When Do Subjective Expectations Explain Asset Prices?

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What drives stock and bond markets?

- Prices are discounted expectations of real cash flows
  - Real earnings for stocks, inflation for bonds
- Statistical forecasts of real cash flows don't explain prices
  - Aggregate stock prices don't predict real earnings, Treasury yields don't predict inflation
- Do biases in expectations explain prices?
  - Theoretical: How to discipline multitude of potential biases?
  - Empirical: Where do relevant errors arise in expectations (short-term or long-term)?

Our approach

- Use accounting identities and allow for any subjective probability distribution
  - Derive necc and suff condition for errors to explain prices, return puzzles
- Test condition on survey expectations of real cash flows
  - Determines where relevant errors do and do not arise in expectations
  - Requires no assumption on mechanism (learning, over-reaction, ...)
- Replicate prices using expected real cash flows
  - Determines if errors large enough to account entirely for price movements

Results

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- Test condition on survey expectations of real cash flows
  - Importance of expected long-term inflation and short-term nominal earnings growth
- Replicate prices using expected real cash flows
  - Match S&P 500 P/E, P/D, and 10yr Treasury yield with R^2 of 0.81, 0.79, 0.66
  - Match stock return predictability and rejection of expectations hypothesis

Connection to current markets

- Current stock, bond prices far above historical average (high P/E, low yields)
- Empirically, high stock or bond prices not followed by higher real cash flows
  - Instead, followed by lower real returns
  - If investors rational, prices driven by discount rates
- Our results indicate prices mainly driven by biased expectations of earnings, inflation
  - Investors think high prices will be justified by higher future real cash flows
  - High prices followed by disappointment
  - Driven by errors in expected short-term earnings growth and long-term inflation

- Not all systematic errors matter for asset pricing
- Importance of expected long-term inflation and short-term nominal earnings growth
- Stocks and bonds explained by expected real cash flows

Not all errors relevant for asset pricing

- Example: stock return predictability

$$Cov\left(P/E, \text{Future real returns}\right) = Cov\left(P/E, \text{Expected real returns}\right) + Cov\left(P/E, \text{Real earnings growth error}\right)$$

  - Forecast errors not correlated with P/E irrelevant, even if systematic
  - Derived from accounting identity, so always holds (learning, over-reaction, extrapolation, ...)

- Empirical diagnostic test: does P/E comove with forecast error?

- Generalized diagnostic test: do current prices comove with real cash flow forecast errors?
  - Determines if forecast errors explain (i) price movements, (ii) stock return predictability, (iii) rejection of expectations hypothesis

Not all errors matter for asset pricing: intuitive example

- Suppose x_t predicts future real earnings growth, but investors do not know this
  - For simplicity, x_t independent of variables in investor information set I_t

  $\Rightarrow$ x_t predicts forecast errors for earnings growth

- These errors do not drive price movements $p_t = f(I_t)$
  - Do not explain why prices predict returns

- Errors that are uncorrelated with prices will not help to explain prices

- Not all systematic errors matter for asset pricing
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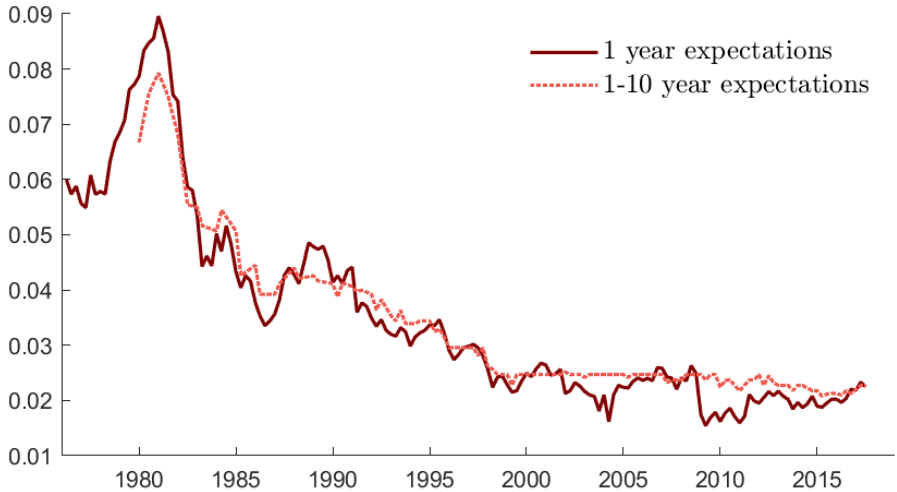
Subjective expectations construction

- Inflation expectations
  - Survey of Professional Forecasters
    - Short-term: 1y
    - Long-term: 1-10y
  - Alternative surveys: Michigan, Livingston, BlueChip
- Nominal earnings growth expectations
  - Thomson Reuters I/B/E/S
  - Build aggregate expectation from individual firm expectations
    - Short-term: 1y
    - Long-term: 3-5y

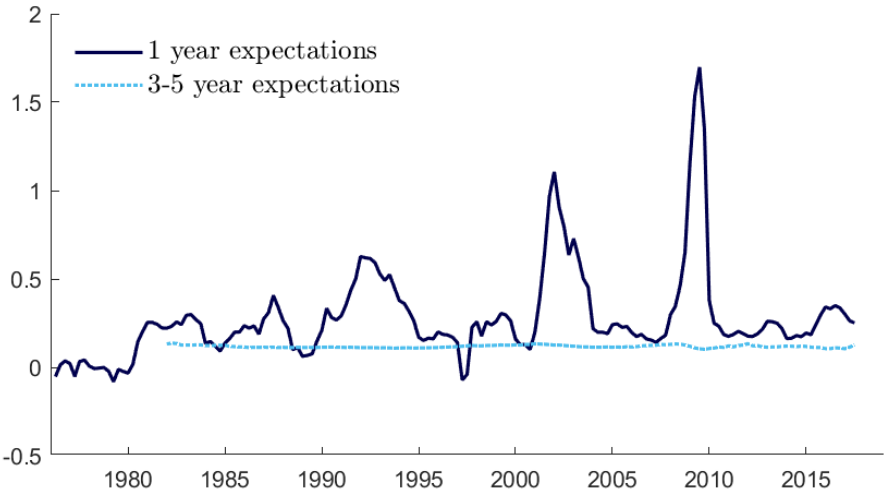
Inflation expectations

- Average 1-10 year expectation moves almost 1-1 with 1 year expectation
- Subjective annual persistence $\phi_\pi = 0.96$, $E_t^* [\pi_{t+1+j}] = \alpha_{\pi,j} + \phi_\pi^j E_t^* [\pi_{t+1}] + \varepsilon_{t,j}^\pi$



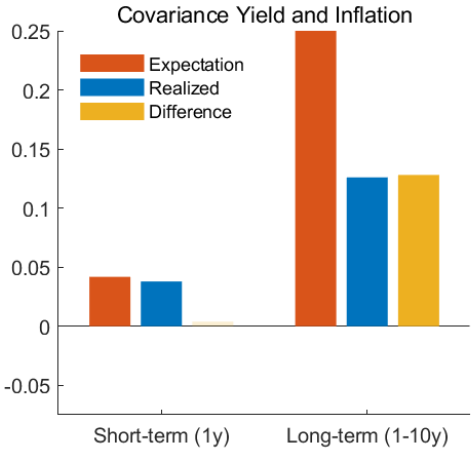
Nominal earnings growth expectations

- Flat long-term expectations
- Subjective annual persistence $\phi_e = 0.004$, $E_t^* [\Delta e_{t+1+j}] = \alpha_{e,j} + \phi_e^j E_t^* [\Delta e_{t+1}] + \varepsilon_{t,j}^e$



Inflation errors concentrated at long horizons

- Diagnostic test: prices must comove with forecast errors
  - Prices must comove with expectations more than realized
  - Shade by significance



Earnings growth errors concentrated at short horizons

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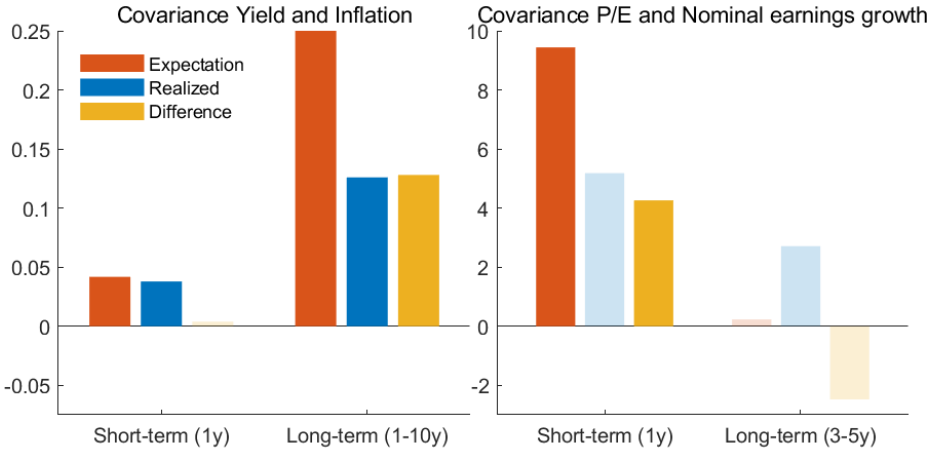
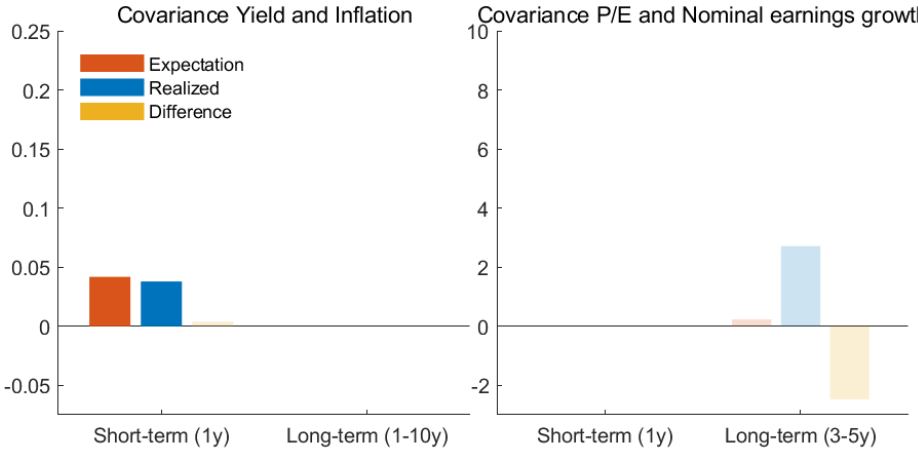


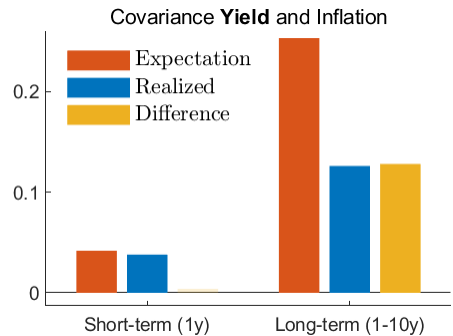
Disciplining relevance for asset pricing

- Expected short-term inflation and long-term nominal earnings growth fail test
  - Stickiness (short-term inflation), overreaction (long-term nom earnings growth) not relevant



Implications for expectations

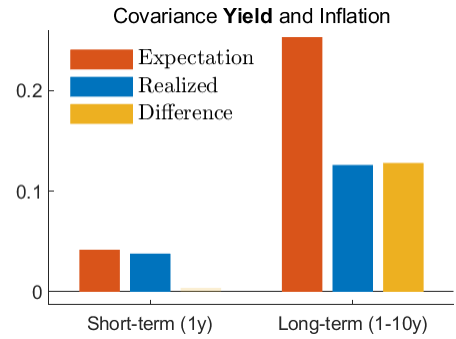
- Focus on inflation expectations



Implications for expectations

- Focus on inflation expectations

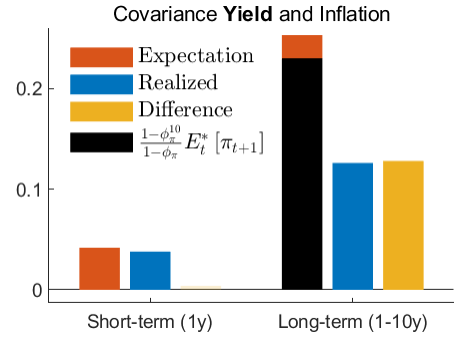
1. Errors in short-term expectations do not drive prices
   - Focus on understanding long-term expectations



Implications for expectations

- Focus on inflation expectations

1. Errors in short-term expectations do not drive prices
   - Focus on understanding long-term expectations
2. Key to long-term is subjective persistence ϕ_π
   - $E_t^* [\pi_{t+1,t+10}] = \alpha_\pi + \frac{1-{\phi_\pi}^{10}}{1-\phi_\pi} E_t^* [\pi_{t+1}] + \varepsilon_t^{LT}$
   - Not driven by information solely about long-term (ε_t^{LT})



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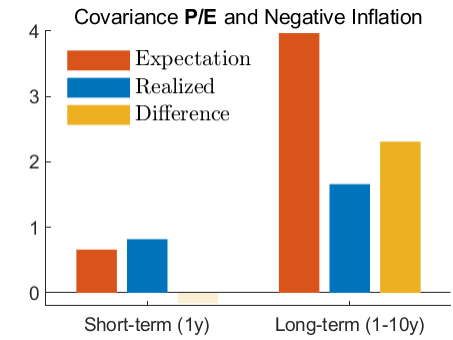
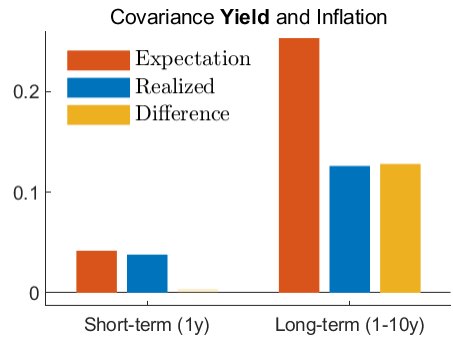
- Results apply to both stocks and bonds





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Expectations explain prices

- Regress observed prices on expected real cash flow
  - 1976-2018
  - S&P 500 P/E on expected real earnings growth
  - 10-year Treasury yield on expected inflation

	β	R^2	R^2 $(\beta = 1)$
P/E	0.96	0.81	0.81
	(0.09)		
Yield	1.55	0.66	0.58
	(0.30)		
P/D	0.96	0.79	0.79
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$(P/E)^{SR}$	0.90	0.81	0.80
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$(P/E)^{LR}$	0.99	0.82	0.82
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- Additional measures of stock prices
  - P/D on expected real earnings growth * (E/D)

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  - Short-run and long-run components of P/E and expected earnings growth

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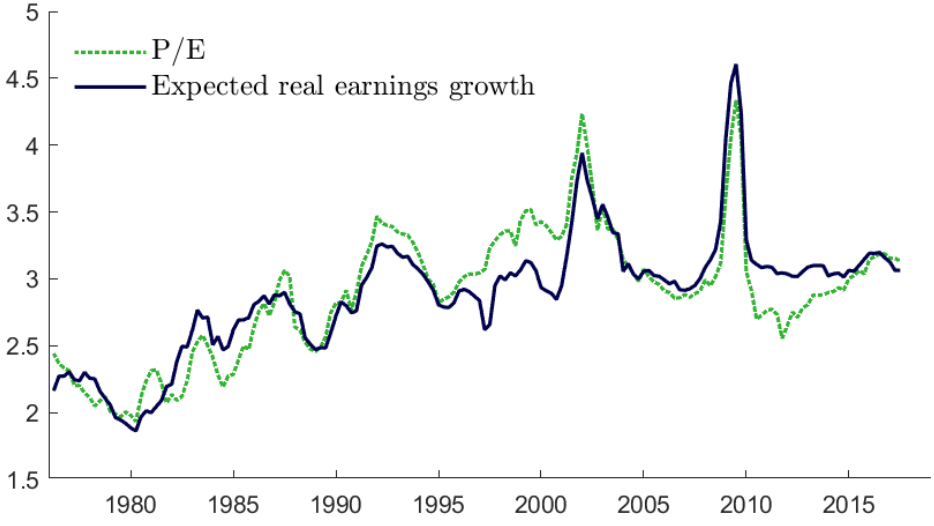
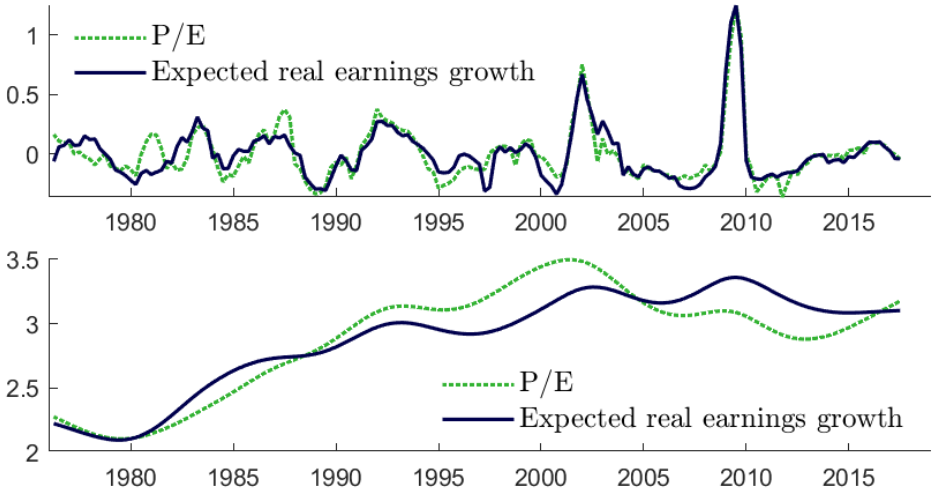
S&P 500 Log Price-earnings Ratio

- Expectations of real earnings growth capture almost all movements in P/E



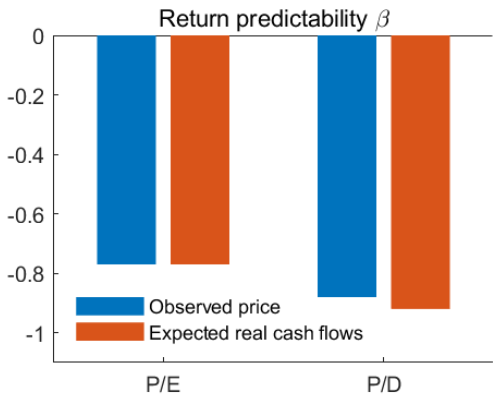
Short-run and long-run movements

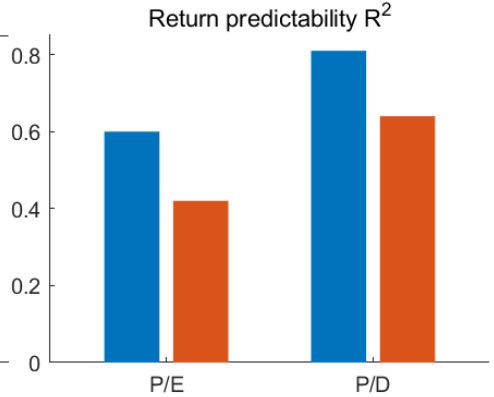
- Expectations captures business cycle movements and secular increase



Stock return predictability

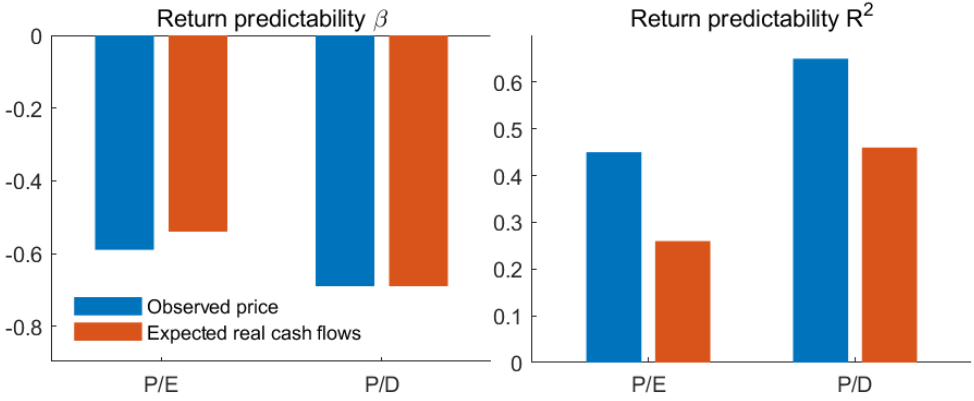
- Regress 10-year cumulative returns on current price ratios
- Expected real cash flows match comovement with future returns and high R^2
  - P/E: expected real earnings growth
  - P/D: expected real earnings growth * (E/D)





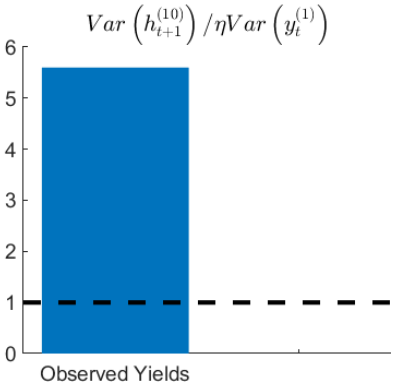
Same results using real returns

- Repeat exercise using real returns
  - P/E: expected real earnings growth
  - P/D: expected real earnings growth * (E/D)



Rejection of expectations hypothesis

- Expectations hypothesis
  - Long-term yields equal expected average future short-rate (plus constant)
  - Movements in long-term yields related to future short-rate



- If expectations rational
  - Variance of holding returns bounded

$$Var\left(h_{t+1}^{(n)}\right) \leq \eta Var\left(y_t^{(1)}\right)$$

  - Clearly rejected in the data (Shiller 1979)
  - Long-term yields driven by time-varying term premia

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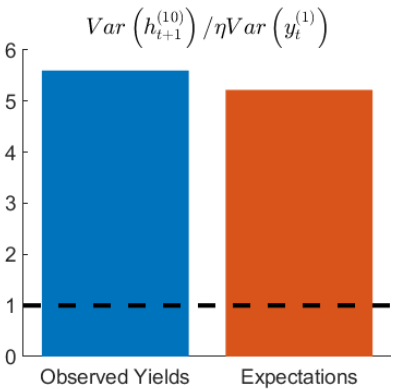

- Inflation expectations match excess volatility
  - Consider yields based only on inflation expectations
    - Changes in expectations determine holding returns
  - Expectations hypothesis holds
  - Volatility due to errors in long-term inflation expectations

Conclusion

- Accounting identities discipline if errors matter for asset prices
  - Not all evidence of behavioral biases is relevant
- Importance of expected long-term inflation and short-term earnings growth
  - Errors significantly correlated with both stock and bond prices
  - High prices predict disappointment
- Expected real cash flows explain stock and bond prices, return puzzles
  - Efficient market hypothesis and expectations hypothesis hold subjectively