Chapter 10
Risk and Return: Lessons from Market History

Key Concepts and Skills
- Know how to calculate the return on an investment
- Know how to calculate the standard deviation of an investment’s returns
- Understand the historical returns and risks on various types of investments
- Understand the importance of the normal distribution
- Understand the difference between arithmetic and geometric average returns

Chapter Outline
10.1 Returns
10.2 Holding-Period Returns
10.3 Return Statistics
10.4 Average Stock Returns and Risk-Free Returns
10.5 Risk Statistics
10.6 More on Average Returns
10.7 The U.S. Equity Risk Premium: Historical and International Perspectives
10.8 2008: Year of Financial Crisis

Returns
Dollar Return = Dividend + Change in Market Value
percentage return = \[
\frac{\text{dollar return}}{\text{beginning market value}} = \frac{\text{dividend} + \text{change in market value}}{\text{beginning market value}} = \text{dividend yield + capital gains yield}
\]

Returns: Example
- Suppose you bought 100 shares of Wal-Mart (WMT) one year ago today at $45. Over the last year, you received $27 in dividends (27 cents per share × 100 shares). At the end of the year, the stock sells for $48. How did you do?
- You invested $45 × 100 = $4,500. At the end of the year, you have stock worth $4,800 and cash dividends of $27. Your dollar gain was $327 = $27 + ($4,800 – $4,500).
- Your percentage gain for the year is: \[
7.3\% = \frac{327}{4,500}
\]
Returns: Example

Dollar Return:
$327 gain

Percentage Return:
7.3% = \frac{$327}{\$4,500}

Time

0

-\$4,500

1

$27

$300

10.2 Holding Period Return

- The holding period return is the return that an investor would get when holding an investment over a period of \( T \) years, when the return during year \( i \) is given as \( R_i \):

\[
HPR = (1 + R_1) \times (1 + R_2) \times \cdots \times (1 + R_T) - 1
\]

Holding Period Return: Example

- Suppose your investment provides the following returns over a four-year period:

<table>
<thead>
<tr>
<th>Year</th>
<th>Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10%</td>
</tr>
<tr>
<td>2</td>
<td>-5%</td>
</tr>
<tr>
<td>3</td>
<td>20%</td>
</tr>
<tr>
<td>4</td>
<td>15%</td>
</tr>
</tbody>
</table>

Your holding period return = 
\[
= (1 + R_1) \times (1 + R_2) \times (1 + R_3) \times (1 + R_4) - 1
= (1.10) \times (.95) \times (1.20) \times (1.15) - 1
= .4421 = 44.21\%
\]

Historical Returns

- A famous set of studies dealing with rates of returns on common stocks, bonds, and Treasury bills was conducted by Roger Ibbotson and Rex Sinquefield.
- They present year-by-year historical rates of return starting in 1926 for the following five important types of financial instruments in the United States:
  - Large-company Common Stocks
  - Small-company Common Stocks
  - Long-term Corporate Bonds
  - Long-term U.S. Government Bonds
  - U.S. Treasury Bills

10.3 Return Statistics

- The history of capital market returns can be summarized by describing the:
  - average return
    \[
    \bar{R} = \frac{(R_1 + \cdots + R_T)}{T}
    \]
  - the standard deviation of those returns
    \[
    SD = \sqrt{VAR} = \sqrt{\frac{(R_1 - \bar{R})^2 + (R_2 - \bar{R})^2 + \cdots + (R_T - \bar{R})^2}{T-1}}
    \]
  - the frequency distribution of the returns

Historical Returns, 1926-2007

<table>
<thead>
<tr>
<th>Series</th>
<th>Average Annual Return</th>
<th>Standard Deviation</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large Company Stocks</td>
<td>12.3%</td>
<td>20.0%</td>
<td></td>
</tr>
<tr>
<td>Small Company Stocks</td>
<td>17.1%</td>
<td>32.6%</td>
<td></td>
</tr>
<tr>
<td>Long-Term Corporate Bonds</td>
<td>6.2%</td>
<td>8.4%</td>
<td></td>
</tr>
<tr>
<td>Long-Term Government Bonds</td>
<td>5.8%</td>
<td>9.2%</td>
<td></td>
</tr>
<tr>
<td>U.S. Treasury Bills</td>
<td>3.8%</td>
<td>3.1%</td>
<td></td>
</tr>
<tr>
<td>Inflation</td>
<td>3.1%</td>
<td>4.2%</td>
<td></td>
</tr>
</tbody>
</table>

10.4 Average Stock Returns and Risk-Free Returns

- The Risk Premium is the added return (over and above the risk-free rate) resulting from bearing risk.
- One of the most significant observations of stock market data is the long-run excess of stock return over the risk-free return.

The average excess return from large company common stocks for the period 1926 through 2007 was: $8.5\% = 12.3\% - 3.8\%$

The average excess return from small company common stocks for the period 1926 through 2007 was: $13.3\% = 17.1\% - 3.8\%$

The average excess return from long-term corporate bonds for the period 1926 through 2007 was: $2.4\% = 6.2\% - 3.8\%$

10.5 Risk Statistics

- There is no universally agreed-upon definition of risk.
- The measures of risk that we discuss are variance and standard deviation.
  - The standard deviation is the standard statistical measure of the spread of a sample, and it will be the measure we use most of this time.
  - Its interpretation is facilitated by a discussion of the normal distribution.

Normal Distribution

- A large enough sample drawn from a normal distribution looks like a bell-shaped curve.

The probability that a yearly return will fall within 20.0 percent of the mean of 12.3 percent will be approximately 2/3.

Risk Premiums

- Suppose that The Wall Street Journal announced that the current rate for one-year Treasury bills is 2%.
- What is the expected return on the market of small-company stocks?
- Recall that the average excess return on small company common stocks for the period 1926 through 2007 was 13.3%.
- Given a risk-free rate of 2%, we have an expected return on the market of small-company stocks of $15.3\% = 13.3\% + 2\%$
### Example – Return and Variance

<table>
<thead>
<tr>
<th>Year</th>
<th>Actual Return</th>
<th>Average Return</th>
<th>Deviation from the Mean</th>
<th>Squared Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.15</td>
<td>0.105</td>
<td>0.045</td>
<td>0.002025</td>
</tr>
<tr>
<td>2</td>
<td>0.09</td>
<td>0.105</td>
<td>-0.015</td>
<td>0.000225</td>
</tr>
<tr>
<td>3</td>
<td>0.06</td>
<td>0.105</td>
<td>-0.045</td>
<td>0.002025</td>
</tr>
<tr>
<td>4</td>
<td>0.12</td>
<td>0.105</td>
<td>0.015</td>
<td>0.000225</td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td></td>
<td>0.00</td>
<td>0.0045</td>
</tr>
</tbody>
</table>

Variance = 0.0045 / (4-1) = 0.0015  
Standard Deviation = 0.03873

### 10.6 More on Average Returns

- **Arithmetic average** – return earned in an average period over multiple periods
- **Geometric average** – average compound return per period over multiple periods
- The geometric average will be less than the arithmetic average unless all the returns are equal.
- Which is better?
  - The arithmetic average is overly optimistic for long horizons.
  - The geometric average is overly pessimistic for short horizons.

### Geometric Return: Example

Recall our earlier example:

Geometric average return = 

$$\left(1 + R_1\right) \times \left(1 + R_2\right) \times \left(1 + R_3\right) \times \left(1 + R_4\right) = 1.4421 = (1.095844)^4$$

So, our investor made an average of 9.58% per year, realizing a holding period return of 44.21%.

### Geometric Return: Example

Note that the geometric average is not the same as the arithmetic average:

Arithmetic average return = 

$$\frac{R_1 + R_2 + R_3 + R_4}{4} = \frac{10\% - 5\% + 20\% + 15\%}{4} = 10\%$$

### Perspectives on the Equity Risk Premium

Over 1926-2007, the U.S. equity risk premium has been quite large:

- Earlier years (beginning in 1802) provide a smaller estimate at 5.4%.
- Comparable data for 1900 to 2005 put the international equity risk premium at an average of 7.1%, versus 7.4% in the U.S.
- Going forward, an estimate of 7% seems reasonable, although somewhat higher or lower numbers could also be considered rational.

### International Equity Risk Premiums

- See Table 10.4
  - Value of United States Stock is about 45% of world total in 2008
  - No other country exceeds 15%
- See Table 10.5
  - Since 1922, Historical equity risk premiums are 5-10%
  - Ignores “gamblers ruin” and small market issues
2008: Year of Financial Crisis

- Large Stocks (S&P500) lost 37%
- Drop was global
- Not shown, 2009 started bad (down 25% thru March), but ended up 25% for year.

Quick Quiz

- Which of the investments discussed has had the highest average return and risk premium?
- Which of the investments discussed has had the highest standard deviation?
- Why is the normal distribution informative?
- What is the difference between arithmetic and geometric averages?

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