Expected Returns in Treasury Bonds

Anna Cieslak
Kellogg School

Pavol Povala
University or London

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Fernando Tassinari Moraes
PhD Business Economics
Insper Instituto de Ensino e Pesquisa

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Agenda

- Motivation
- Term-Structure Model
- Data
- Results
- Discussion

Motivation

Motivation

- Focus: risk premium in U.S. Treasury bonds
- Yield curve as function of: **inflation expectations** and **maturity-specific interest cycles**
- Extract the risk premium by controlling for the EH term
- Goal: forecast risk premium by **factor cycle**

Term-Structure Model

Term-Structure Model

1) The yield of an n-period nominal Treasury bond:

- Average of future short rates + average one-period risk premium

$$y_t^{(1)} = \frac{1}{n}\left(E_t \sum_{i=0}^{n-1} y_{t+i}^{(1)} + \sum_{i=0}^{n-2} rx_{t+i-1}^{(n-i)}\right) \quad (1)$$

2) Nominal yields are driven by three state variables

- trend inflation: $\tau_t = \mu_\tau + \phi_\tau \tau_{t-1} + \sigma_\tau \varepsilon_t^\tau$ (2)
- the real factor: $r_t = \mu_r + \phi_r r_{t-1} + \sigma_r \varepsilon_t^r$ (3)
- price-of-risk factor: $x_t = \mu_x + \phi_x x_{t-1} + \sigma_x \varepsilon_t^x$ (4)

- By (2) to (4): $F_t = \mu + \Phi F_{t-1} + \Sigma \varepsilon_t$ (5)

3) Nominal one-period interest rate:

- Do not present price-of-risk factor:
- $y_t^{(1)} = \delta_0 + \delta_1^T F_t$ (6)
- $\delta_1 = (\delta_\tau, \delta_r, 0)^T$ (7)

Term-Structure Model

4) Definition of log nominal SDF + no arbitrage (Duffee 2012):

- $m_{t+1} = -y_t^{(1)} - 0.5\Lambda_t^T \Lambda_t - \Lambda_t^T \varepsilon_{t+1}$ (8)

Λ_t is the investor con compensation for facing ε_{t+1}:

- $\Lambda_t = \Sigma^{-1}(\lambda_0 + \Lambda_1 F_t)$ (9)

"Investors require compensation for facing shocks to **trend inflation** and the **real factor**, and that bond risk premiums at all maturities vary with a single factor x_t (**price-of-risk factor**)."

- $\lambda_0 = \begin{bmatrix} \lambda_{0\tau} \\ \lambda_{0r} \\ 0 \end{bmatrix}$ and $\Lambda_1 = \begin{bmatrix} 0 & 0 & \lambda_{\tau x} \\ 0 & 0 & \lambda_{rx} \\ 0 & 0 & 0 \end{bmatrix}$ (10)

Term-Structure Model

5) Putting all together:

- $y_t^{(n)} = -\frac{1}{n}(\mathcal{A}_n + \mathcal{B}_n^T F_t)$

- $\mathcal{B}_n = (\mathcal{B}_n^\tau, \mathcal{B}_n^r, \mathcal{B}_n^x)^T$

- $\mathcal{B}_1 = -\delta_1$

- $\mathcal{B}_n^\tau = -\delta_\tau \frac{1-\phi_\tau^n}{1-\phi_\tau}$

- $\mathcal{B}_n^r = -\delta_r \frac{1-\phi_r^n}{1-\phi_r}$

- $\mathcal{B}_n^x = -\mathcal{B}_{n-1}^\tau \lambda_{\tau x} - \mathcal{B}_{n-1}^r \lambda_{rx} + \mathcal{B}_{n-1}^x \phi_x$

Also define orthogonal component to trend inflation:

- $c_t^{(n)} = \mathcal{B}_n^r r_t + \mathcal{B}_n^x x_t$

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Data

Data

End-of-month constant maturity Treasury (CMT) (FED)

- Nov/1971 to Dez/2011
- 6 month and 1, 2, 3, 5, 7, 10 and 20 years of maturity
- Bootstrap for zero-coupon yield curve

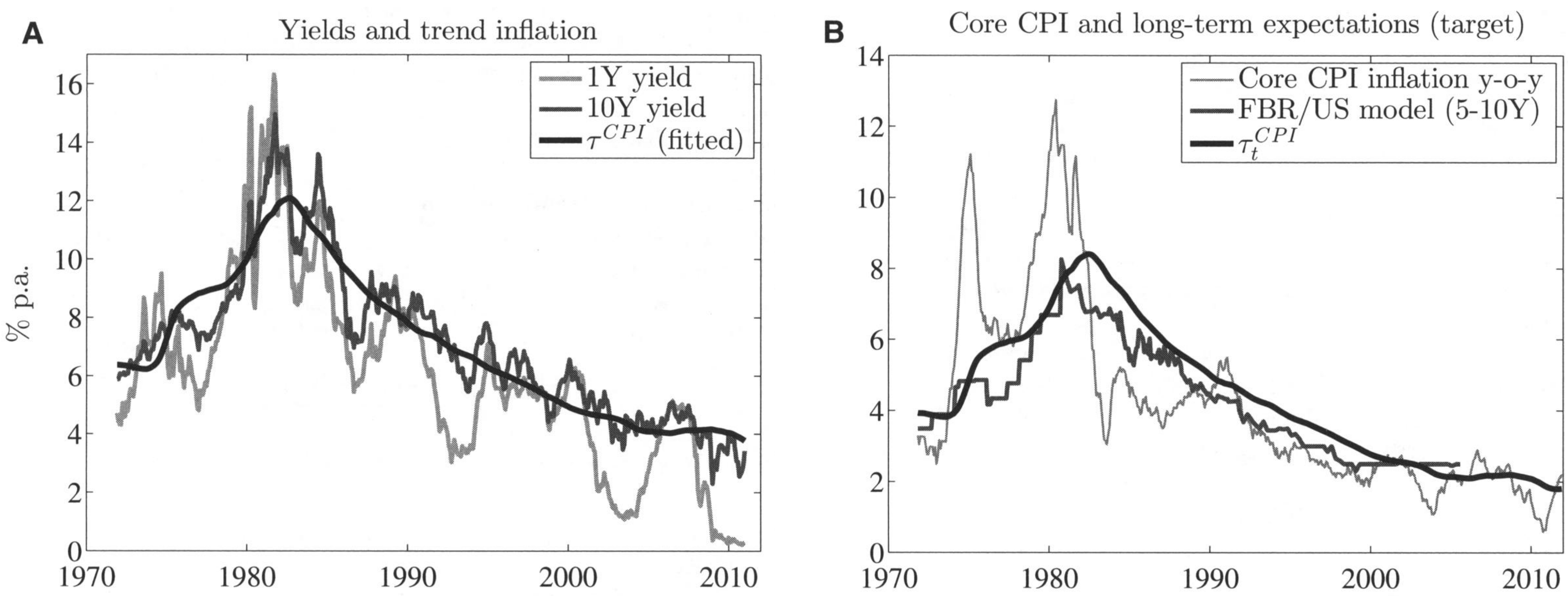
Inflation

- End-of-month public data
- CPI

Data

Measuring trend inflation:

- $\tau_t = (1-v)\sum_{i=0}^{t-1} v^i \pi_{t-i}$



Data

Measuring orthogonal component to trend inflation ($c_t^{(n)}$)

A. Regressions of yields on τ_t^{CPI}: $y_t^{(n)} = a_n + b_n^\tau \tau_t^{CPI} + \varepsilon_t$

	$y_t^{(1)}$	$y_t^{(2)}$	$y_t^{(5)}$	$y_t^{(7)}$	$y_t^{(10)}$	$y_t^{(15)}$	$y_t^{(20)}$
$a_n \times 100$	−0.35	−0.12	0.68	1.09	1.43	1.97	2.51
	(−0.45)	(−0.17)	(1.47)	(2.87)	(4.66)	(7.44)	(8.91)
b_n^τ	1.43	1.44	1.37	1.32	1.28	1.20	1.13
	(8.64)	(10.31)	(13.06)	(14.58)	(15.98)	(16.26)	(14.93)
$\bar{R}^2$	0.71	0.77	0.84	0.86	0.88	0.89	0.86

B. Properties of cycles $c_t^{(n)} = y_t^{(n)} - \widehat{a}_n - \widehat{b}_n^\tau \tau_t^{CPI}$

	$c_t^{(1)}$	$c_t^{(2)}$	$c_t^{(5)}$	$c_t^{(7)}$	$c_t^{(10)}$	$c_t^{(15)}$	$c_t^{(20)}$
Correlations							
$c_t^{(1)}$	1.00	.	.	.	.	.	.
$c_t^{(2)}$	0.98	1.00	.	.	.	.	.
$c_t^{(5)}$	0.89	0.95	1.00	.	.	.	.
$c_t^{(7)}$	0.82	0.90	0.99	1.00	.	.	.
$c_t^{(10)}$	0.74	0.83	0.95	0.98	1.00	.	.
$c_t^{(15)}$	0.62	0.72	0.88	0.93	0.98	1.00	.
$c_t^{(20)}$	0.55	0.64	0.80	0.87	0.90	0.96	1.00
St.dev. × 100	1.74	1.50	1.14	1.01	0.88	0.81	0.85
Half-life (months)	15.07	14.00	10.75	9.81	9.34	8.72	8.83
Yields:	$y_t^{(1)}$	$y_t^{(2)}$	$y_t^{(5)}$	$y_t^{(7)}$	$y_t^{(10)}$	$y_t^{(15)}$	$y_t^{(20)}$
St.dev. × 100	3.23	3.13	2.84	2.71	2.59	2.43	2.31
Half-life (months)	67.18	84.35	92.34	97.61	107.75	98.71	79.53

Panel A presents univariate regressions of yields on τ_t^{CPI}, as in Equation (20). T-statistics in parentheses are Newey–West adjusted with 18 lags. Panel B reports unconditional correlations between cycles of different maturities, as well as standard deviations and half-lives of cycles. The half-life is defined as $\ln(0.5)/\ln(|\psi_z|)$, where ψ_z is the estimated first-order autoregressive coefficient for a given variable z_t.

Construction by resides:

$c_t^{(n)}$ is orthogonal to inflation term

Results

Results (inflation and orthogonal factors)

Dependent variable: average of excess returns across maturities

- $\overline{rx}_{t+1} = \frac{1}{19}\sum_{k=2}^{20} \frac{rx_{t+1}^{(k)}}{k}$
- Where one-period risk premium is given by:
- $rx_{t+1}^{(n)} = -(n-1)y_{t+1}^{(n-1)} + ny_1^{(n)} - y_t^{(1)}$

A. Predictive regressions

Regressors →	Yields only (1)	Yields+τ^{CPI} (2)	$\bar{y}_t, y_t^{(1)}$ (3)	$\bar{y}_t, y_t^{(1)}, \tau_t^{CPI}$ (4)	$\bar{c}_t, c_t^{(1)}$ (5)
Regression coefficients					
$y^{(1)}$ or $c^{(1)}$	−1.13	−1.09	−0.42	−0.61	−0.61
	(−1.87)	(−1.64)	(−2.48)	(−3.70)	(−3.67)
$y^{(2)}$ or $c^{(2)}$	0.73	1.06	–	–	–
	(0.62)	(0.81)	–	–	–
$y^{(5)}$ or $c^{(5)}$	0.83	−0.71	–	–	–
	(0.99)	(−0.10)	–	–	–
$y^{(7)}$ or $c^{(7)}$	0.40	0.51	–	–	–
	(0.15)	(0.32)	–	–	–
$y^{(10)}$ or $c^{(10)}$	−1.15	0.84	–	–	–
	(−1.69)	(0.43)	–	–	–
$y^{(20)}$ or $c^{(20)}$	0.37	0.21	–	–	–
	(0.94)	(0.49)	–	–	–
τ^{CPI}	–	−1.02	–	−1.01	–
	–	(−4.30)	–	(−4.65)	–
$\bar{y}$ or $\bar{c}$	–	–	0.54	1.45	1.45
	–	–	(2.47)	(5.03)	(5.03)
Regression statistics					
$\bar{R}^2$	0.24	0.54	0.18	0.53	0.53
Wald test	12.34	34.86	6.46	28.61	25.34
pval	0.05	0.00	0.04	0.00	0.00
Rel.prob. (BIC)	0	3e-4	0	0.57	1.00

EH components:
Necessary to a high R2
“risk premium and the EH components could load on the same set of factors”

EH component:
Necessary to a high R2

Hence: τ_t and $c_t^{(1)}$
“can be used to control for the expectations hypothesis term and than neither of them forecasts future returns”

Results (past interest rates)

Predictive regressions with trends based on smoothed past interest rates

$\tau_t^{yld} \rightarrow$	Smoothed 1-year yield, $y_t^{(1)}$				Smoothed 5-year yield, $y_t^{(5)}$			
	DMA (1)	MA_{12} (2)	MA_{24} (3)	MA_{60} (4)	DMA (5)	MA_{12} (6)	MA_{24} (7)	MA_{60} (8)
A. Smoothed past interest rates: $\overline{rx}_{t+1} = d_0 + d_1 y_t^{(1)} + d_2 \bar{y}_t + d_3 \tau_t^{yld} + \varepsilon_{t+1}$								
$y^{(1)}$	−0.48	−0.42	−0.43	−0.51	−0.47	−0.42	−0.47	−0.51
	(−2.94)	(−2.19)	(−2.26)	(−3.20)	(−2.84)	(−2.51)	(−2.98)	(−3.25)
$\bar{y}_t$	0.72	0.54	0.53	0.75	0.66	0.56	0.76	0.78
	(2.52)	(2.38)	(2.28)	(2.56)	(2.38)	(2.10)	(2.81)	(2.59)
τ_t^{yld}	−0.16	−0.00	0.01	−0.16	−0.11	−0.02	−0.18	−0.18
	(−0.94)	(0.03)	(0.09)	(−0.88)	(−0.70)	(−0.11)	(−0.99)	(−0.93)
$\bar{R}^2$	0.20	0.18	0.18	0.21	0.19	0.18	0.20	0.21
B. Smoothed past interest rate plus trend inflation: $\overline{rx}_{t+1} = d_0 + d_1 y_t^{(1)} + d_2 \bar{y}_t + d_3 \tau_t^{yld} + d_4 \tau_t^{CPI} + \varepsilon_{t+1}$								
$y^{(1)}$	−0.58	−0.74	−0.73	−0.56	−0.58	−0.64	−0.58	−0.56
	(−3.51)	(−3.55)	(−3.68)	(−3.33)	(−3.46)	(−3.84)	(−3.66)	(−3.34)
$\bar{y}_t$	1.39	1.42	1.35	1.37	1.39	1.17	1.29	1.37
	(4.37)	(5.04)	(4.90)	(4.24)	(4.36)	(4.02)	(4.44)	(4.25)
τ_t^{yld}	0.11	0.21	0.29	0.13	0.09	0.44	0.30	0.14
	(0.75)	(1.26)	(1.59)	(0.64)	(0.63)	(1.74)	(1.45)	(0.67)
τ_t^{CPI}	−1.09	−1.08	−1.13	−1.11	−1.07	−1.21	−1.24	−1.13
	(−4.81)	(−4.62)	(−4.75)	(−4.51)	(−4.94)	(−4.82)	(−4.40)	(−4.42)
$\bar{R}^2$	0.54	0.55	0.57	0.54	0.54	0.59	0.57	0.54

Table 3 presents predictive regressions of $\overline{rx}_{t+1}$ on $y_t^{(1)}$, $\bar{y}_t$, τ_t^{yld} (smoothed past interest rate), and τ_t^{CPI}. In the columns we consider different ways of smoothing the past interest rates: either 1-year yield (Columns (1)–(4)) or 5-year yield (Columns (5)–(8)). Columns labeled DMA apply the discounted moving average in Equation (19) with the same parameters as for inflation. Columns MA_{12}, MA_{24}, and MA_{60} use smoothed past interest rates with a simple moving average over the window of 12, 24, and 60 months, respectively. Reverse regression t-statistics are in parentheses.

Past interest rates are insignificant to explain the average risk premium

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Results (single return-forecasting factor)

- Cochrane and Piazzesi (2005):"show that a single forecasting factor, a fitted value from projecting $\overline{rx}_{t+1}$ on a set of time-t forward rates, captures the variation in expected bond excess returns across different maturities."
- Cycle factor: $\widehat{cf}_t = \hat{\gamma}_0 + \hat{\gamma}_1 c_t^{(1)} + \hat{\gamma}_1 \bar{c}_t$

Predicting returns with the cycle factor

	$rx^{(2)}$	$rx^{(5)}$	$rx^{(7)}$	$rx^{(10)}$	$rx^{(15)}$	$rx^{(20)}$
A. Cycle factor						
$rx_{t+1}^{(n)} = \beta_0 + \beta_1 \widehat{cf}_t + \varepsilon_{t+1}^{(n)}$, where $\widehat{cf}_t = \hat{\gamma}_0 + \hat{\gamma}_1 c_t^{(1)} + \hat{\gamma}_2 \bar{c}_t$						
$\widehat{cf}_t$	0.62	0.68	0.70	0.73	0.74	0.72
	(3.80)	(4.64)	(4.92)	(5.16)	(5.26)	(5.06)
t-stat (SS,[5%,95%])	[1.31,4.27]	[2.05,4.91]	[2.38,5.16]	[2.56,5.38]	[2.72,5.47]	[2.66, 5.30]
$\bar{R}^2$	0.38	0.46	0.49	0.53	0.54	0.51
$\Delta\bar{R}^2$	0.02	0.01	0.01	0.01	0.01	0.04
B. Maturity-specific cycles						
B1. $rx_{t+1}^{(n)} = \alpha_0 + \alpha_1 c_t^{(1)} + \alpha_2 c_t^{(n)} + \varepsilon_{t+1}$						
$c_t^{(1)}$	−1.60	−0.93	−0.72	−0.54	−0.39	−0.31
	(−2.82)	(−3.67)	(−3.77)	(−3.71)	(−3.07)	(−2.55)
$c_t^{(n)}$	1.95	1.63	1.52	1.43	1.27	1.11
	(3.26)	(4.73)	(5.16)	(5.29)	(5.10)	(4.88)
$\bar{R}^2$	0.33	0.46	0.51	0.53	0.52	0.50
B2. $rx_{t+1}^{(n)} = \alpha_0 + \alpha_1 c_t^{(n)} + \varepsilon_{t+1}$						
$c_t^{(n)}$	0.13	0.36	0.49	0.63	0.76	0.76
	(2.24)	(2.94)	(3.34)	(3.57)	(3.77)	(3.88)
$\bar{R}^2$	0.04	0.11	0.16	0.23	0.30	0.34

Panel A shows the predictability of individual bond excess returns achieved with the cycle factor. The cycle factor $\widehat{cf}_t$ is defined in Equation (27). The row denoted "t-stat (SS,[5%,95%])" summarizes the small sample distributions of the reverse regression t-statistics obtained with nonparametric block bootstrap. Row $\Delta\bar{R}^2$ reports the difference in $\bar{R}^2$ between yields-plus-τ_t^{CPI} Regression (23) and the single-factor regression. Panel B presents regressions of individual excess returns on cycles of a given maturity. T-statistics in parentheses are obtained with the reverse regression delta method.

Good job

"cycles contain not only the term premium but also the EH component, which we have shown to be uncorrelated with the premium"

Indication of:
"cycles with different maturities do not move on a single factor"

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Results (Predicting short-rate change)

- If τ_t and $y_t^{(1)}$ capture the EH term in the yield curve, they should predict future short rates.

C. Trend inflation and 1-period cycle

	$\Delta y^{(1)}_{t,t+h}=\alpha_0+\alpha_1 y_t^{(1)}+\alpha_2\tau_t^{CPI}+\varepsilon_{t,t+h}$				$\Delta y^{(1)}_{t,t+h}=\alpha_0+\alpha_1 c_t^{(1)}+\varepsilon_{t,t+h}$			
h years	1	2	3	4	1	2	3	4
const. × 100	−0.25	−0.39	−0.31	0.04	−0.12	−0.24	−0.36	−0.45
	(−0.39)	(−0.33)	(−0.19)	(0.02)	(−0.41)	(−0.42)	(−0.42)	(−0.41)
$y_t^{(1)}$	−0.40	−0.90	−1.25	−1.39	–	–	–	–
	(−2.08)	(−2.87)	(−3.49)	(−3.91)	–	–	–	–
τ_t^{CPI}	0.57	1.25	1.68	1.78	–	–	–	–
	(2.80)	(3.41)	(3.30)	(2.66)	–	–	–	–
$c_t^{(1)}$	–	–	–	–	−0.40	−0.90	−1.24	−1.37
	–	–	–	–	(−2.09)	(−2.87)	(−3.47)	(−3.84)
$\bar{R}^2$	0.15	0.34	0.46	0.48	0.15	0.34	0.46	0.47
pval Wald	0.02	0.00	0.00	0.00	–	–	–	–

Table 5 presents the predictability of future changes in the 1-year yield, $\Delta y^{(1)}_{t,t+h}=y^{(1)}_{t+h}-y^{(1)}_t$, for horizons h from 1 to 4 years ahead. In Panel B (without dummy) and C, rows "pval Wald" report p-values for a Wald test that regression coefficients (excluding constant) are jointly equal to zero; the p-value in panel B (with dummy) is for a Wald test that all regression coefficients (including constant) are zero. The dummy variable D_{81} in panel B takes value of one up till August 1981 and zero afterwards following Fama (2006). T-statistics (in parentheses) and Wald tests are obtained with reverse regressions.

Significant variation in the short-rate expectations due to business cycle frequency that is uncorrected with the trend inflation

Good job compering Fama and Bliss (1987)

Results (putting all together)

- $y_t^{(n)} = A_n + B_n^{\tau}\tau_t + B_n^{r}c_t^{(1)} + B_n^{x}\widehat{cf}_t + e_t^{(n)}$
- Explain 99,7% on average of the yields variation
- τ_t captures 86,5%

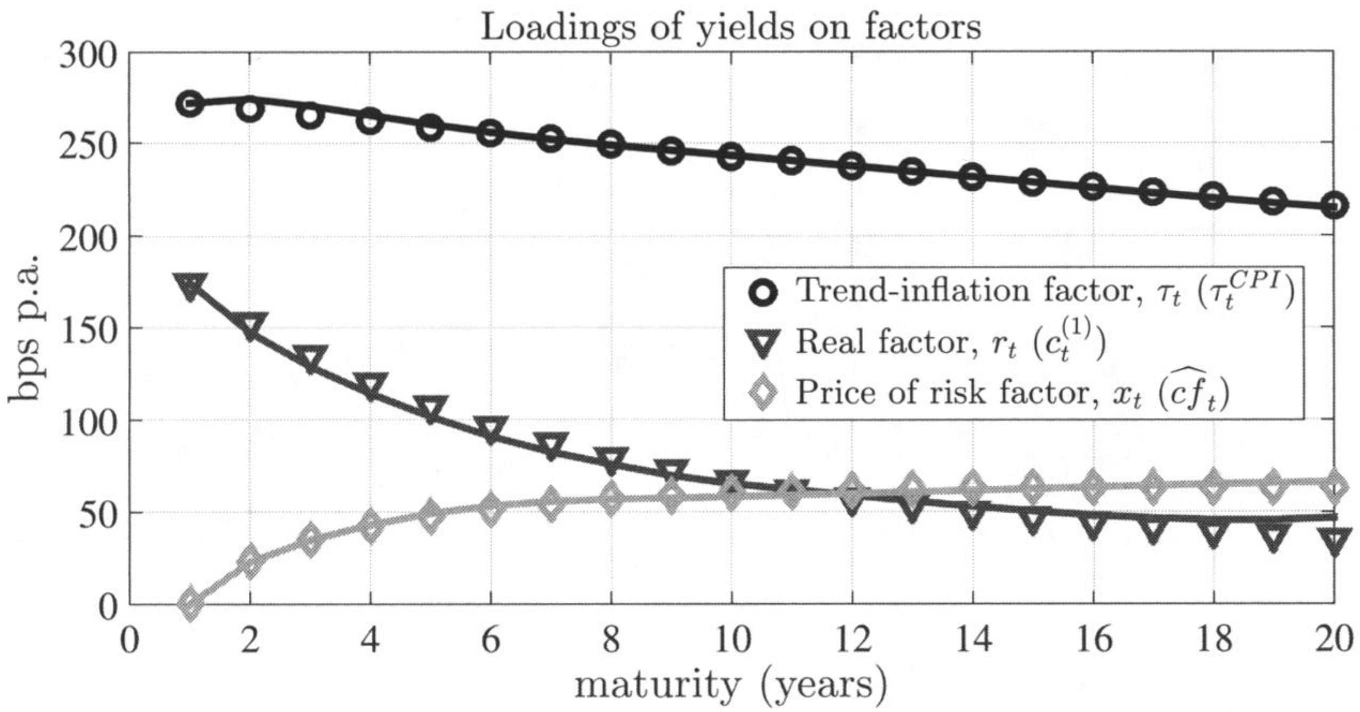

Figure 4
Loadings of yields on factors: regressions vs. affine model

The solid lines present the loadings of yields on observable factors $\tilde{F}_t = \left(\tau_t^{CPI}, c_t^{(1)}, \widehat{cf}_t\right)'$ obtained from Regression (30). The markers present the loadings obtained from the affine model given in Equation (17) for factors $F_t = (\tau_t, r_t, x_t)'$. The parameters of the affine model are calibrated by minimizing the sum of squared distances between the loadings from the regression and from the affine model, see Equations (31)–(32).

Results (Cochrane-Piazzesi factor)

Bivariate predictive regressions with the CP and the cycle factor

A. CMT zero-coupon yields

	$rx^{(2)}$	$rx^{(5)}$	$rx^{(7)}$	$rx^{(10)}$	$rx^{(15)}$	$rx^{(20)}$
CP_t	−0.01	−0.05	−0.02	−0.03	0.00	0.07
	(−0.88)	(−0.41)	(−0.23)	(−0.18)	(0.03)	(0.36)
$\widehat{cf}_t$	0.63	0.71	0.72	0.75	0.74	0.67
	(3.55)	(3.84)	(3.93)	(4.05)	(3.99)	(3.63)
$\bar{R}^2$ (CP + $\widehat{cf}$)	0.38	0.46	0.49	0.53	0.54	0.51
R^2 from univariate regressions:						
R^2 (CP)	0.17	0.19	0.22	0.22	0.25	0.27
R^2 ($\widehat{cf}$)	0.38	0.46	0.49	0.53	0.54	0.51

B. Fama–Bliss zero-coupon yields

	$rx^{(2)}$	$rx^{(3)}$	$rx^{(4)}$	$rx^{(5)}$
CP_t	0.07	0.09	0.13	0.08
	(−0.28)	(0.09)	(0.37)	(0.22)
$\widehat{cf}_t$	0.56	0.56	0.56	0.59
	(4.02)	(4.21)	(4.36)	(4.51)
$\bar{R}^2$ (CP + $\widehat{cf}$)	0.36	0.39	0.41	0.41
R^2 from univariate regressions:				
R^2 (CP)	0.17	0.19	0.22	0.20
R^2 ($\widehat{cf}$)	0.36	0.38	0.41	0.41

Table 8 reports the results from bivariate predictive regressions of bond excess returns with the CP factor and the $\widehat{cf}$ factor as regressors: $rx_{t+1}^{(n)} = \alpha + \beta_1 CP_t + \beta_2 \widehat{cf}_t + \varepsilon_{t+1}$. The last two rows of each panel provide the predictive R^2 from univariate regressions using either the CP factor or the $\widehat{cf}$ factor as the regressor. Panel A uses CMT-based zero-coupon yields (forwards) with maturities of 1, 2, 5, 7, 10, and 20 years, to construct $\widehat{cf}_t$ and $CP_t = \hat{\gamma}'\mathbf{f}_t$ factors, as in Equations (27) and (35), respectively. Analogously, Panel B uses Fama-Bliss zero-coupon yields with maturities from 1 through 5 years to construct the forecasting factors. Reverse regression delta method t-statistics are in parentheses. All variables are standardized.

CP_t becomes insignificant in the presence of cf

cf_t does a better job

Results (Out-of-sample predictability)

Table 9

Out-of-sample tests

Test	$rx^{(2)}$	$rx^{(5)}$	$rx^{(7)}$	$rx^{(10)}$	$rx^{(15)}$	$rx^{(20)}$
A. Out-of-sample period: 1978–2011						
(1) ENC-NEW	139.69	146.19	157.23	176.97	176.40	157.61
(2) Bootstrap 95% CV	75.99	61.93	60.60	57.37	57.62	57.55
(3) MSE(6 cyc)/MSE(6 fwd)	0.70	0.63	0.60	0.56	0.56	0.62
(4) MSE(2 cyc)/MSE(6 fwd)	0.66	0.57	0.55	0.50	0.50	0.63
(5) R^2_{oos}(6 cyc)	0.10	0.19	0.26	0.30	0.31	0.31
(6) R^2_{oos}(2 cyc)	0.16	0.27	0.33	0.38	0.38	0.30
(7) R^2_{oos}(6 fwd)	−0.29	−0.28	−0.23	−0.25	−0.24	−0.12
(8) R^2_{oos}(fwd-spot spread)	0.10	0.09	0.07	0.08	0.09	0.09
B. Out-of-sample period: 1985–2011						
(1) ENC-NEW	116.49	115.58	127.23	145.34	146.33	134.47
(2) Bootstrap 95% CV	48.52	39.18	39.04	39.81	41.76	44.06
(3) MSE(6 cyc)/MSE(6 fwd)	0.69	0.64	0.62	0.60	0.62	0.67
(4) MSE(2 cyc)/MSE(6 fwd)	0.59	0.52	0.52	0.50	0.52	0.59
(5) R^2_{oos}(6 cyc)	−0.08	0.16	0.25	0.30	0.31	0.31
(6) R^2_{oos}(2 cyc)	0.08	0.31	0.37	0.42	0.42	0.39
(7) R^2_{oos}(6 fwd)	−0.55	−0.31	−0.20	−0.17	−0.11	−0.04
(8) R^2_{oos}(fwd-spot spread)	0.07	0.07	0.05	0.08	0.09	0.10
C. Out-of-sample period: 1995–2011						
(1) ENC-NEW	61.65	57.88	66.75	81.24	86.43	81.53
(2) Bootstrap 95% CV	22.28	23.11	25.34	24.53	27.28	36.22
(3) MSE(6 cyc)/MSE(6 fwd)	0.67	0.64	0.59	0.52	0.50	0.54
(4) MSE(2 cyc)/MSE(6 fwd)	0.46	0.46	0.42	0.41	0.38	0.33
(5) R^2_{oos}(6 cyc)	−0.58	−0.26	−0.16	−0.03	0.01	−0.12
(6) R^2_{oos}(2 cyc)	−0.09	0.10	0.17	0.20	0.26	0.32
(7) R^2_{oos}(6 fwd)	−1.37	−0.97	−0.97	−0.97	−0.97	−1.07
(8) R^2_{oos}(fwd-spot spread)	−0.19	−0.06	−0.09	−0.06	−0.06	−0.06

2 cyc model ($c_t^{(1)}$ and $\bar{c}_t$) outperforms 6cyc and 6 fwd models

Discussion

Discussion

- Decompose yield curve into: EH + risk premium terms

- Yield curve as function of: τ_t and $c_t^{(1)}$

- τ_t and $c_t^{(1)}$ "can be used to control for the expectations hypothesis term and than neither of them forecasts future returns"

- Construction of cycle factor: $\widehat{cf}_t = \hat{\gamma}_0 + \hat{\gamma}_1 c_t^{(1)} + \hat{\gamma}_1 \bar{c}_t$

- $\widehat{cf}_t$ "forecasts bond excess returns across the entire maturity spectrum, both in and out of sample, subsuming other standard bond predictors used in the literature such as the term spread or the linear combination of forward rates."