accounting identity

innovation in nominal yield \equiv news about expected inflation

+ news about expected real rates

+ news about expected excess returns

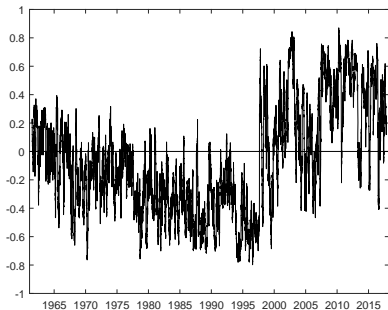
- How big are last two components?
- I construct a complicated dynamic model to infer news about expected future short-term real rates and expected future excess returns
- Results on next slide

(Non) Results

- I cannot reliably separate news about expected future real rates from news about expected future excess returns
- Key problem: short-term real rates vary substantially over time. How persistent are these variations? We cannot tell

An extension, with a plot

Rolling sample correlations between the daily return to the U.S. stock market and the daily change in the yield on a ten-year nominal Treasury bond



- What explains this picture?
- My results: probably not changes in the relation between inflation and the stock market

My “explanation”

- Time-varying correlation between stock returns and short-term *real* interest rates
- Why does this correlation vary? Not because of changing macroeconomic dynamics . . .
- See my latest working paper