21 Week 8. Term structure I Expectations Hypothesis and Bond Risk Premia – Overheads

1. Definitions

2. Expectation hypothesis – 3 statements.

3. Bond risk premia (how expectations fails) – Fama/Bliss; Cochrane/Piazzesi.

4. FX risk premia. Links between regressions and portfolios; factors (Lustig/Roussanov/Verdelhan)

21.1 Definitions

1. *Discount (zero-coupon) bond*: Promise to pay $1 at time $t + n$.

2. *Price*

   \[ P_t^{(n)} = \text{price of } n \text{ year discount bond at time } t \]

   Example. \( P_t^{(2)} = 0.9 \iff 10\% \text{ interest rate} \)

   \( p_t^{(n)} = \text{log price of } n\text{-year discount bond at time } t. \)

   Example: \( \ln(0.9) = -0.10536 \approx -0.1 \) or “10% discount

3. *Yield*.

   (a) Definition (words) *What constant discount rate would make sense of the bond price, if we knew the future for sure and there were no default?*

   (b) For discount bonds,

   \[ P_t^{(n)} = \frac{1}{Y_t^{(n)}} \implies Y_t^{(n)} = \left[ P_t^{(n)} \right]^{-\frac{1}{n}}; \]

   \[ y_t^{(n)} = -\frac{1}{n} p_t^{(n)}. \]

   Example: \( p_t^{(2)} = -0.1 \rightarrow y_t^{(2)} = 0.1 \cdot 0.05, \text{ “5% discount per year.”} \)

   (c) Yield \( \neq \text{return!} \)
4. Forward rate.

(a) Definition: The rate at which you can contract today to borrow from time \( t + n - 1 \) and pay back at time \( t + n \).

\[
F_t^{(n)} = F_t^{(n-1-n)} \equiv \frac{p_t^{(n-1)}}{p_t^{(n)}}
\]

\[
f_t^{(n)} = f_t^{(n-1-n)} \equiv p_t^{(n-1)} - p_t^{(n)}
\]

(c) Example.

\[
p_t^{(3)} = -0.15; \quad p_t^{(2)} = -0.10 \rightarrow f_t^{(2-3)} = 0.05 = 5\%
\]

5. Holding period return.

(a) Definition (words). Buy an \( n \)-year bond at time \( t \) and sell it − now an \( n - 1 \) year bond − at time \( t + 1 \).

(b) Definition (equations)

\[
R_{t+1}^{(n)} = \frac{p_{t+1}^{(n-1)}}{p_t^{(n)}}; \quad r_{t+1}^{(n)} \equiv p_{t+1}^{(n-1)} - p_t^{(n)}.
\]

(c) Excess log returns (over the risk free rate)

\[
r_{x_{t+1}}^{(n)} \equiv r_{t+1}^{(n)} - y_t^{(1)}
\]

6.

Coupon bond price \( t = p_t^{(1)} \times CF_1 + p_t^{(2)} \times CF_2 + ... \)

7. Summary:

\[
p_t^{(n)} = \log(F_t^{(n)}) \text{ e.g. } -0.1
\]

\[
y_t^{(n)} = \frac{1}{n} p_t^{(n)}
\]

\[
f_t^{(n)} = p_t^{(n-1)} - p_t^{(n)}
\]

\[
r_t^{(n)} = p_{t+1}^{(n-1)} - p_t^{(n)}
\]

\[
r_{x_{t+1}}^{(n)} = r_{t+1}^{(n)} - y_t^{(1)}.
\]

21.2 Expectations hypothesis
2. Why are yields different for bonds with different maturity? Three equivalent statements:

(a) *Long maturity yield = average of expected future short rates (plus risk premium)*
(b) *Forward rate = expected future spot rate (plus risk premium)*
(c) *Expected holding period returns should be equal across maturities (plus risk premium)*

3. Big picture
Hold long term for one period
Hold N period zero
Roll over 1 period bonds
Forward rate
Hold N period zero
Short rate
Roll over 1 period bonds
Spot rate

(a) \(0\) to \(N\):

Buy \(N\) year zero
\[ r_{0 \rightarrow N} = -p^{(N)} = Ny^{(N)} \]
\[ y^{(N)}_0 = \frac{1}{N} E \left( y^{(1)}_0 + y^{(1)}_1 + y^{(1)}_2 + \ldots + y^{(1)}_{N-1} \right) \] (+risk premium)

(b) \(N-1\) to \(N\):

lock in = \(E\) (wait and use spot) (+risk premium)
\[ f^{(N)}_t = E_t \left[ y^{(1)}_{t+N-1} \right] \] (+risk premium)

(c) \(0\) to \(1\):

hold \(N\) period bond 1 year = hold 1 period bond for 1 year
\[ E_t \left[ r^{(N)}_{t \rightarrow t+1} \right] = E_t \left[ r^{(1)}_{t \rightarrow t+1} \right] = y^{(1)}_t \] (+risk premium)

4. Example:
5. Exchange rates. Realized return = foreign interest + exchange rate depreciation

\[ r_{t-t+1}^{US} = r_{t-t+1}^{Euro} + s_t - s_{t+1} \]

Expectations hypothesis:

\[ r_t^{US} = r_t^{Euro} + s_t - E_t(s_{t+1}) \]

(a) Expected return is the same, so *Us Rate* = *Foreign rate* + expected depreciation of dollar

(b) Interest spread = expected depreciation

\[ E_t(s_{t+1}) - s_t = r_t^{US} - r_t^{Euro} \]

(c) Forward rate = expected spot rate. (Left, expectations. Right, arbitrage)

\[ E_t(s_{t+1}) - s_t = f_t - s_t = r_t^{US} - r_t^{Euro} \]

### 21.3 Risk premia

1. What risk premium do we expect? Which end of these ways to get money from x to y is riskier?

   **Summary:** *The sign of risk premium can go either way; it depends on investor’s horizon relative to supply of bonds, and whether real interest rates or inflation are the source of interest rate risk.*

2. Theory II: as always,

\[ E_t(R_t^{e+1}) = \text{cov}_t(R_t^{e+1}, m_{t+1}) = \gamma t \text{cov}_t(R_t^{e}, \Delta e_{t+1}) \]

   Do interest rate surprises come in good times or bad times?

3. Terminology: The “strict expectations hypothesis” means no risk premium. The “expectations hypothesis” alone means that the risk premium is small and *constant over time.*

### 21.4 Empirical evaluation of yield curves and risk premia

1. Facts
Yields of 1–5 year zeros and fed funds

Yield spreads $y^{(n)} - y^{(1)}$
(a) In 03-05, expectations seems to work
(b) Risk premium on average?

### Interest rate data 1964:01-2010:09

<table>
<thead>
<tr>
<th>Maturity n</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>$E[y^{(n)}]$</td>
<td>5.95</td>
<td>6.17</td>
<td>6.34</td>
<td>6.49</td>
<td>6.59</td>
</tr>
<tr>
<td>$E[y^{(n)} - y^{(1)}]$</td>
<td>-0.21</td>
<td>0.39</td>
<td>0.54</td>
<td>0.63</td>
<td></td>
</tr>
<tr>
<td>$E[r^{(n)} - r^{(1)}]$</td>
<td>-0.50</td>
<td>0.87</td>
<td>1.13</td>
<td>1.18</td>
<td></td>
</tr>
<tr>
<td>t statistic</td>
<td>(1.83)</td>
<td>(1.74)</td>
<td>(1.63)</td>
<td>(1.39)</td>
<td></td>
</tr>
<tr>
<td>$\sigma[r^{(n)} - r^{(1)}]$</td>
<td>1.84</td>
<td>3.37</td>
<td>4.68</td>
<td>5.73</td>
<td></td>
</tr>
<tr>
<td>“Sharpe”</td>
<td>0.27</td>
<td>0.26</td>
<td>0.24</td>
<td>0.21</td>
<td></td>
</tr>
</tbody>
</table>

### 2. Expectations failures—Fama Bliss. (Updated 1964-2010)

\[
\begin{align*}
\tau x_{t+1}^{(n)} &= a + b \left( f_t^{(n)} - y_t^{(1)} \right) + \varepsilon_{t+1} \\
y_{t+n-1}^{(1)} - y_t^{(1)} &= a + b \left( f_t^{(n)} - y_t^{(1)} \right) + \varepsilon_{t+1}
\end{align*}
\]

<table>
<thead>
<tr>
<th>n</th>
<th>$b$</th>
<th>$\sigma(b)$</th>
<th>$R^2$</th>
<th>$a$</th>
<th>$\sigma(b)$</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>0.83</td>
<td>0.27</td>
<td>0.11</td>
<td>0.17</td>
<td>0.27</td>
<td>0.01</td>
</tr>
<tr>
<td>3</td>
<td>1.14</td>
<td>0.35</td>
<td>0.13</td>
<td>0.53</td>
<td>0.33</td>
<td>0.05</td>
</tr>
<tr>
<td>4</td>
<td>1.38</td>
<td>0.43</td>
<td>0.15</td>
<td>0.84</td>
<td>0.26</td>
<td>0.14</td>
</tr>
<tr>
<td>5</td>
<td>1.05</td>
<td>0.49</td>
<td>0.07</td>
<td>0.92</td>
<td>0.17</td>
<td>0.17</td>
</tr>
</tbody>
</table>

(a) Higher rows do not add up to 1. Why?
3. Q: Why do we run $y_{t+1}^{(1)} - y_t^{(1)}$ on $f_t^{(2)} - y_t^{(1)}$? EH says $f_t^{(1-2)} = E_t \left[y_{t+1}^{(1)}\right]$, so why not run $y_{t+1}^{(1)}$ on $f_t^{(1-2)}$?

4. Interpretation.

(a) Like DP, forecasts returns not $\Delta D$

(b) “Sluggish adjustment.” “Buy Yield”
There are big risk premia and they vary over time.


(a)

<table>
<thead>
<tr>
<th></th>
<th>DM</th>
<th>£</th>
<th>¥</th>
<th>SF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean appreciation</td>
<td>-1.8</td>
<td>3.6</td>
<td>-5.0</td>
<td>-3.0</td>
</tr>
<tr>
<td>Mean interest differential</td>
<td>-3.9</td>
<td>2.1</td>
<td>-3.7</td>
<td>-5.9</td>
</tr>
<tr>
<td>$R^2$</td>
<td>.026</td>
<td>.033</td>
<td>.034</td>
<td>.033</td>
</tr>
<tr>
<td>$b$, 1976-1996</td>
<td>-0.7</td>
<td>-1.8</td>
<td>-2.4</td>
<td>-1.3</td>
</tr>
</tbody>
</table>

$s_{t+1} - s_t = a + b(f_t - s_t) + \varepsilon_{t+1} = a + b(r^f_t - r^d_t) + \varepsilon_{t+1}$

6. Picture: as above for yields.
21.5 Cochrane-Piazzesi update

Bottom line

1. Forecast 1 year horizon returns on treasury bonds, using all forwards

   (a) FB:
   \[ r_{x_{t+1}}^{(n)} = a_n + b_n(f_t^{(n)} - y_t^{(1)}) + \varepsilon_{t+1}^{(n)} \]

   (b) CP:
   \[ r_{x_{t+1}}^{(n)} = a_n + \beta_{n,1}y_t^{(1)} + \beta_{n,2}f_t^{(2)} + \beta_{n,3}f_t^{(3)} + \beta_{n,4}f_t^{(4)} + \beta_{n,5}f_t^{(5)} + \varepsilon_{t+1}^{(n)} \]

2. \( R^2 \) rises up to 44%, up from Fama-Bliss 15%

3. A single “factor” \( \gamma f_t \) forecasts bond returns \( r_{x_{t+1}} \) of all maturities. High expected returns in “bad times.”

4. A tent-shaped factor tells you when to bail out – when rates will rise in an upward-slope environment
Basic regression

Unrestricted

Restricted

\[ r x_{t+1}^{(n)} = a_n + \beta_{n,1} y_t^{(1)} + \beta_{n,2} f_t^{(2)} + \ldots + \beta_{n,5} f_t^{(5)} + \varepsilon_{t+1} \]
A single factor for expected bond returns

\[ r x_{t+1}^{(n)} = b_n \left( \gamma_0 + \gamma_1 y_t^{(1)} + \gamma_2 f_t^{(2)} + ... + \gamma_5 f_t^{(5)} \right) + \varepsilon_{t+1}^{(n)}; \quad \frac{1}{4} \sum_{n=2}^{5} b_n = 1. \]

- Two step estimation; first \( \gamma \) then \( b \).

\[ \bar{r} x_{t+1} = \frac{1}{4} \sum_{n=2}^{5} r x_{t+1}^{(n)} = \gamma_0 + \gamma_1 y_t^{(1)} + \gamma_2 f_t^{(1-2)} + ... + \gamma_5 f_t^{(4-5)} + \varepsilon_{t+1} = \gamma' f_t + \varepsilon_{t+1} \]

Then

\[ r x_{t+1}^{(n)} = b_n (\gamma' f_t) + \varepsilon_{t+1}^{(n)} \]

Results:

Table 1 Estimates of the single-factor model

<table>
<thead>
<tr>
<th>A. Estimates of the return-forecasting factor, ( \bar{r} x_{t+1} = \gamma' f_t + \varepsilon_{t+1} )</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OLS estimates</strong></td>
</tr>
<tr>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>Restricted</td>
</tr>
<tr>
<td>Unrestricted</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>B. Individual-bond regressions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>n</strong></td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>2</td>
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<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>5</td>
</tr>
</tbody>
</table>
More lags

\[
n_{t+1}^{(n)} = a_n + b_n^{(i)} x_{t-i} + \varepsilon_{t+1}^{(n)}
\]

\[
x_{t+1} = a_n + \sum_{i=1}^{3} b_n^{(i)} x_{t-i} + \varepsilon_{t+1}^{(n)}
\]

- Suggests moving averages

\[
x_{t+1} = a + \gamma \left( f_t + f_{t-1} + f_{t-2} + \ldots \right) \varepsilon_{t+1}
\]

<table>
<thead>
<tr>
<th>(k)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>(R^2)</td>
<td>0.35</td>
<td>0.41</td>
<td>0.43</td>
<td>0.44</td>
<td>0.43</td>
</tr>
</tbody>
</table>
Stock Return Forecasts

Table 3. Forecasts of excess stock returns (VWNYSE)

\[ r_{t+1} = a + b x_t + \varepsilon_{t+1} \]

<table>
<thead>
<tr>
<th>( \gamma f )</th>
<th>(t)</th>
<th>( d/p )</th>
<th>(t)</th>
<th>( y^{(5)} - y^{(1)} )</th>
<th>(t)</th>
<th>( R^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.73</td>
<td>(2.20)</td>
<td>3.56</td>
<td>(1.80)</td>
<td>3.29</td>
<td>(1.48)</td>
<td>0.08</td>
</tr>
<tr>
<td>1.87</td>
<td>(2.38)</td>
<td>-0.58</td>
<td>(-0.20)</td>
<td>0.07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.49</td>
<td>(2.17)</td>
<td>2.64</td>
<td>(1.39)</td>
<td>0.10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MA ( \gamma f )</td>
<td>2.11</td>
<td>(3.39)</td>
<td>0.12</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MA ( \gamma f )</td>
<td>2.23</td>
<td>(3.86)</td>
<td>1.95</td>
<td>(1.02)</td>
<td>-1.41</td>
<td>(-0.63)</td>
</tr>
</tbody>
</table>

- Coefficient is about right.
- Does better than D/P and spread; Drives out spread; Survives with D/P
- A common term risk premium in stocks, bonds! Reassurance on fads & measurement errors.
- A common factor across stocks, bonds, fx?
History

- Consistent in many episodes
- $\gamma'f$ and slope are correlated. Both show a rising yield curve but no rate rise
- $\gamma'f$ improvement in many episodes. $\gamma'f$ says get out in 1984, 1987, 1994, 2004. What’s the signal...?
• Green: CP say go. Red: FB say go, CP say no.
• Tent-shaped coefficients interact with tent-shaped forward curve to produce the signal.
• CP: in the past, tent-shape often came with upward slope. Others saw upward slope, thought that was the signal. But an upward slope without a tent does not work. The tent is the real signal.
Regression forecasts $\hat{\gamma}^T f_t$. “Real-time” re-estimates the regression at each $t$ from 1965 to $t$. 
• Point of history, real time and macro: this is the kind of analysis you do to make sure you’re not finding a fish. 1/20 t statistics look good. You need to persuade yourself.
21.5.1 Latest data, and Treasury curves during the crash

Weird FB curves.
Here are the underlying data. In 06 it was all sensible
In Dec 07 things were getting worse. Negative tent predicts bad returns – interest rise – that didn’t happen.

12/08 it’s just a mess. The on the run off the run spread went wild in the crisis.
Failures and spread trades (Optional)

• If the one-factor model is exactly right, then deviations from the single-factor model should not be predictable.

\[ r x_{t+1}^{(2)} - b_2 \tau_{t+1} = a^{(2)} + 0' f_t + \varepsilon_{t+1} = a^{(2)} + 0' y_t + \varepsilon_{t+1} \]

(Why?)

\[ r x_{t+1}^{(2)} = \alpha^{(2)} + b_2 (\gamma' f_t) + \varepsilon_{t+1}^{(2)} \]

\[ \tau_{t+1} = \alpha + \gamma' f_t + \varepsilon_{t+1} \]

multiply the second by \( b_2 \) and subtract.)

Table 7. Forecasting the failures of the single-factor model

A. Coefficients and t-statistics

<table>
<thead>
<tr>
<th>Left hand var.</th>
<th>Constant</th>
<th>( y_t^{(1)} )</th>
<th>( y_t^{(2)} )</th>
<th>( y_t^{(3)} )</th>
<th>( y_t^{(4)} )</th>
<th>( y_t^{(5)} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( r x_{t+1}^{(2)} - b_2 \tau_{t+1} )</td>
<td>-0.11</td>
<td>-0.20</td>
<td><strong>0.80</strong></td>
<td>-0.30</td>
<td>-0.66</td>
<td>0.40</td>
</tr>
<tr>
<td>(t-stat)</td>
<td>(-0.75)</td>
<td>(-1.43)</td>
<td>(2.19)</td>
<td>(-0.90)</td>
<td>(-1.94)</td>
<td>(1.68)</td>
</tr>
<tr>
<td>( r x_{t+1}^{(3)} - b_3 \tau_{t+1} )</td>
<td>0.14</td>
<td>0.23</td>
<td>-1.28</td>
<td><strong>2.36</strong></td>
<td>-1.01</td>
<td>-0.30</td>
</tr>
<tr>
<td>(t-stat)</td>
<td>(1.62)</td>
<td>(2.22)</td>
<td>(-5.29)</td>
<td>(11.24)</td>
<td>(-4.97)</td>
<td>(-2.26)</td>
</tr>
<tr>
<td>( r x_{t+1}^{(4)} - b_4 \tau_{t+1} )</td>
<td>0.21</td>
<td>0.20</td>
<td>-0.06</td>
<td>-1.18</td>
<td><strong>1.84</strong></td>
<td>-0.82</td>
</tr>
<tr>
<td>(t-stat)</td>
<td>(2.33)</td>
<td>(2.39)</td>
<td>(-0.33)</td>
<td>(-8.45)</td>
<td>(9.13)</td>
<td>(-5.48)</td>
</tr>
<tr>
<td>( r x_{t+1}^{(5)} - b_5 \tau_{t+1} )</td>
<td>-0.24</td>
<td>-0.23</td>
<td>0.55</td>
<td>-0.88</td>
<td>-0.17</td>
<td><strong>0.72</strong></td>
</tr>
<tr>
<td>(t-stat)</td>
<td>(-1.14)</td>
<td>(-1.06)</td>
<td>(1.14)</td>
<td>(-2.01)</td>
<td>(-0.42)</td>
<td>(2.61)</td>
</tr>
</tbody>
</table>

B. Regression statistics

<table>
<thead>
<tr>
<th>Left hand var.</th>
<th>( R^2 )</th>
<th>( \chi^2(5) )</th>
<th>( \sigma(\tilde{y}^\top) )</th>
<th>( \sigma(lhs) )</th>
<th>( \sigma(b^{(n)}\gamma^\top z) )</th>
<th>( \sigma(r x_{t+1}^{(n)}) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( r x_{t+1}^{(2)} - b_2 \tau_{t+1} )</td>
<td>0.15</td>
<td>41</td>
<td>0.17</td>
<td>0.43</td>
<td>1.12</td>
<td>1.93</td>
</tr>
<tr>
<td>( r x_{t+1}^{(3)} - b_3 \tau_{t+1} )</td>
<td>0.37</td>
<td>151</td>
<td>0.21</td>
<td>0.34</td>
<td>2.09</td>
<td>3.53</td>
</tr>
<tr>
<td>( r x_{t+1}^{(4)} - b_4 \tau_{t+1} )</td>
<td>0.33</td>
<td>193</td>
<td>0.18</td>
<td>0.30</td>
<td>2.98</td>
<td>4.90</td>
</tr>
<tr>
<td>( r x_{t+1}^{(5)} - b_5 \tau_{t+1} )</td>
<td>0.12</td>
<td>32</td>
<td>0.21</td>
<td>0.61</td>
<td>3.45</td>
<td>6.00</td>
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</tbody>
</table>
21.6 FX update

1. Jurek Table I,
   (a) Country by country regressions
   (b) “Pooled, FE”
   \[ s_{t+1}^i - s_t^i = a_t + b(f_t^i - s_t^i) + \varepsilon_{t+1} \]
   (c) “XS” lets each time have its own intercept,
   \[ s_{t+1}^i - s_t^i = a_t + b(f_t^i - s_t^i) + \varepsilon_{t+1} \]

2. Jurek Table IIB. Carry trade portfolios. A small regression can still mean a big Sharpe ratio

3. Lustig, Roussanov, Verdelhan. Let’s form portfolios like Fama and French!
   (a) Table 1: mean returns etc. by portfolio

4. The “Peso problem” and fat tails. Jurek Figure 1
21.7 Bond expectations / risk premia summary


   (a) Forward rate = expected future spot rate
   (b) Long term bond yield = expected future short yields
      i. You expect to earn the same amount on bonds of any maturity over the next year
   (c) A rising term structure (yield higher with maturity, like right now) implies that interest
      rates will rise in the future, not that you make more money holding long term bonds.

2. Empirical evidence – averages

   (a) On average, the yield curve slopes slightly upwards, and returns are slightly higher on
      long term bonds. But poor Sharpe ratios.

3. Empirical evidence – regressions. Big picture:

   \[ \text{excess return}_{t-t+1} = a + bX_t + \varepsilon_{t+1} \]

   As with stocks, are there times when one kind of bond is expected to do better than another?

4. Fama-Bliss

   (a) Right hand variable: For the \( n \) period bond, use the forward rate \( (n - 1 \rightarrow n) \) less spot
      rate.
   (b) Fact: \( b \approx 1 \). At a one year horizon, a forward rate 1\% higher than the 1 year rate means
      you expect to earn 1\% more on long term bonds.
(c) Bond math: \( f - y \) mechanically means either return or rise in one year yield. At a one year horizon, a forward rate 1% higher than the 1 year rate does not signal a rise in interest rates!

(d) At a 5 year horizon, a forward rate 1% higher than the 1 year rate does signal a 1% rise in interest rates. “Sluggish adjustment” Interest rates are Waiting For Godot.

5. Empirical evidence – Cochrane-Piazzesi

(a) Central innovation – forecast returns with \( X = \text{all forward rates, not just the matched forward spot spread.} \)

(b) A common “factor” (linear combination of yields and forward rates) forecasts bond returns of all maturities. Long bond expected returns move more than short maturity expected returns. (This is the most important finding, and holds even if the \( R^2 \) improvement and tent are not important.)

(c) \( R^2 \) rises to 0.35-0.44 from FB 0.15.

(d) Expected bond returns are high in bad times – until the inevitable rise in interest rates happens. Then you get killed in long term bonds. Watch out!

(e) “Signal” is curvature in the forward rate curve. This is not the usual “curvature” factor in the yield curve – more curved at the long end.

(f) Big question: What the heck is \( \gamma'f \)? What does the tent shape mean?