Quantifying Interest Rate Risk

0. Overview

• Tools and Their Uses

• Price and Yield

• DV01, Duration, and Convexity

• Value-at-Risk

• Active Investment Strategies
1. Examples

- Example 1: Bell Atlantic
  - Long or short (floating rate) debt?
  - Liquidity management
  - Risk exposure
  - Accounting methods
1. Examples (continued)

- Example 2: Banc One
  
  - Measurement of interest-sensitivity
  
  - Regulatory reporting
  
  - Liquidity management
  
  - Risk management and financial engineering
  
  - Accounting methods
1. Examples (continued)

- Example 3: Proprietary Trading at Long-Term Capital

  - Making money
    
    * Spotting good deals
    
    * Taking calculated risks
  
  - Risk assessment
    
    * How much risk does the firm face?
    
    * How much risk does a specific trader or position add?
  
  - Risk management
    
    * Should some or all of the risk be hedged?
    
    * Silber: good traders know what they’re betting on
1. Examples (continued)

- Example 4: Bond Funds

  - Mission:

    * Target specific markets?

    * Target specific maturities?

    * Index or active investing?

  - Risk reporting to customers

  - Risk management
1. Examples (continued)

- Example 5: Dedicated Portfolios
  - Purpose: fund fixed liabilities
  - Example: defined-benefit pensions
  - Objective: minimize cost
  - Approach tied to accounting of liabilities
2. Tools and Their Uses

- Toolkit 1: DV01, duration, and convexity
  - Risk management: approximation based on parallel shifts in yield curve
  - Crude but relatively easy to implement
  - Standard language among practitioners

- Toolkit 2: Statistical risk measures
  - Risk management: variance of portfolio based on variances and covariances of individual positions
  - Greater complexity leads hopefully to greater accuracy
  - Current standard in risk management

- Toolkit 3: State-contingent claims models
  - Standard tool for valuing derivatives
  - Difference from statistical models is an indication that this is an art, not a science

- Remark:
  - We’ll study toolkit 1 in depth, toolkit 2 a little, and toolkit 3 later on
2. Price and Yield

- Price and yield are inversely related:

\[
p(y) = \frac{c_1}{(1 + y/2)} + \frac{c_2}{(1 + y/2)^2} + \cdots + \frac{c_n}{(1 + y/2)^n}
\]

- Long bonds are more sensitive to yield changes than short bonds.
3. **DV01**

- Our task is to produce numbers that quantify our sense that the price-yield relation is “steeper” for long bonds.

- Measure 1 is the DV01: “Dollar Value of an 01” (aka Present Value of a Basis Point or PVBP).

- Definition: DV01 is the decline in price associated with a one basis point increase in yield:

  \[
  DV01 = -\text{Slope of Price-Yield Relation} \times 0.01\% \\
  = -\frac{dp}{dy} \times 0.0001
  \]

- Calculation (direct method):
  
  (a) compute yield associated with (invoice) price
  (b) compute price associated with yield plus 0.01%
  (c) DV01 is difference between prices in (a) and (b)
  (d) NB: This method requires precision in (a)

- Usage:

  \[
  \Delta p \cong -DV01 \times (10000\Delta y)
  \]

  (Approximation good for small changes in \( y \))
3. DV01 (continued)

- Example 1 (2-year 10% bond, spot rates at 10%)
  - Initial values: \( p = 100, \ y = 0.1000 \)
  - At \( y = 0.1001 \) (one bp higher), \( p = 99.9823 \)
  - DV01 = \( 100 - 99.9823 = 0.0177 \)

- Example 2 (5-year 10% bond, spot rates at 10%)
  - Initial values: \( p = 100, \ y = 0.1000 \)
  - At \( y = 0.1001 \) (one bp higher), \( p = 99.9614 \)
  - DV01 = \( 100 - 99.9614 = 0.0386 \)
  - More sensitive than the 2-year bond

- Example 3 (2-year zero, spot rates at 10%)
  - Initial price: \( p = 100/1.05^4 = 82.2702 \)
  - At \( y = 0.1001 \) (one bp higher), \( p = 82.2546 \)
  - DV01 = \( 82.2702 - 82.2546 = 0.0157 \)

- Example 4 (10-year zero, spot rates at 10%)
  - Initial price: \( p = 100/1.05^{20} = 37.6889 \)
  - DV01 = \( 37.6889 - 37.6531 = 0.0359 \)
4. DV01 Formulas

- Formulas that reproduce Bloomberg’s calculation
  
  - Same setup as bond yield calculations:
    
    * Coupon $C$ paid $k$ times per year
    * Fraction $w$ of a period left till next coupon
  
  - Given yield $y$, compute $d = 1/(1 + y/k)$
  
  - Price-yield relation is
    
    $\text{Invoice Price} = d^w \left(\frac{1 - d^n}{1 - d}\right) C + d^{w+n-1} 100$
  
  - Derivative formula:
    
    $$A = \left[ d^{n+1}(w + n - 1) - d^n (w + n) + d(1 - w) + w \right]$$
    $$- \frac{dp}{dy} = \frac{d^{w+1} A}{k(1 - d)^2} \times C + \frac{(w + n - 1)d^{w+n}}{k} \times 100$$
    
    (Sorry, I know how ugly this is.)
  
  - DV01: minus slope times 0.0001 (one bp):
    
    $$\text{DV01} = -\frac{dp}{dy} \times 0.0001$$
4. DV01 Formulas (continued)

- Example 5 (Citicorp 7 1/8s revisited)
  
  - Terms:
    * Semi-annual US corporate $\Rightarrow C = 7.125/2$
    * Settlement 6/16/95, matures 3/15/04
      $\Rightarrow n = 18, w = 0.494$
    * Invoice price = 103.056
    * Yield = 6.929% $\Rightarrow d = 0.966515$

  - DV01 (direct method):
    * Price at $y = 6.939\%$ (+1 bp) is $p = 102.991$
    * DV01 = 103.056 − 102.991 = 0.065

  - DV01 (formula): 0.065

- Remarks
  * The two approaches give slightly different answers
    (the formula is an approximation based on a linear approximation to the price-yield relation)
  * Don’t get bogged down in the math — think of the formula (if you use it) as a useful shortcut.
5. DV01 for Portfolios

Similar methods work for portfolios

- Consider a position with \( x \) units of a bond:
  \[
  \Delta v = x \Delta p \\
  \cong -x \times DV01 \times (10000 \Delta y)
  \]

- Consider a portfolio with positions in two bonds:
  - Portfolio has value
    \[
    v = x_1 p_1 + x_2 p_2
    \]
  - Change in value is
    \[
    \Delta v = x_1 \Delta p_1 + x_2 \Delta p_2 \\
    \cong -x_1 \times DV01_1 \times (10000 \Delta y_1) - x_2 \times DV01_2 \times (10000 \Delta y_2)
    \]

- Consider an arbitrary bond portfolio:
  - Portfolio has value
    \[
    v = \sum_j x_j p_j
    \]
  - Change in value is
    \[
    \Delta v = \sum_j x_j \Delta p_j \\
    \cong -\sum_j x_j \times DV01_j \times (10000 \Delta y_j)
    \]
5. DV01 for Portfolios (continued)

- We define the DV01 of a portfolio as the change in value resulting from equal one basis point declines in all yields (ie, $\Delta y_j = -0.0001$ for all $j$):

\[
DV01 = \sum_j x_j \times DV01_j
\]

- Summary for emphasis: the DV01 for a bunch of positions is the sum of the DV01’s of the individual positions
  - Very helpful, since it’s portfolios we care about
  - Based on equal changes in all yields
  - This is a standard risk management number: How sensitive is the portfolio to general changes in bond yields?

- Example 6: one 2-year bond and three 5-year bonds (examples 1 and 2)

\[
DV01 = 1 \times 0.0177 + 3 \times 0.0386 = 0.1335
\]

In words: if yields rise 1 bp, we lose 13 cents.
6. Application: Yield Spread Trades

- Betting on yield spreads
  - Scenario: Spot rates flat at 10%
  - We expect the yield curve to steepen, but have no view on its level. Specifically, we expect the 10-year spot rate to rise relative to the 2-year.
  - Strategy: buy the 2-year, short the 10-year, in proportions that leave no exposure to overall yield changes

- Using DV01 to construct the trade:
  - We showed earlier that a one basis point rise in yield reduces the price of the 2-year zero by 0.0157 and the 10-year zero by 0.0359 (examples 3 and 4).
  - To eliminate exposure to equal changes in yields:
    \[
    \Delta v = (x_2 \times \text{DV01}_2 + x_{10} \times \text{DV01}_{10}) (10000 \Delta y)
    \]
    \[
    = 0
    \]
  - Hence we buy more of the 2-year than we sell of the 10-year:
    \[
    \frac{x_2}{x_{10}} = -\frac{\text{DV01}_{10}}{\text{DV01}_2} = -\frac{0.0359}{0.0157} = -2.29
    \]
    (the minus sign tells us one is a short position)
  - Remark: 2.29 is sometimes referred to as a **hedge ratio**
7. Duration

- Definition: (modified) duration is the proportional decline in price associated with a unit increase in yield:

\[ D = \frac{-\text{Slope of Price-Yield Relation}}{\text{Price}} = \frac{-dp/\ dy}{p} \]

- Formula with semiannual compounding and even first period:

\[ D = \frac{-dp/\ dy}{p} = (1 + y/2)^{-1} \sum_{j=1}^{n} (j/2) \times w_j \]

with

\[ w_j = \frac{(1 + y/2)^{-j} c_j}{p} \]

- Usage:

\[ \Delta p \approx -p \times D \times \Delta y \]

(Approximation good for small changes in \( y \))

- Remarks:
  - Weight \( w_j \) is fraction of value due to the \( j \)th payment
  - Sum is weighted average life of payments
  - Conveys same information as DV01
7. Duration (continued)

- Example 1 (2-year 10% bond, spot rates at 10%)

Intermediate calculations:

<table>
<thead>
<tr>
<th>Payment (j)</th>
<th>Cash Flow (c_j)</th>
<th>Value</th>
<th>Weight (w_j)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>4.762</td>
<td>0.04762</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>4.535</td>
<td>0.04535</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>4.319</td>
<td>0.04319</td>
</tr>
<tr>
<td>4</td>
<td>105</td>
<td>86.384</td>
<td>0.86384</td>
</tr>
</tbody>
</table>

Duration:

\[ D = (1 + .10/2)^{-1}(0.5 \times 0.04762 + 1.0 \times 0.04535 + 1.5 \times 0.04319 + 2.0 \times 0.86384) \]
\[ = 1.77 \text{ years} \]

If \( y \) rises 100 basis points, price falls 1.77\%.
6. Duration (continued)

- Example 2 (5-year 10% bond, spot rates at 10%)
  \[ D = 3.86. \]

- Example 3 (2-year zero, spot rates at 10%)
  Duration for an \( n \)-period zero is
  \[ D = (1 + .10/2)^{-1}(n/2) \]
  Note the connection between duration and maturity.
  Here \( n = 4 \) and \( D = 1.90 \).

- Example 4 (10-year zero, spot rates at 10%)
  \[ D = (1 + .10/2)^{-1}(20/2) = 9.51. \]
8. Duration Formulas

Reproducing Bloomberg’s calculation

- Duration formula becomes (semiannual compounding)

\[
D \equiv -\frac{dp/dy}{p} = (1 + y/2)^{-1}\sum_{j=1}^{n}[(w + j - 1)/2] \times w_j
\]

with

\[
w_j = \frac{(1 + y/2)^{-w-j+1}c_j}{p}.
\]

- Short cut for coupon bonds:

\[
A = -\frac{n(1 - d) - (1 - d^n)]C}{(1 - d)(1 - d^n)C + (1 - d)^2d^{n-1}100}
\]

\[
D = \frac{d}{k}[(w + n - 1) + A]
\]

where \(k\) is the number of coupons per year, \(C\) is the coupon (not the annual coupon rate!), and \(d = 1/(1 + y/k)\).

- Remarks

  - Don’t ask, it works!
  - Role of \(k\): duration depends on interest rate convention
8. Duration Formulas (continued)

- Example 5 (Citicorp 7 1/8s again)
  - Parameters: $n = 18$, $p$ (invoice price) = 103.056, $w = 0.494$, $y = 6.929\%$
  - Answer: $D = 6.338$ years (less than maturity of 8.75 years)
9. Duration for Portfolios

Similar methods work for portfolios

- Consider an arbitrary portfolio of bonds:
  - Portfolio has value
  \[ v = \sum_j x_j p_j \]
  - Change in value is
  \[ \Delta v = \sum_j x_j \Delta p_j \]
  \[ \approx - \sum_j x_j p_j \times D_j \times \Delta y_j \]
  - Proportional change in value is
  \[ \frac{\Delta v}{v} \approx - \sum_j \left( \frac{x_j p_j}{v} \right) \times D_j \times \Delta y_j \]
  \[ \approx - \sum_j w_j \times D_j \times \Delta y_j \]
  where \( w_j = \frac{x_j p_j}{v} \) is the fraction of value in bond \( j \).

- We define the duration of a portfolio as the proportional change in value resulting from equal changes in all yields (\( \Delta y_j = \Delta y \) all \( j \)):
  \[ D = - \frac{dv/dy}{v} = \sum_j w_j D_j \]
9. Duration for Portfolios (continued)

- Example 6: one 2-year bond and three 5-year bonds (examples 1 and 2)
  - Since prices are equal, value weights are 1/4 and 3/4
  - \( D = 0.25 \times 1.77 + 0.75 \times 3.86 = 3.38 \)

- Example 7: combination of 2- and 10-year zeros with duration equal to the 5-year par bond
  - This kind of position is known as a barbell, since the cash flows have two widely spaced lumps (picture a histogram of the cash flows)
  - If we invest fraction \( w \) in the 2-year, the duration is
    \[
    D = w \times 1.90 + (1 - w) \times 9.51 = 3.86
    \]
  Answer: \( w = 0.742 \).
9. Duration for Portfolios (continued)

- Spread trade for 2- and 10-year zeros
  - Recall: exploit expected yield-curve steepening
  - Durations are 1.90 (2-year) and 9.51 (10-year)
  - Dollar sensitivity is duration times price
  - To eliminate overall sensitivity, set
    \[
    \Delta v = (x_2 p_2 D_2 + x_{10} p_{10} D_{10}) \Delta y, \\
    = 0,
    \]
    which implies
    \[
    \frac{x_2}{x_{10}} = -\frac{p_{10}D_{10}}{p_2D_2} = -\frac{37.69 \times 9.51}{82.27 \times 1.90} = -2.29
    \]
  - Same answer as before: DV01 and duration contain the same information (slope of price-yield relation).
10. Duration: History and Assessment

Duration comes in many flavors:

- Our definition is generally called “modified duration”

- The textbook standard is Macaulay’s duration
  - Differs from ours in lacking the \((1 + y/2)^{-1}\) term:
    \[
    D = - \sum_{j=1}^{n} (j/2) \times w_j
    \]
  - Leads to a closer link between duration and maturity
    (for zeros, they’re the same)
  - Nevertheless, duration is a measure of sensitivity;
    its link with maturity is interesting but incidental
  - Our approach depends on coupon frequency; since large
    \(k\) leads to Macaulay, hard to say the difference matters
  - Frederick Macaulay studied bonds in the 1930s

- Fisher-Weil duration: compute weights with spot rates
  - Makes a lot of sense
  - Used in many risk-management systems
    (RiskMetrics, for example)
  - Rarely makes much difference with bonds
10. Duration: History and Assessment (cont’d)

- Bottom line: duration is an approximation (ditto DV01)
  - Based on parallel shifts of the yield curve
    (presumes all yields change the same amount)
  - Holds over short time intervals
    (otherwise maturity and the price-yield relation change)
  - Holds for small yield changes:
    \[
    \Delta p = -pD
    \]
    \[
    \Rightarrow \quad p - p_0 \approx -p_0 \times D \times (y - y_0)
    \]
11. Convexity

- Convexity measures curvature in the price-yield relation

- Common usage: “callable bonds have negative convexity” (the price-yield relation is concave to the origin)

- Definition (semiannual, full first period):

  \[
  C \equiv \frac{d^2p/dy^2}{p} \\
  = (1 + y/2)^{-2} \sum_{j=1}^{n} \frac{j(j + 1)/4}{\sum_{j} w_j}
  \]

  with

  \[
  w_j = \frac{(1 + y/2)^{-j}c_j}{p}
  \]

- Convexity is
  
  - higher for long bonds
  - higher for coupon bonds
  - higher yet for barbells (highly spread out cash flows)
11. Convexity (continued)

- Example 1 (2-year 10% bond, spot rates at 10%)
  \( C = 4.12 \).

- Example 3 (2-year zero, spot rates at 10%)
  Convexity for an \( n \)-period zero is
  \[
  C = (1 + 0.10/2)^{-2}[n(n + 1)/4],
  \]
  or 4.53 when \( n = 4 \).

- Bloomberg calculations (fractional first period \( w \))

  \[
  C = (1 + y/2)^{-2} \sum_{j=1}^{n} [(j - 1 + w)(j + w)/4] \times w_j
  \]

  with

  \[
  w_j = \frac{(1 + y/2)^{-j+1-w}c_j}{p}
  \]
  (Bloomberg divides this number by 100.)

- There’s a formula for this, but it’s really ugly.

- Example 5 (Citicorp 7 1/8s again)

  Answer: \( C = 51.3 \) (0.513 on Bloomberg)
11. Convexity (continued)

Convexity and returns

- Second-order approximation:

\[
\frac{\Delta p}{p} = -D \Delta y + \frac{1}{2} C (\Delta y)^2
\]

- Other things equal, high \( C \) is good
  ("The benter the better")

- Standard usage: "convexity added 6 bps to returns"
12. Statistical Measures of Interest Sensitivity

- Standard approach to measuring risk in finance:
  standard deviations and correlations of price changes
- Fixed income applications
  - Standard deviations and correlations of yield changes
  - Use DV01 to translate into price changes
  - Bottom line: yield changes not equal
- Statistical properties of monthly changes in spot rates

<table>
<thead>
<tr>
<th></th>
<th>1-Year</th>
<th>3-Year</th>
<th>5-Year</th>
<th>7-Year</th>
<th>10-Year</th>
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<tbody>
<tr>
<td>A. Standard Deviations of Changes (Percent)</td>
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<td>0.441</td>
<td>0.382</td>
<td>0.340</td>
<td>0.309</td>
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<td>B. Correlations of Changes</td>
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<td></td>
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<tr>
<td></td>
<td>1-Year</td>
<td>3-Year</td>
<td>5-Year</td>
<td>7-Year</td>
<td>10-Year</td>
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<td>0.800</td>
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<td>0.923</td>
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<td>0.930</td>
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<td></td>
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<tr>
<td>7-Year</td>
<td>1.000</td>
<td>0.970</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

12. Statistical Measures (continued)

- Examples of yield curve shifts (spot rates)

- Remark: not just parallel shifts!
12. Statistical Measures (continued)

- Typical components of yield curve shifts

- Remarks:
  - Component 1: Roughly parallel, but less at long end
  - Component 2: Twist accounts for 10-15% of variance
  - Bottom line: DV01/duration only approximate
13. More on Statistical Risk Measures

Industry Practice: JP Morgan’s RiskMetrics

- Daily estimates of standard deviations and correlations
  (This is critical: volatility varies dramatically over time)

- Twenty-plus countries, hundreds of markets

- Yield “volatilities” based on proportional changes:

  \[
  \log (y_t/y_{t-1}) \approx \frac{y_t - y_{t-1}}{y_{t-1}}
  \]

- Maturities include 1 day; 1 week; 1, 3, and 6 months
  Others handled by interpolation

- Documentation available on the Web
  (useful but not simple)

- Similar methods in use at most major institutions

- **Situation:** We own $x_5$ units of 5-year notes.

- **Problem:** Short 10-years to minimize risk. How many?

- **Conventional approach:** use DV01’s
  
  - Assume equal yield changes for 5s and 10s
  
  - Zero change in value:
    \[
    \Delta v = (x_5 \times \text{DV01}_5 + x_{10} \times \text{DV01}_{10}) \Delta y \times 10000
    
    = 0
    \]

  - Hedge ratio is
    \[
    \frac{x_{10}}{x_5} = -\frac{\text{DV01}_5}{\text{DV01}_{10}}
    \]
14. Application: Hedging (continued)

- Statistical approach (don’t sweat the details)
  - Notation shortcut: use $\delta$ for DV01
  - Variance of change in value:
    \[
    \sigma^2 = \text{Var}(\Delta v) \\
    = (x_5 \delta_5)^2 \sigma_5^2 + (x_{10} \delta_{10})^2 \sigma_{10}^2 + 2\rho(x_5 \delta_5)(x_{10} \delta_{10})\sigma_5 \sigma_{10}
    \]
    (This is the variance of a sum: $\sigma$’s are standard deviations in bps and $\rho$ is the correlation between the two yields.)

- Choose $x_{10}$ to minimize the variance:
  \[
  \frac{\partial \sigma^2}{\partial x_{10}} = 2x_{10} \delta_{10}^2 \sigma_{10}^2 + 2\rho x_5 \delta_5 \delta_{10} \sigma_5 \sigma_{10} = 0.
  \]

- Hedge ratio:
  \[
  \frac{x_{10}}{x_5} = -\rho \left( \frac{\sigma_5}{\sigma_{10}} \right) \left( \frac{\text{DV01}_5}{\text{DV01}_{10}} \right)
  \]

- Remarks:
  - Last term: the conventional ratio of DV01’s
  - First term: if correlation is low, do less hedging
  - Middle term: correction for different yield volatilities
  - Bottom line: conventional approach different unless $\sigma_5 = \sigma_{10}$ and $\rho = 1$
15. Value-at-Risk

- Compute and report risk to management and shareholders
- Statistical approach (continued)
- Value-at-Risk (VAR) generally defined as $k \times \sigma$
  ($k = 1, k = 2.336$, etc. based on level of confidence)
- Example: portfolio with 1- and 10-year zeros (5 each)
  - The usual 10% flat spot rate curve
  - DV01’s are 0.0086 and 0.0359
  - Std deviations are 54.7 and 30.9 (monthly in bps)
  - Correlation is 0.748
  - Variance of change in value:
    \[
    \sigma^2 = Var(\Delta v) = (x_1 \delta_1)^2 \sigma_1^2 + (x_{10} \delta_{10})^2 \sigma_{10}^2 + 2 \rho(x_1 \delta_1)(x_{10} \delta_{10})\sigma_1 \sigma_{10}
    \]
  - Answer: $\sigma = 7.46$.
  - Translation:
    * Portfolio is worth 641.96
    * One standard deviation is 6.78 (about 1%)
15. Value-at-Risk

- Goldman Sachs: Daily VAR ($m), May 1998

<table>
<thead>
<tr>
<th>Risk category</th>
<th>VAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest rates</td>
<td>33</td>
</tr>
<tr>
<td>Currencies</td>
<td>11</td>
</tr>
<tr>
<td>Equities</td>
<td>22</td>
</tr>
<tr>
<td>Commodities</td>
<td>7</td>
</tr>
<tr>
<td>Diversification</td>
<td>(26)</td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
</tr>
</tbody>
</table>

- Similar table for our example:

<table>
<thead>
<tr>
<th>Asset</th>
<th>VAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-Years</td>
<td>2.35</td>
</tr>
<tr>
<td>10-Years</td>
<td>5.55</td>
</tr>
<tr>
<td>Diversification</td>
<td>(1.12)</td>
</tr>
<tr>
<td>Total</td>
<td>6.78</td>
</tr>
</tbody>
</table>

- Remarks:
  - Individual assets are $|x_j| \times DV01_j \times \sigma_j$
  - Total is less than sum (equal if correlations are one)
  - Diversification is the difference
16. Active Investment Strategies

- Basic investment strategies
  - Indexing: make the market return
  - Exploit arbitrage opportunities
  - Bet on the level of yields
  - Bet on the shape of the yield curve (yield spreads)
  - Bet on credit spreads

- Betting on yields
  - If you expect yields to fall, lengthen duration
  - If you expect yields to rise, shorten duration
  - Modifications typically made with treasuries or futures (lower transactions costs than, say, corporates)
  - Forecasting requires a combination of bond analytics, macroeconomics, and psychology
  - Henry Kaufman made two great calls in the 1980s

- Mutual Funds
  - Prospectuses and reporting standards vague
  - Often benchmarked to indexes (which?)
  - Cross-over investors muddy the water further
17. Interview with Henry Kaufman

- Biographical sketch
  - Started Salomon’s bond research group
  - Legendary interest rate forecaster
  - Picked rate rise in 1981, when most thought the “Volcker shock” of 1979 was over
  - Now runs boutique

- Investment strategy
  - Study macroeconomic fundamentals (chart room)
  - Adjust duration depending on view
  - Adjustment through sale and purchase of treasuries
  - Some foreign bonds
  - No derivatives (except occasional currency hedge)

- Thoughts on modern risk analytics
  - What’s “market value”? 
  - RiskMetrics-like methods look backwards, but history can be a poor guide to the future in financial markets
Summary

- Bond prices fall when yields rise

- Prices of long bonds fall more

- DV01 and duration measure sensitivity to generalized changes in yields — parallel shifts

- Statistical measures are based on historical standard deviations and correlations

- Statistical measures allow different yield changes at different maturities

- Active investment strategies include bets on the level and shape of the yield curve

- Risk measurement and management remains as much art as science