SF Fed Conference: The past and future of monetary policy

Expecting the Fed

Anna Cieślak and Pavol Povala

Northwestern Kellogg and University of Lugano

March 1, 2013

Motivation

Fact. There is information in the time series of interest rates and in macro variables that is not in today's yield curve, but predicts bond returns/yields.

H1. [FIRE] A variable has an offsetting effect on the risk premium vs the expected short rate, maturity by maturity:

$$y_t^{(2)} = \frac{1}{2} F_t \left(i_t + i_{t+1}\right) + \frac{1}{2} F_t \left(rx_{t+1}^{(2)}\right) \quad \text{(ex-ante)} \tag{1}$$

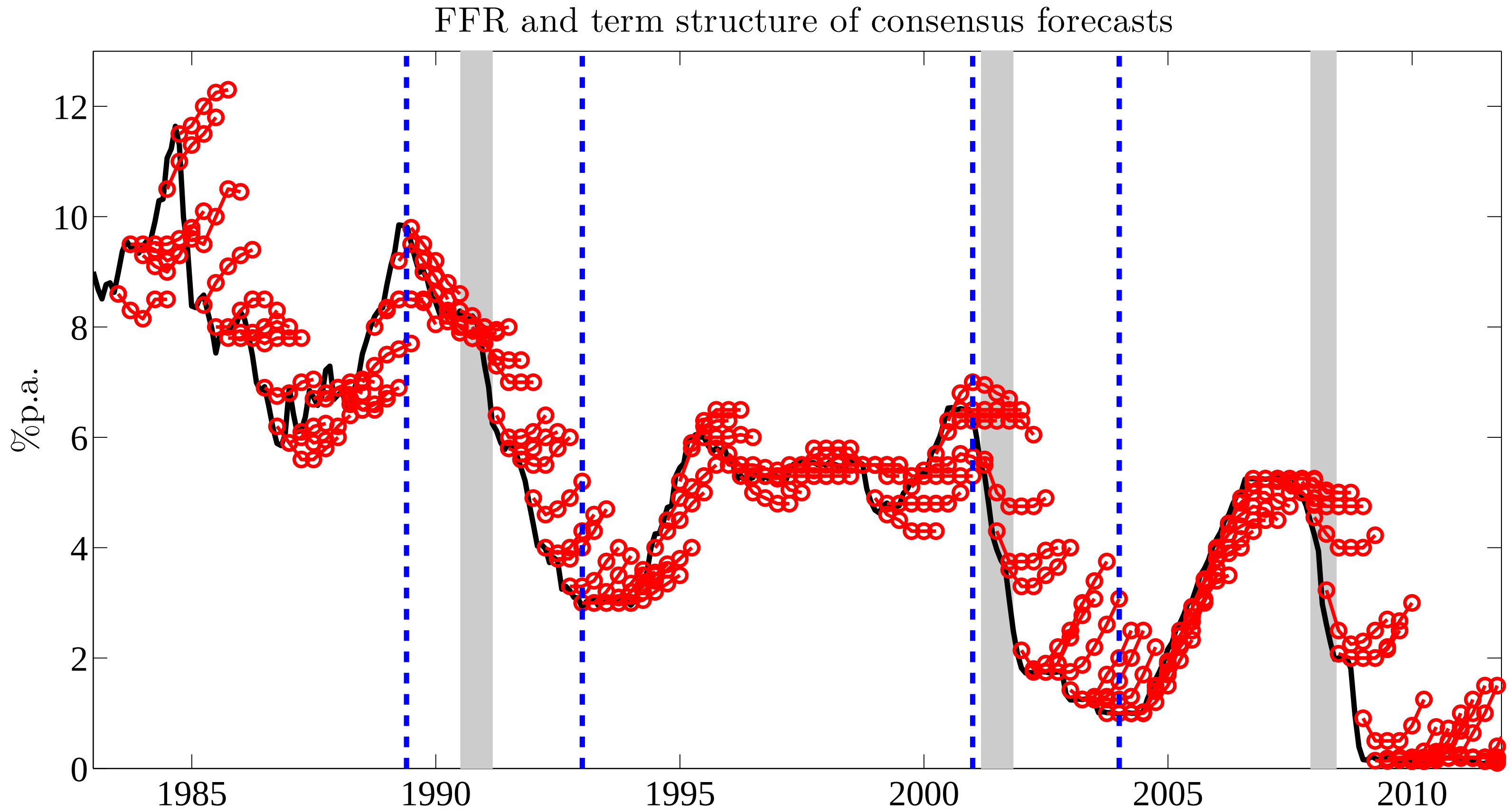
H2. [≠FIRE] Forecast errors about the short rate are ex-post predictable:

$$y_t^{(2)} = \frac{1}{2}\left(i_t + i_{t+1}\right) + \frac{1}{2} rx_{t+1}^{(2)} \quad \text{(ex-post)} \tag{2}$$

$$i_{t+1} - F_t(i_{t+1}) = -\left[rx_{t+1}^{(2)} - F_t(rx_{t+1}^{(2)})\right] \tag{3}$$

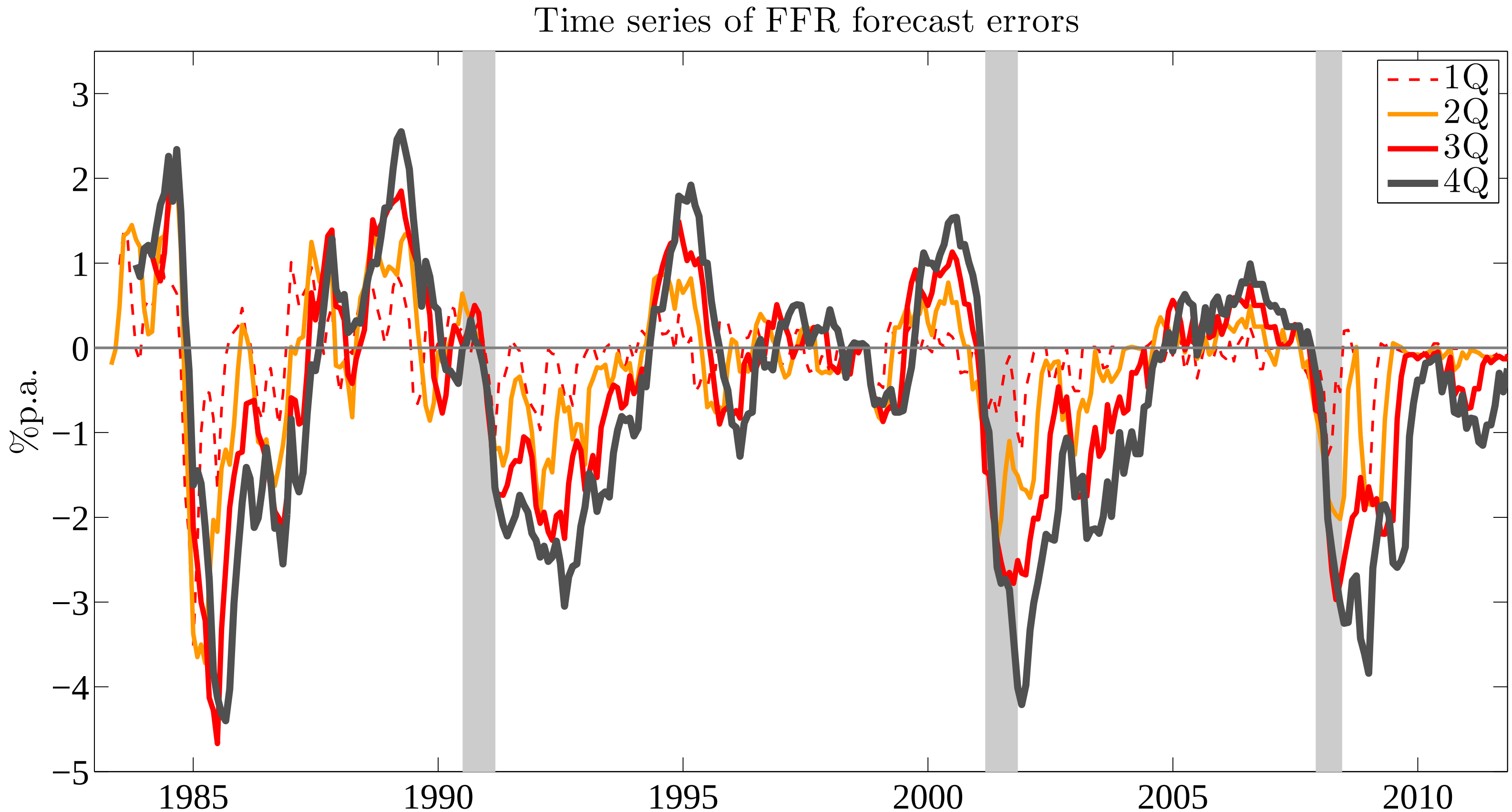
Focus. How does the private sector form and update expectations about i_t and thus future path of monetary policy?

Term structure of short rate expectations



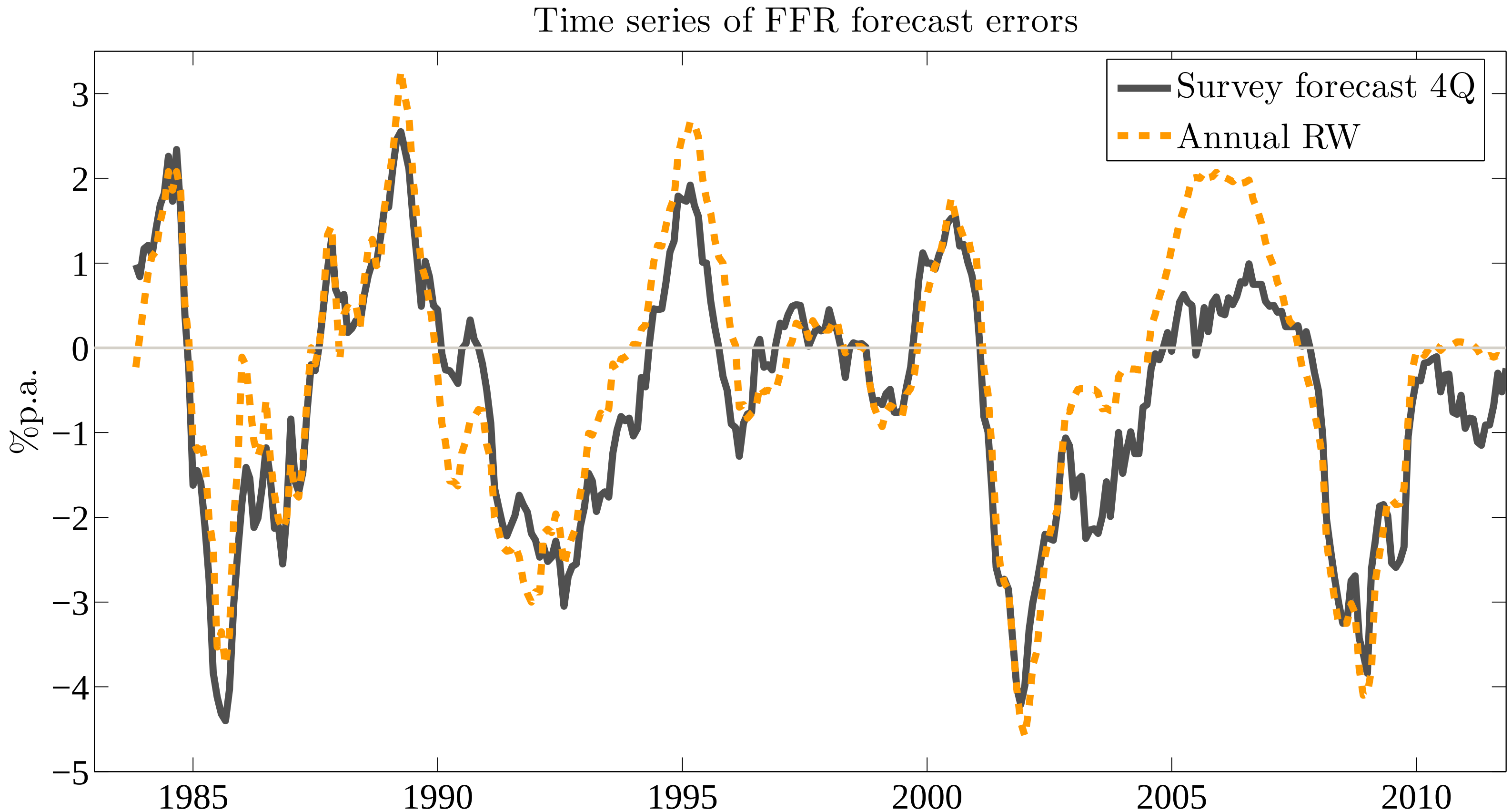
- Professional forecasts from the Blue Chip survey (BCFF), available 1983-2010
- Similar pattern for Greenbook forecasts of FFR as well as for SPF and BCFF forecasts of 3-month T-bill
- Forecasters predict about **18%** of variation in FFR one year ahead; more than **80%** remains unexplained

Term structure of forecast errors



- Forecast error defined as: $FE^{FFR}_{t-h,t} = FFR_t - E^s_{t-h}(FFR_t)$, where h ranges from one through four quarters, $E^s(\cdot)$ denotes survey-based expectations
- Largest and most volatile errors occur in easing episodes; avg. forecast error $= -$**1.43%** in easings and **0.60%** in tightenings, at $h =$4Q

Term structure of forecast errors



	h=Q1	h=Q2	h=Q3	h=Q4
(1) **FFR survey**	**0.33**	**0.75**	**1.12**	**1.47**
(2) Random walk	0.54	0.95	1.31	1.63
(3) AR(2)	0.52	0.95	1.29	1.60
(4) AR(p) dynamic	0.55	0.97	1.30	1.61
(5) VAR(2) OLS	0.55	0.93	1.30	1.64
(6) TVP VAR(2)	0.56	1.02	1.42	1.79

The table reports out-of-sample (sequential) RMSEs (in % p.a.) for forecasting FFR at horizons 1–4Q ahead, OOS period 1983-2010.

This paper

i. Ex-post, the short rate appears more predictable than it has been ex-ante

- Distant lags of short rate predict its changes *after* conditioning on information in the yield curve
- Slow mean-reversion at business cycle frequency

ii. A wedge between information in the time series and cross section of yields

- Effect located at the short maturity range
- Lagged information explains up to 25% of ex-post FFR forecast errors
- Traces low-frequency variation in monetary policy surprises

iii. Two factor structure in realized/predictable bond excess returns

- At short maturities, ex-ante unexpected short rate component
- At long maturities, "usual" risk premium

iv. More general feature of expectations formation?

- Lagged information survives in tests for information frictions (noisy, sticky)
- Explains portion of ex-post errors of unemployment controlling for other information rigidities
- Visible in money market fund flows; evidence of extrapolation

Literature

Expectations formation: Coibion and Gorodnichenko (2011a,b), Fuster, Laibson and Mendel (2010), Piazzesi and Schneider (2011), Kurz and Motolese (2011), Rudebusch (2002)

Monetary policy shocks: Christiano, Eichenbaum and Evans (1996), Cochrane and Piazzesi (2002), Kuttner (2001), Rudebusch (1998), Campbell, Evans, Fisher, Justiniano (2012)

Monetary policy and information frictions: Woodford (2001), Mankiw and Reis (2002), Orphanides and Williams (2005), Sims (2003), Angeletos and La'O (2011)

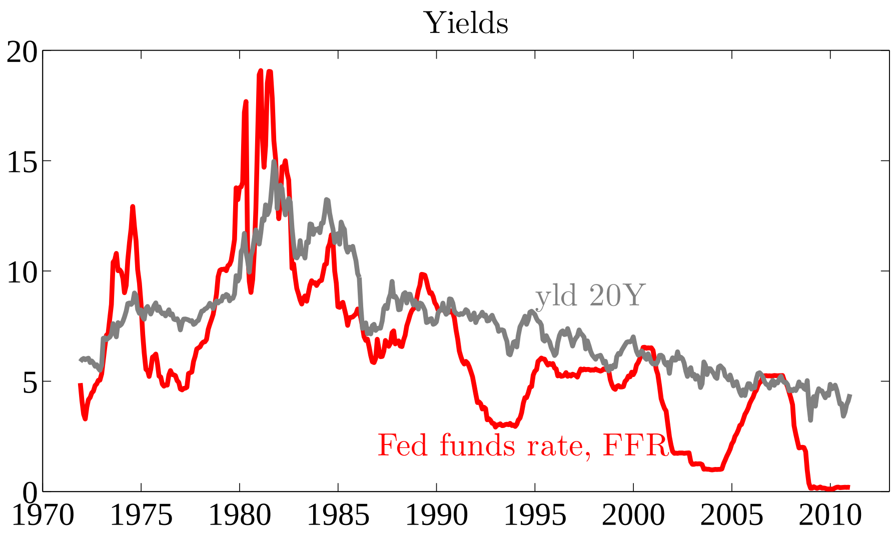
Slope and growth: Harvey (1989), Estrella and Hardouvelis (1991), Bernanke and Blinder (1992), Stock and Watson (1989), Hamilton and Kim (2002)

Bond risk premia and unspanned factors: Cochrane and Piazzesi (2005, 2008), Cooper and Priestley (2008), Ludvigson and Ng (2009), Duffee (2011, 2012), Joslin, Priebsch and Singleton (2012), Joslin, Le, Singleton (2012, 2013), Nimark (2012), Piazzesi and Swanson (2008)

Information frictions in other asset markets: Greenwood and Shleifer (2013), Nagel (2012), Singleton (2012), Frankel and Froot (1987), Froot (1989), Gourinchas and Tornell (2004), Bacchetta, Mertens and Wincoop (2009)

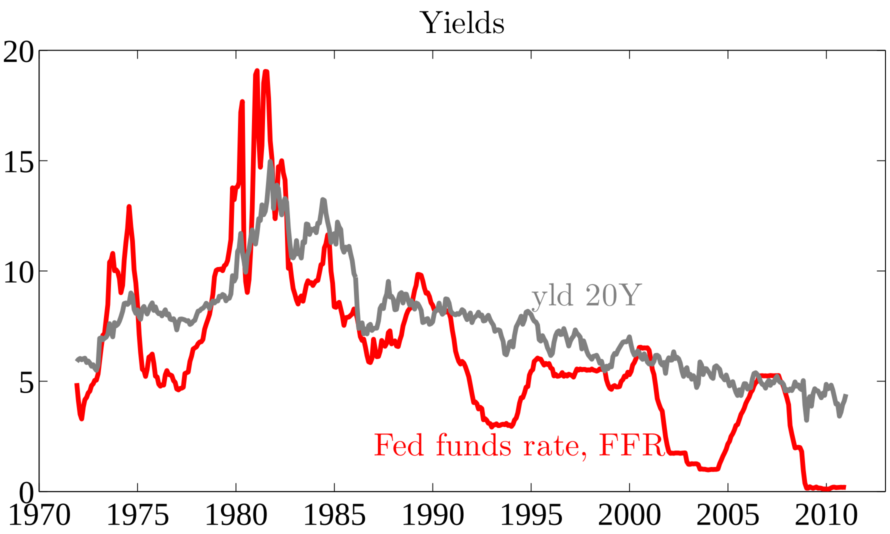
Short rate expectations

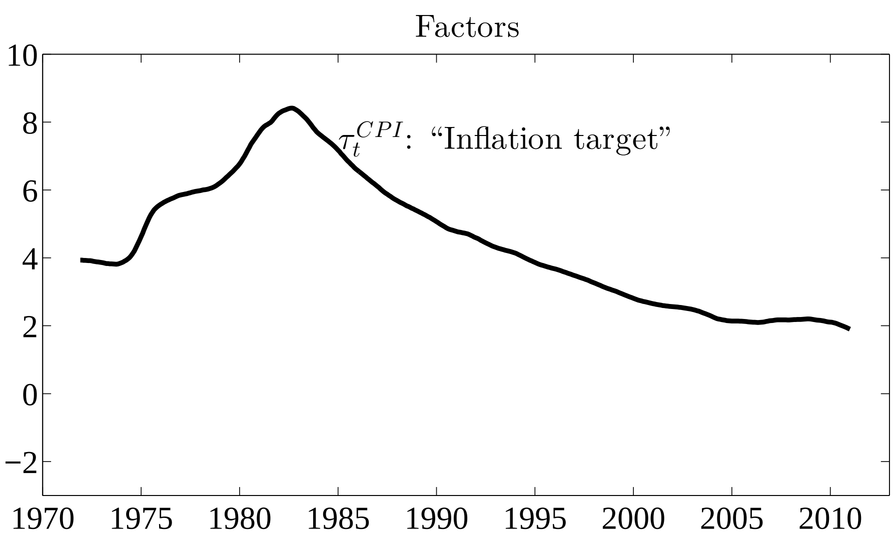
A yield curve decomposition



$\Delta FFR^c = \Delta FFR$ FFR^c=-slope

A yield curve decomposition



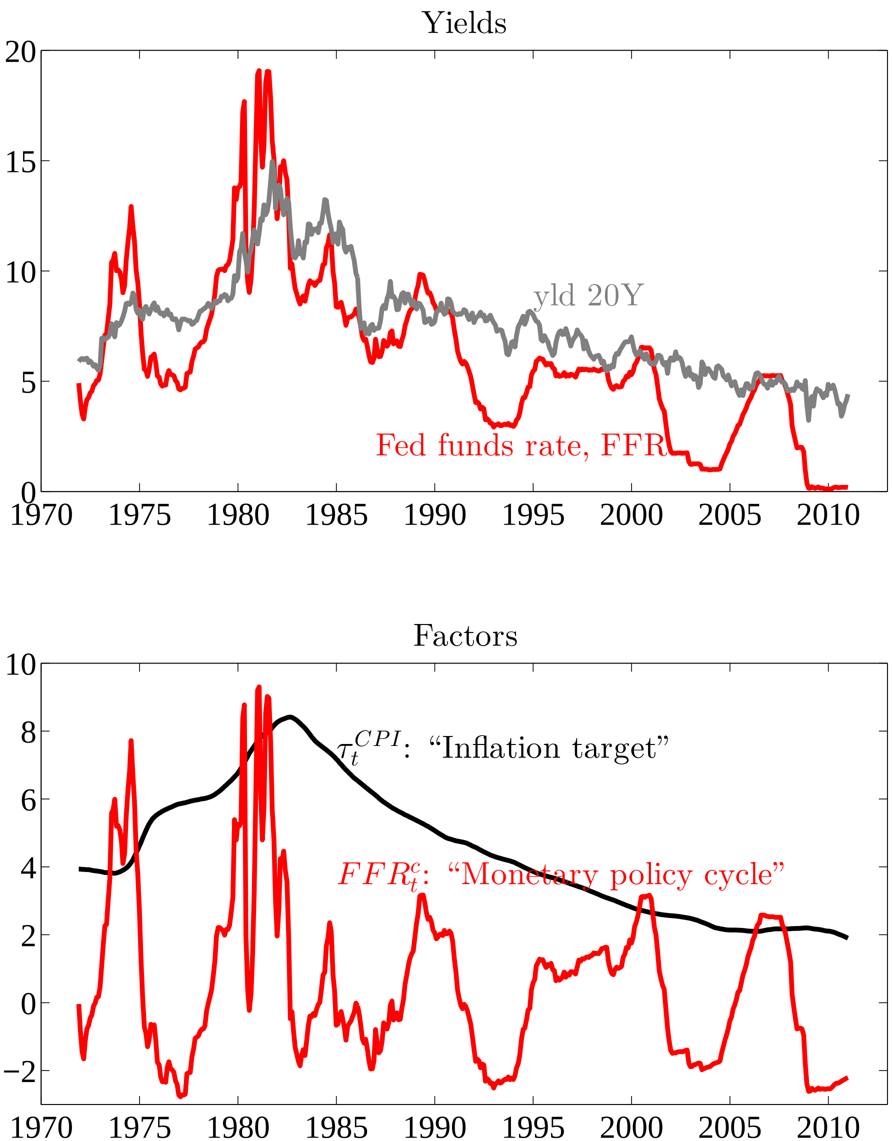


Cieslak and Povala (2011):

i. τ_t^{CPI}: Slow-moving inflation endpoint (target) $\rightarrow$ level

$\Delta FFR^c = \Delta FFR$ $\quad FFR^c$=-slope

A yield curve decomposition



Cieslak and Povala (2011):

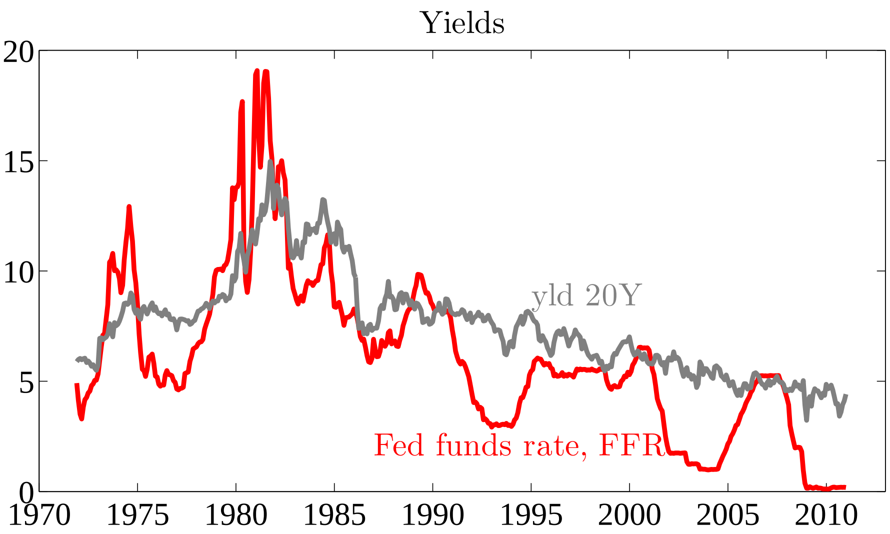
i. τ_t^{CPI}: Slow-moving inflation endpoint (target) $\rightarrow$ level

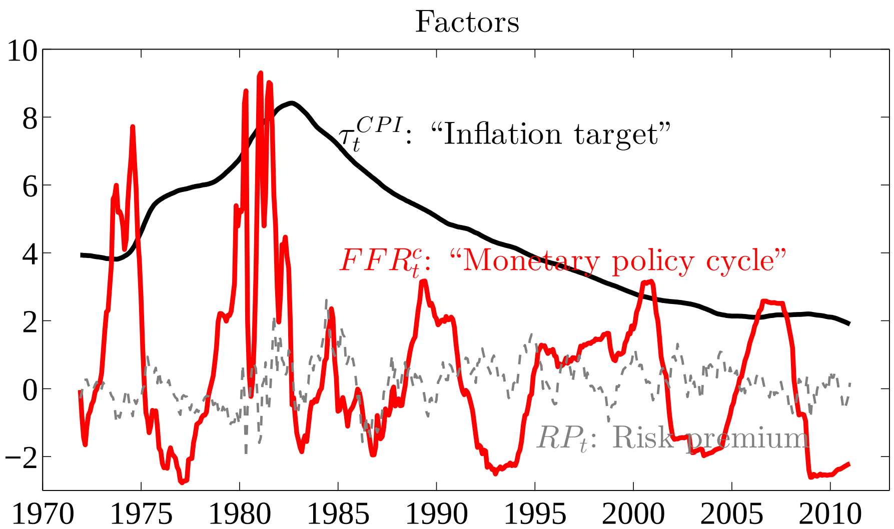
ii. FFR_t^c: Monetary policy cycle moving the short end $\rightarrow$ slope

$$FFR_t^c = FFR_t - \hat{\beta}\tau_t^{CPI}, \quad \hat{\beta} = 1.26$$

$\Delta FFR^c = \Delta FFR$ FFR^c=-slope

A yield curve decomposition





Cieslak and Povala (2011):

i. τ_t^{CPI}: Slow-moving inflation endpoint (target) $\rightarrow$ level

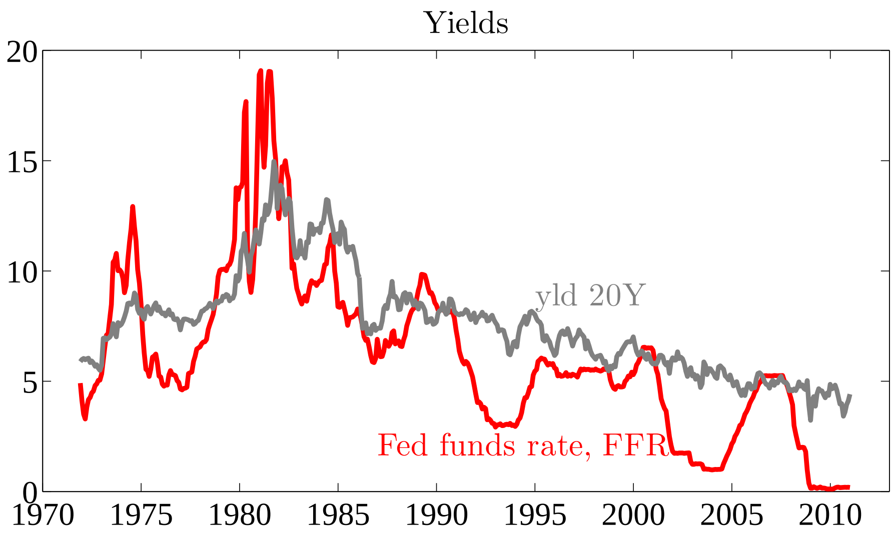
ii. FFR_t^c: Monetary policy cycle moving the short end $\rightarrow$ slope

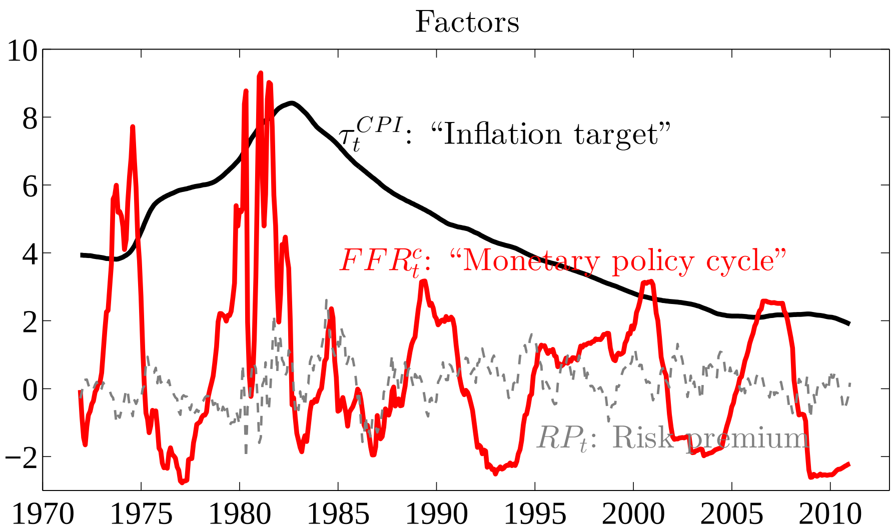
$$FFR_t^c = FFR_t - \hat{\beta}\tau_t^{CPI}, \quad \hat{\beta} = 1.26$$

iii. RP_t: A risk premium factor

$\Delta FFR^c = \Delta FFR$ $\quad FFR^c$=-slope

A yield curve decomposition





Cieslak and Povala (2011):

i. τ_t^{CPI}: Slow-moving inflation endpoint (target) $\rightarrow$ level

ii. FFR_t^c: Monetary policy cycle moving the short end $\rightarrow$ slope

$$FFR_t^c = FFR_t - \hat{\beta}\tau_t^{CPI}, \quad \hat{\beta} = 1.26$$

iii. RP_t: A risk premium factor

- Inflation target $\tau_t^{CPI} \approx$ random walk
- Forecasting $\Delta FFR_{t,t+1}$ amounts to forecasting $\Delta FFR_{t,t+1}^c$ [corr. 0.99]
- $FFR_t^c \approx$ slope w/o risk premium [corr. w/ slope -0.93]
- For robustness, we fix $\hat{\beta} = 1$, and use long-term inflation surveys

$\Delta FFR^c = \Delta FFR$ FFR^c=-slope

Short rate dynamics and expectations

Statistics, but not surveys, tells us that short rate is quite predictable (survey sample 1983-2010):

$$\Delta FFR_{t,t+1} = \alpha_0 + \underbrace{\alpha_1}_{\substack{-0.15 \\ [-1.35]}} FFR^c_t + \underbrace{\alpha_2}_{\substack{-0.60 \\ [-5.02]}} FFR^c_{t-1} + \varepsilon_{t+1}, \quad \bar{R}^2 = 0.46$$

Long-run mean reversion appears not fully subsumed in FFR forecasts:

$$\Delta FFR_{t,t+1} = \alpha_3 + \underbrace{\alpha_4}_{\substack{0.37 \\ [1.92]}} \left[E^s_t(FFR_{t+1}) - FFR_t\right] + \underbrace{\alpha_5}_{\substack{-0.59 \\ [-6.10]}} FFR^c_{t-1} + \varepsilon_{t+1}, \quad \bar{R}^2 = 0.46$$

Lagged slope plays a similar role to FFR^c_{t-1} (though risk premium):

$$\Delta FFR_{t,t+1} = \alpha_6 + \underbrace{\alpha_7}_{\substack{0.32 \\ [1.30]}} \left[E^s_t(FFR_{t+1}) - FFR_t\right] + \underbrace{\alpha_8}_{\substack{0.57 \\ [3.89]}} S_{t-1} + \varepsilon_{t+1}, \quad \bar{R}^2 = 0.31$$

Short rate dynamics and expectations

Statistics, but not surveys, tells us that short rate is quite predictable (survey sample 1983-2010):

$$\Delta FFR_{t,t+1} = \alpha_0 + \underbrace{\alpha_1}_{\substack{-0.15 \\ [-1.35]}} FFR^c_t + \underbrace{\alpha_2}_{\substack{-0.60 \\ [-5.02]}} FFR^c_{t-1} + \varepsilon_{t+1}, \quad \bar{R}^2 = 0.46$$

Long-run mean reversion appears not fully subsumed in FFR forecasts:

$$\Delta FFR_{t,t+1} = \alpha_3 + \underbrace{\alpha_4}_{\substack{0.37 \\ [1.92]}} [E^s_t(FFR_{t+1}) - FFR_t] + \underbrace{\alpha_5}_{\substack{-0.59 \\ [-6.10]}} FFR^c_{t-1} + \varepsilon_{t+1}, \quad \bar{R}^2 = 0.46$$

Lagged slope plays a similar role to FFR^c_{t-1} (though risk premium):

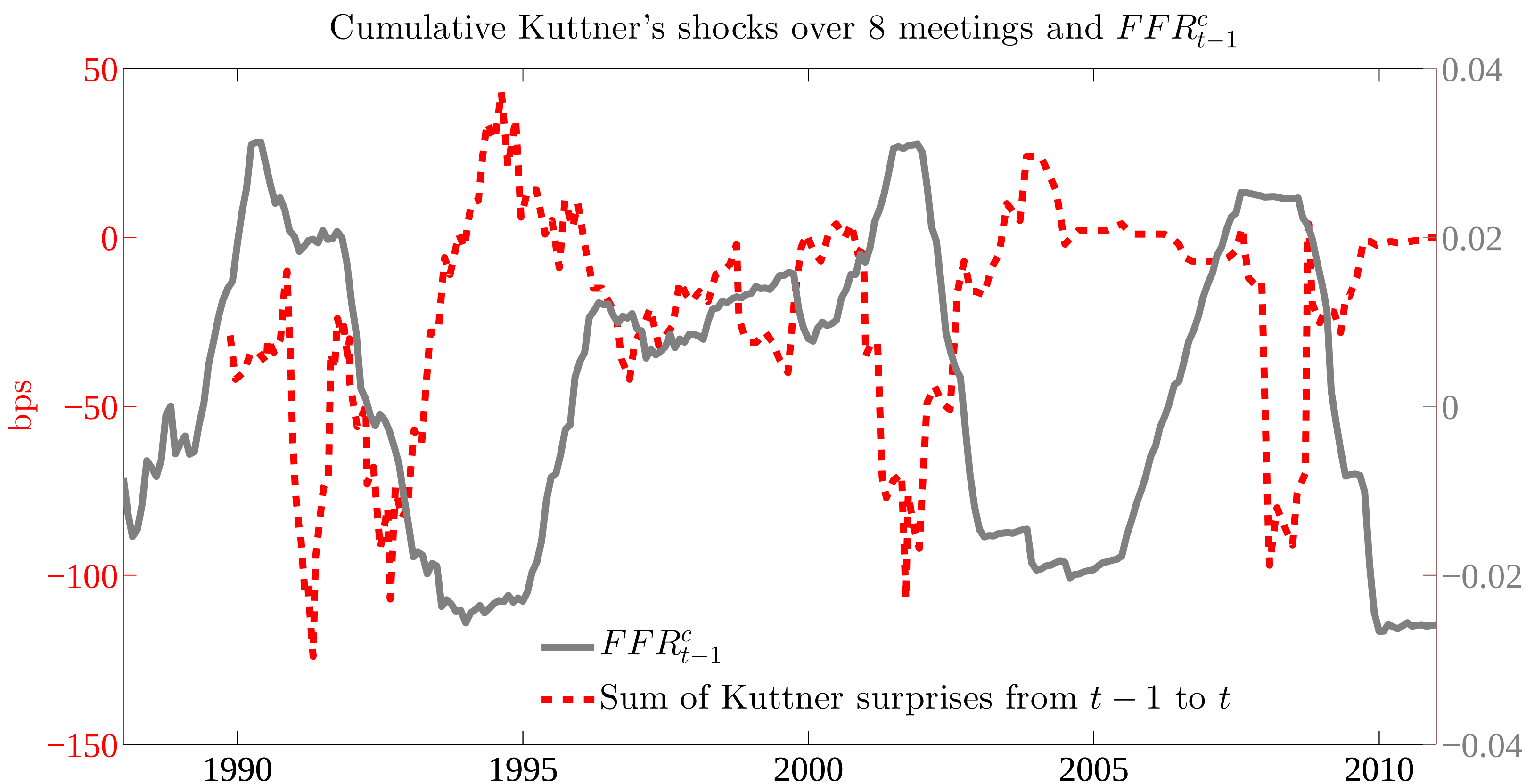
$$\Delta FFR_{t,t+1} = \alpha_6 + \underbrace{\alpha_7}_{\substack{0.32 \\ [1.30]}} [E^s_t(FFR_{t+1}) - FFR_t] + \underbrace{\alpha_8}_{\substack{0.57 \\ [3.89]}} S_{t-1} + \varepsilon_{t+1}, \quad \bar{R}^2 = 0.31$$

Thus, ex-post forecast errors are predictable with lagged information:

$$\dashrightarrow \quad FE^{FFR}_{t,t+1} = \delta_0 + \underbrace{\delta_1}_{\substack{-0.46 \\ [-4.48]}} FFR^c_{t-1} + \varepsilon_{t+1}, \quad \bar{R}^2 = 0.26 \quad \dashleftarrow$$

S_{t-1} explains 15%; FFR^c_{t-1} constructed with inflation surveys explains 25%.

Persistent monetary policy surprises



- Kuttner (2001) surprises available from 1989:12; change in the fed funds futures around FOMC announcement; we sum them up over 8 meetings
- Tight policy in the past $\rightarrow$ more negative surprises going forward as policy eases; suggestive of private sector extrapolating recent experience

A different look at FE predictability

i. Time series: $\Delta FFR_{t-1,t}$

ii. Expectations/ "Cross section": $E_t^s(FFR_{t+1}^c) = E_t^s(FFR_{t+1}) - \tau_t^{CPI}$

No need to estimate proj. coefficient for τ_t^{CPI}; τ_t^{CPI} is real time

A different look at FE predictability

i. Time series: $\Delta FFR_{t-1,t}$

ii. Expectations/ "Cross section": $E_t^s(FFR_{t+1}^c) = E_t^s(FFR_{t+1}) - \tau_t^{CPI}$

No need to estimate proj. coefficient for τ_t^{CPI}; τ_t^{CPI} is real time

To fit the FE, a projection extracts a component orthogonal to t expectations:

$$FE_{t,t+1}^{FFR} = \delta_3 + \underbrace{\delta_4}_{\substack{0.63 \\ [6.5]}} [\Delta FFR_{t-1,t} - E_t^s(FFR_{t+1}^c)] + \varepsilon_{t+1}, \quad \bar{R}^2 = 0.33$$

Similar results using inflation surveys instead of τ^{CPI}; range of $\bar{R}^2$: 20%-25%

A different look at FE predictability

i. Time series: $\Delta FFR_{t-1,t}$
ii. Expectations/ "Cross section": $E_t^s(FFR_{t+1}^c) = E_t^s(FFR_{t+1}) - \tau_t^{CPI}$
No need to estimate proj. coefficient for τ_t^{CPI}; τ_t^{CPI} is real time

To fit the FE, a projection extracts a component orthogonal to t expectations:

$$FE_{t,t+1}^{FFR} = \delta_3 + \underbrace{\delta_4}_{\substack{0.63 \\ [6.5]}} [\Delta FFR_{t-1,t} - E_t^s(FFR_{t+1}^c)] + \varepsilon_{t+1}, \quad \bar{R}^2 = 0.33$$

Similar results using inflation surveys instead of τ^{CPI}; range of $\bar{R}^2$: 20%-25%

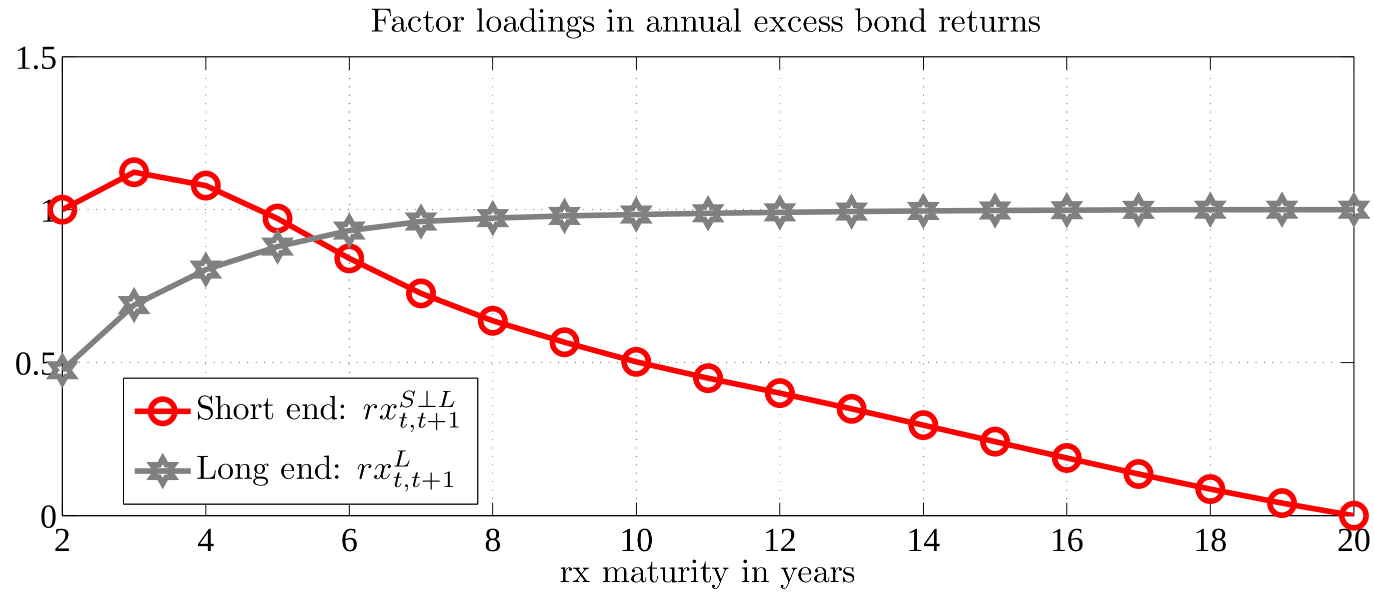
Define: $MP_t^{\perp} = \Delta FFR_{t-1,t} - E_t^s(FFR_{t+1}^c)$

- ☐ Idea that there is persistent information in short rate dynamics that is not impounded into expectations in real time
- ☐ $MP^{\perp}$ is essentially orthogonal to time-t yield curve (proj. on 5 PCs gives $\bar{R}^2 = 10\%$)
- ☐ If expectations ≈ RW, $MP_t^{\perp}$ collapses to $-FFR_{t-1}^c$ [corr=−0.90]
- ☐ An interpretation of an *unspanned short rate factor*

Expected and ex-ante unexpected returns

Factor structure of excess bonds returns

- Bond excess returns move on **two factors** with opposite loadings across maturities; two factors capture $>$ 95% of variation
- Long-maturity component explained well with RP_t; short-maturity component—with lagged short rate information
- Similar in spirit to JPS, JLS who combine macro and yield curve info



Factor structure of excess bonds returns

$$rx^{(n)}_{t,t+1} = \alpha_0 + \alpha_1 RP_t + \alpha_2 FFR^c_{t-1} + \varepsilon_{t+1}$$

	$rx^{(2)}$	$rx^{(3)}$	$rx^{(5)}$	$rx^{(7)}$	$rx^{(10)}$	$rx^{(20)}$
A. $rx^{(n)}_{t,t+1} = \alpha_0 + \alpha_1 RP_t + \varepsilon_{t,t+1}$						
RP_t	0.52	0.56	0.64	0.68	0.72	0.70
	(4.26)	(5.22)	(6.62)	(7.23)	(8.09)	(7.11)
$\bar{R}^2$	**0.26**	0.31	0.41	0.47	0.52	0.49
B. $rx^{(n)}_{t,t+1} = \alpha_0 + \alpha_1 RP_t + \alpha_2 FFR^c_{t-1} + \varepsilon_{t,t+1}$						
RP_t	0.56	0.60	0.67	0.71	0.74	0.71
	(4.57)	(5.80)	(7.14)	(7.54)	(8.13)	(6.77)
FFR^c_{t-1}	**0.49**	0.45	0.34	0.27	0.21	**0.11**
	(4.89)	(4.16)	(3.14)	(2.57)	(2.05)	**(1.11)**
$\bar{R}^2$	**0.50**	0.51	0.52	0.54	0.56	0.50

RP_t is bond risk premium constructed by Cieslak and Povala (2011).

Similarly, lagged slope, S_{t-1}, increases the R^2 to 45% at the short end.

Factors in RX ↷ RX lagged slope ↷ Real time FFR^c_t ↷ Monthly RX ↷

Decomposing realized return on 2-year bond

- Focus on the short end where effect of lags is the strongest: 2-year bond
- Obtain a direct survey-based measure of ex-ante **un**expected returns
- BCFF survey, same panel of forecasters as above, but available over shorter sample 1988–2010
- Decompose the annual return on the 2-year Treasury bond as:

$$rx^{(2)}_{t,t+1} = \underbrace{\left[f^{(2)}_t - E^s_t(y^{(1)}_{t+1})\right]}_{\substack{\text{expected return} \\ E_t(rx^{(2)}_{t,t+1})}} - \underbrace{\left[y^{(1)}_{t+1} - E^s_t(y^{(1)}_{t+1})\right]}_{\substack{\text{unexpected return} \\ U_t(rx^{(2)}_{t,t+1})}}.$$

- Unexpected return comoves strongly with the FFR forecast error:

$$\text{corr}(U_t(rx^{(2)}_{t,t+1}), FE^{FFR}_{t,t+1}) = -0.93$$

Survey RX

Predicting components of realized return on 2-year bond

	(1)	(2)	(3)	(4)	(5)	(6)
	$MP_t^{\perp}$	FFR_{t-1}^c	S_{t-1}	CFNAI$_t$	ΔUnempl$_t$	RP_t
A. Predicting **ex-ante unexpected** return on 2-year bond						
β	-0.60	0.57	-0.48	-0.39	0.42	0.17
	(-5.12)	(4.46)	(-3.75)	(-2.43)	(2.63)	(1.22)
$\bar{R}^2$	0.35	0.32	0.22	0.15	0.18	**0.02**
B. Predicting **expected return** on 2-year bond						
β	-0.05	0.01	-0.14	0.17	-0.05	0.48
	(-0.34)	(0.08)	(-0.77)	(1.49)	(-0.47)	(4.33)
$\bar{R}^2$	0.00	0.00	0.02	0.02	0.00	0.23

Projections of unexpected and expected return on 2-year bond:

Columns (1)-(3): on lagged term structure information

Columns (4)–(5): on real activity proxies as predictors: CFNAI and growth of unemployment

Column (6): on statistical risk premium proxy, RP_t

Available BCFF sample: 1987:12-2010:12

Predicting components of realized return on 2-year bond

	(1)	(2)	(3)	(4)	(5)	(6)
	$MP_t^{\perp}$	FFR^c_{t-1}	S_{t-1}	CFNAI$_t$	ΔUnempl$_t$	RP_t
A. Predicting **ex-ante unexpected** return on 2-year bond						
β	-0.60	0.57	-0.48	-0.39	0.42	0.17
	(-5.12)	(4.46)	(-3.75)	(-2.43)	(2.63)	(1.22)
$\bar{R}^2$	0.35	0.32	0.22	0.15	0.18	**0.02**
B. Predicting **expected return** on 2-year bond						
β	-0.05	0.01	-0.14	0.17	-0.05	0.48
	(-0.34)	(0.08)	(-0.77)	(1.49)	(-0.47)	(4.33)
$\bar{R}^2$	0.00	0.00	0.02	0.02	0.00	0.23

Projections of unexpected and expected return on 2-year bond:

Columns (1)-(3): on lagged term structure information

Columns (4)–(5): on real activity proxies as predictors: CFNAI and growth of unemployment

Column (6): on statistical risk premium proxy, RP_t

Available BCFF sample: 1987:12-2010:12

- FIRE explanation for excess predictability (**H1**: offsetting risk premia and expectations) requires significant relationship between expected returns and predictors ($\neq$ panel B, cols (1)-(5))
- At the short end, survey evidence speaks to $\neq$FIRE story (**H2**), i.e. ex-post predictable but ex-ante unexpected returns (panel A)
- This does not preclude the first effect (**H1**) to take hold at the long end

Offset FIRE

Additional evidence

Long samples, frictions, concerns

Long sample: short rate dynamics pre- and post-Fed

A Consider a simple autoregressive **time series** model for the short rate
[e.g. Modigliani and Sutch (1966), Sargent (1972)]

B Use the **cross-sectional** information (fitted slope $\hat{S}_t$) to predict changes

	A. $\Delta i_{t,t+1} = \alpha_c + \sum_j \alpha_j i_{t-j} + \varepsilon^i_{t+1}$			**B.** $\Delta i_{t,t+1} = \beta_0 + \beta^e \hat{S}_t + \varepsilon^e_{t+1}$		
Sample period	$\bar{R}^2$ lags	Wald pval lags	BIC max.lag (qtrs)	β^e [t-stat]	$\bar{R}^2$ $[\hat{S}_t]$	$\bar{R}^2$ [raw S_t]
1875:3-1913:4	0.40	0.27	–	1.13 [5.70]	0.39	0.35
1914:1-1951:2	0.07	0.20	–	0.28 [1.60]	0.07	0.06
1951:3-1979:2	0.39	0.00	14	0.56 [3.61]	0.17	0.14
1984:1-2011:4	0.41	0.00	16	0.50 [2.65]	0.12	0.09
1951:3-2011:4	0.13	0.00	16	0.26 [1.25]	0.02	0.03

$\hat{S}_t$ is a fitted value from a regression of slope on lags of $i_{t-j} : j \in 0, 1, 2, 4$ years

- ☐ Distant lags double predictability of short rate changes relative to time t information
- ☐ Extra information in the dynamics seems to coincide with an active monetary policy (post-Accord)
- ☐ Clear data limitations: slope does not capture the whole time t information *(see next)*

Short rate dynamics post Accord

- Post Fed-Treasury Accord period: condition on the entire available cross section of yields (PCs); select lags optimally (BIC)

$$\Delta i_{t,t+1} = \beta_0 + \sum_{j=1}^{6} \beta_j PC_t^j + \delta_1 i_{t-L_1} + \delta_2 i_{t-L_2} + \varepsilon_{t+1}$$

Sample period	$\bar{R}^2$ PCs	$\bar{R}^2$ PCs & lags	Wald pval lags	BIC max.lag (qtrs)
1952:3–1979:2	0.08	0.36	0.00	13
1984:1–2011:4	0.37	0.55	0.00	16
1952:3–2011:4	0.18	0.25	0.01	16

- Significant information in lagged short rates beyond time t cross section
- Evidence that lag structure not constant across monetary policy regimes

Which information frictions?

- Noisy and sticky information models imply that forecast errors are predictable with forecast updates (Coibion and Gorodnichenko (2012)):

$$FE^{FFR}_{t,t+h} = \beta_0 + \beta_1 \left[E^s_t(FFR_{t+h}) - E^s_{t-1/4}(FFR_{t+h})\right] + \beta_X \boxed{X_t} + \varepsilon_{t+h}$$

with $\beta_1 > 1$ and $\beta_X = 0$

	$h = 1$Q ahead				$h = 3$Q ahead			
		X_t				X_t		
	Baseline	$MP^{\perp}_t$	FFR^c_{t-1}	S_{t-1}	Baseline	$MP^{\perp}_t$	FFR^c_{t-1}	S_{t-1}
β_1	0.15	0.13	0.11	0.14	0.34	0.26	0.22	0.29
	(6.95)	(5.23)	(3.22)	(5.36)	(2.99)	(2.57)	(1.97)	(2.73)
β_X	–	0.12	-0.12	0.07	–	0.46	-0.44	0.29
	–	(3.18)	(-2.78)	(1.66)	–	(4.08)	(-3.00)	(2.54)
$\bar{R}^2$	0.09	0.15	0.15	0.10	0.08	0.22	0.20	0.13

- Importance of forecast updates subsides with horizon h; role of yield curve lags increases
- Similarly, lagged yield curve predicts unemployment FE beyond forecast updates

FE and macro ↷ Disagreement ↷ Speculative dynamics ↷

Extensions and concerns

We have not settled on a final story, but have documented additional facts:

- **Greenbook** FFR forecasts have similar properties [corr = 88% with BCFF FE at h =4Q]
- **Other macro variables.** Unemployment FE are strongly related to FE^{FFR} [corr = -70%], and also predictable with lagged yield curve info
- **Flows** into money market are high following high FFR_t^c (flat S_t) suggesting extrapolation of recent past
  - Some evidence of market segmentation: speculative positions in Eurodollar futures predict the direction of FEs (Piazzesi and Swanson 2008), no such link in fed funds futures
- **Risk premia.** Could it just be risk premium at the short end of the curve?
  - Survey-based expected returns are uncorrelated with fitted ones from predictive regressions using real activity and uncertainty proxies
  - But indeed, FE of one investor type can be risk premium for someone else
- **Survey samples** are short, and the 1983-2010 period is unique in many ways

Survey vs. statistical premia Tbills

Conclusions

- Based on survey forecasts, a portion of ex-post predictable short rate variation seems not anticipated ex-ante
- Distinguishing these sources of predictability in bond returns is potentially important: different channels/models

Going forward:

- Which model of expectations formation? Learning about time-varying policy rule, natural expectations, other...
- Implications within GE models
- Importance for real effects of monetary policy?