Example I: Who Wants To Be A Millionaire?

• You can retire with One Million Dollars (or more).

• How? Suppose:
  – You invest $300 per month.
  – Your investments earn 9% per year.
  – You decide to take advantage of deferring taxes on your investments.

• It will take you about 36.25 years. Hmm. Too long.
Example II: Who Wants To Be A Millionaire?

• Instead, suppose:
  – You invest $500 per month.
  – Your investments earn 12% per year
  – you decide to take advantage of deferring taxes on your investments

• It will take you 25.5 years.

• Realistic?
  • $250 is about the size of a new car payment, and perhaps your employer will kick in $250 per month
  • Over the last 80 years, the S&P 500 Index return was about 12%

  *Try this calculator: cgi.money.cnn.com/tools/millionaire/millionaire.html*
A Brief History of Risk and Return

• Our goal in this chapter is to see what financial market history can tell us about risk and return.

• There are two key observations:
  – First, there is a substantial reward, on average, for bearing risk.
  – Second, greater risks accompany greater returns.
Dollar Returns

- **Total dollar return** is the return on an investment measured in dollars, accounting for all interim cash flows and capital gains or losses.

- Example:

  \[ \text{Total Dollar Return on a Stock} = \text{Dividend Income} + \text{Capital Gain (or Loss)} \]
Percent Returns

- **Total percent return** is the return on an investment measured as a percentage of the original investment.

- The total percent return is the return for *each dollar* invested.

- Example, you buy a share of stock:

\[
\text{Percent Return on a Stock} = \frac{\text{Dividend Income} + \text{Capital Gain (or Loss)}}{\text{Beginning Stock Price}}
\]

or

\[
\text{Percent Return} = \frac{\text{Total Dollar Return on a Stock}}{\text{Beginning Stock Price (i.e., Beginning Investment)}}
\]
Example: Calculating Total Dollar and Total Percent Returns

• Suppose you invested $1,000 in a stock with a share price of $25.
• After one year, the stock price per share is $35.
• Also, for each share, you received a $2 dividend.

• What was your total dollar return?
  – $1,000 / $25 = 40 shares
  – Capital gain: 40 shares times $10 = $400
  – Dividends: 40 shares times $2 = $80
  – Total Dollar Return is $400 + $80 = $480

• What was your total percent return?
  – Dividend yield = $2 / $25 = 8%
  – Capital gain yield = ($35 – $25) / $25 = 40%
  – Total percentage return = 8% + 40% = 48%

Note that $480 divided by $1000 is 48%.

**Source:** Stocks, Bonds, Bills, and Inflation Yearbook™, Ibbotson Associates, Inc., Chicago (annually updated by Roger G. Ibbotson and Rex Sinquefield). All rights reserved.
Financial Market History

**FIGURE 1.2** Financial Market History

Total return indexes (1801–2001)

- **Stocks**: $8.80 million
- **Bonds**: $13,975
- **Bills**: $4,455
- **Gold**: $14.67 (CPI)
- **CPI**: $14.38 (GOLD)

*Value of a $1 investment*

The Historical Record: Total Returns on Large-Company Stocks.

**FIGURE 1.3** Year-to-Year Total Returns on Large-Company Stocks: 1926–2005

Source: * Stocks, Bonds, Bills, and Inflation Yearbook™, Ibbotson Associates, Inc., Chicago (annually updated by Roger G. Ibbotson and Rex A. Sinquefield). All rights reserved.
The Historical Record: Total Returns on Small-Company Stocks.

**FIGURE 1.4** Year-to-Year Total Returns on Small-Company Stocks: 1926–2005

Source: Stocks, Bonds, Bills, and Inflation Yearbook™, Ibbotson Associates, Inc., Chicago (annually updated by Roger G. Ibbotson and Rex A. Sinquefield). All rights reserved.
The Historical Record: Total Returns on U.S. Bonds.

**FIGURE 1.5** Year-to-Year Total Returns on Bonds and Bills: 1926–2005

*Long-term government bonds*

Return indices, returns, and yields

![Bar chart showing total annual returns (in percent) from 1925 to 2005.](image)
The Historical Record: Total Returns on T-bills.

Source: Stocks, Bonds, Bills, and Inflation Yearbook™, Ibbotson Associates, Inc., Chicago (annually updated by Roger G. Ibbotson and Rex A. Sinquefield). All rights reserved.
The Historical Record:
Inflation.

Figure 1.6: Year-to-Year Inflation: 1926–2005

Inflation
Cumulative index and rates of change

Source: Stocks, Bonds, Bills, and Inflation Yearbook™, Ibbotson Associates, Inc., Chicago (annually updated by Roger G. Ibbotson and Rex A. Sinquefield). All rights reserved.
Historical Average Returns

- A useful number to help us summarize historical financial data is the simple, or arithmetic average.

- Using the data in Table 1.1, if you add up the returns for large-company stocks from 1926 through 2005, you get about 984 percent.

- Because there are 80 returns, the average return is about 12.3%. How do you use this number?

- If you are making a guess about the size of the return for a year selected at random, your best guess is 12.3%.

- The formula for the historical average return is:

  \[
  \text{Historical Average Return} = \frac{\sum_{i=1}^{n} \text{yearly return}}{n}
  \]
Average Annual Returns for Five Portfolios

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td><strong>Using a spreadsheet to calculate average returns and standard deviations</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Looking back in the chapter, the data suggests that the 1990s were one</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>of the best decades for stock market investors. We will find out just how good by</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>calculating the average returns and standard deviations for this period. Here are the</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>year-by-year returns on the large company S&amp;P 500 index:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td><strong>Year</strong></td>
<td><strong>Return(%)</strong></td>
<td><strong>Year</strong></td>
<td><strong>Return(%)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>1990</td>
<td>−3.10</td>
<td>1995</td>
<td>37.58</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>1991</td>
<td>30.46</td>
<td>1996</td>
<td>22.96</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>1992</td>
<td>7.62</td>
<td>1997</td>
<td>33.36</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>1993</td>
<td>10.08</td>
<td>1998</td>
<td>28.58</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>1994</td>
<td>1.32</td>
<td>1999</td>
<td>21.04</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Average return (%):</td>
<td>18.99</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Standard deviation (%):</td>
<td>14.16</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>The formulas we used to do the calculations are just =AVERAGE(C10:C14,E10:E14)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>and =STDEV(C10:C14;E10:E14). Notice that the average return in the 1990s was 18.99</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>percent per year, which is larger than the long-run average of 12 percent. At the same</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>time, the standard deviation, 14.16 percent, was smaller than the 20 percent long-run value.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Average Returns: The First Lesson

- **Risk-free rate**: The rate of return on a riskless, i.e., certain investment.

- **Risk premium**: The extra return on a risky asset over the risk-free rate; i.e., the reward for bearing risk.

- **The First Lesson**: There is a reward, on average, for bearing risk.

- By looking at Table 1.3, we can see the risk premium earned by large-company stocks was 8.5%!
# Average Annual Risk Premiums for Five Portfolios

**TABLE 1.3 Average Annual Returns and Risk Premiums: 1926–2005**

<table>
<thead>
<tr>
<th>Investment</th>
<th>Average Return</th>
<th>Risk Premium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large stocks</td>
<td>12.3%</td>
<td>8.5%</td>
</tr>
<tr>
<td>Small stocks</td>
<td>17.4</td>
<td>13.6</td>
</tr>
<tr>
<td>Long-term corporate bonds</td>
<td>6.2</td>
<td>2.8</td>
</tr>
<tr>
<td>Long-term government bonds</td>
<td>5.8</td>
<td>2.0</td>
</tr>
<tr>
<td>U.S. Treasury bills</td>
<td>3.8</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Source: *Stocks, Bonds, Bills, and Inflation Yearbook™*, Ibbotson Associates, Inc., Chicago (annually updated by Roger G. Ibbotson and Rex A. Sinquefield). All rights reserved.
Why Does a Risk Premium Exist?

- Modern investment theory centers on this question.
- Therefore, we will examine this question many times in the chapters ahead.
- However, we can examine part of this question by looking at the dispersion, or spread, of historical returns.
- We use two statistical concepts to study this dispersion, or variability: variance and standard deviation.
- **The Second Lesson**: The greater the potential reward, the greater the risk.
Return Variability: The Statistical Tools

- The formula for return variance is ("n" is the number of returns):
  \[
  \text{VAR}(R) = \sigma^2 = \frac{\sum_{i=1}^{N} (R_i - \overline{R})^2}{N - 1}
  \]

- Sometimes, it is useful to use the standard deviation, which is related to variance like this:
  \[
  \text{SD}(R) = \sigma = \sqrt{\text{VAR}(R)}
  \]
• **Variance** is a common measure of return dispersion. Sometimes, return dispersion is also called variability.

• **Standard deviation** is the square root of the variance.
  – Sometimes the square root is called volatility.
  – Standard Deviation is handy because it is in the same "units" as the average.

• **Normal distribution**: A symmetric, bell-shaped frequency distribution that can be described with only an average and a standard deviation.

• Does a normal distribution describe asset returns?
Frequency Distribution of Returns on Common Stocks, 1926—2005

Large company stocks

1931 1937 1930 1941 1929 1947 1926 1942 1927 1928 1933

Source: Stocks, Bonds, Bills, and Inflation Yearbook™, Ibbotson Associates, Inc., Chicago (annually updated by Roger G. Ibbotson and Rex A. Sinquefield). All rights reserved.
Example: Calculating Historical Variance and Standard Deviation

- Let’s use data from Table 1.1 for large-company stocks.
- The spreadsheet below shows us how to calculate the average, the variance, and the standard deviation (the long way…).

<table>
<thead>
<tr>
<th>Year</th>
<th>Return</th>
<th>Average Return</th>
<th>Difference: (2) - (3)</th>
<th>Squared: (4) x (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1926</td>
<td>13.75</td>
<td>12.12</td>
<td>1.63</td>
<td>2.66</td>
</tr>
<tr>
<td>1927</td>
<td>35.70</td>
<td>12.12</td>
<td>23.58</td>
<td>556.02</td>
</tr>
<tr>
<td>1928</td>
<td>45.08</td>
<td>12.12</td>
<td>32.96</td>
<td>1086.36</td>
</tr>
<tr>
<td>1929</td>
<td>-8.80</td>
<td>12.12</td>
<td>-20.92</td>
<td>437.65</td>
</tr>
<tr>
<td>1930</td>
<td>-25.13</td>
<td>12.12</td>
<td>-37.25</td>
<td>1387.56</td>
</tr>
<tr>
<td></td>
<td>Sum: 60.60</td>
<td>Sum: 12.12</td>
<td>Sum: 3470.24</td>
<td></td>
</tr>
</tbody>
</table>

Average: 12.12  Variance: 867.56

Standard Deviation: 29.45
Historical Returns, Standard Deviations, and Frequency Distributions: 1926—2005

**FIGURE 1.8**

<table>
<thead>
<tr>
<th>Series</th>
<th>Average return</th>
<th>Standard deviation</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large company stocks</td>
<td>12.3%</td>
<td>20.2%</td>
<td></td>
</tr>
<tr>
<td>Small company stocks</td>
<td>17.4</td>
<td>32.9</td>
<td>*</td>
</tr>
<tr>
<td>Long-term corporate bonds</td>
<td>6.2</td>
<td>8.5</td>
<td></td>
</tr>
<tr>
<td>Long-term government</td>
<td>5.8</td>
<td>9.2</td>
<td></td>
</tr>
<tr>
<td>Intermediate-term government</td>
<td>5.5</td>
<td>5.7</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>4.3</td>
<td></td>
</tr>
</tbody>
</table>

*The 1933 small company stocks total return was 142.9 percent.*

Source: *Stocks, Bonds, Bills, and Inflation Yearbook™*, Ibbotson Associates, Inc., Chicago (annually updated by Roger G. Ibbotson and Rex A. Sinquefield). All rights reserved.
The Normal Distribution and Large Company Stock Returns

FIGURE 1.9 The Normal Distribution: Illustrated Returns Based on the Historical Return and Standard Deviation for a Portfolio of Large Common Stocks
Key facts on Normal Distribution

• The normal distribution is completely described by its mean and standard deviation
• The normal distribution is symmetric
• The standard normal distribution has mean 0 and standard deviation 1.
• The probability of being within 1 standard deviation of the mean is about 2/3
• The probability of being within 2 standard deviations of the mean is about .95
• The probability of being within 3 standard deviations of the mean is about .99
• Real world returns are asymmetric and bounded below by -100%. So normality is only an approximation.
## Top 12 One-Day Percentage Declines in the Dow Jones Industrial Average

*Source: Dow Jones*

<table>
<thead>
<tr>
<th>Date</th>
<th>Percentage Decline</th>
<th>Date</th>
<th>Percentage Decline</th>
</tr>
</thead>
<tbody>
<tr>
<td>December 12, 1914</td>
<td>-24.4%</td>
<td>August 12, 1932</td>
<td>-8.4%</td>
</tr>
<tr>
<td>October 19, 1987</td>
<td>-22.6%</td>
<td>March 14, 1907</td>
<td>-8.3</td>
</tr>
<tr>
<td>October 28, 1929</td>
<td>-12.8%</td>
<td>October 26, 1987</td>
<td>-8.0</td>
</tr>
<tr>
<td>October 29, 1929</td>
<td>-11.7%</td>
<td>July 21, 1933</td>
<td>-7.8</td>
</tr>
<tr>
<td>November 6, 1929</td>
<td>-9.9%</td>
<td>October 18, 1937</td>
<td>-7.7</td>
</tr>
<tr>
<td>December 18, 1899</td>
<td>-8.7%</td>
<td>February 1, 1917</td>
<td>-7.2</td>
</tr>
</tbody>
</table>
Arithmetic Averages versus Geometric Averages

• The arithmetic average return answers the question: “What was your return in an average year over a particular period?”

• The geometric average return answers the question: “What was your average compound return per year over a particular period?”

• When should you use the arithmetic average and when should you use the geometric average?

• First, we need to learn how to calculate a geometric average.
Example: Calculating a Geometric Average Return

- Let’s use the large-company stock data from Table 1.1.

- The spreadsheet below shows us how to calculate the geometric average return.

<table>
<thead>
<tr>
<th>Year</th>
<th>Percent Return</th>
<th>One Plus Return</th>
<th>Compounded Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>1926</td>
<td>13.75</td>
<td>1.1375</td>
<td>1.1375</td>
</tr>
<tr>
<td>1927</td>
<td>35.70</td>
<td>1.3570</td>
<td>1.5436</td>
</tr>
<tr>
<td>1928</td>
<td>45.08</td>
<td>1.4508</td>
<td>2.2394</td>
</tr>
<tr>
<td>1929</td>
<td>-8.80</td>
<td>0.9120</td>
<td>2.0424</td>
</tr>
<tr>
<td>1930</td>
<td>-25.13</td>
<td>0.7487</td>
<td>1.5291</td>
</tr>
</tbody>
</table>

\[(1.5291)^{(1/5)}: \] 1.0887

Geometric Average Return: 8.87%
Arithmetic Averages versus Geometric Averages

- The arithmetic average tells you what you earned in a typical year.
- The geometric average tells you what you actually earned per year on average, compounded annually.
- *When we talk about average returns, we generally are talking about arithmetic average returns.*
- For the purpose of forecasting future returns:
  - The arithmetic average is probably "too high" for long forecasts.
  - The geometric average is probably "too low" for short forecasts.
# Geometric versus Arithmetic Averages

## TABLE 1.4

<table>
<thead>
<tr>
<th>Series</th>
<th>Geometric Mean</th>
<th>Arithmetic Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large-company stocks</td>
<td>10.4%</td>
<td>12.3%</td>
<td>20.2%</td>
</tr>
<tr>
<td>Small-company stocks</td>
<td>12.6</td>
<td>17.4</td>
<td>32.9</td>
</tr>
<tr>
<td>Long-term corporate bonds</td>
<td>5.9</td>
<td>6.2</td>
<td>8.5</td>
</tr>
<tr>
<td>Long-term government bonds</td>
<td>5.5</td>
<td>5.8</td>
<td>9.2</td>
</tr>
<tr>
<td>Intermediate-term government bonds</td>
<td>5.3</td>
<td>5.5</td>
<td>5.7</td>
</tr>
<tr>
<td>U.S. Treasury bills</td>
<td>3.7</td>
<td>3.8</td>
<td>3.1</td>
</tr>
<tr>
<td>Inflation</td>
<td>3.0</td>
<td>3.1</td>
<td>4.3</td>
</tr>
</tbody>
</table>
Blume’s formula

- If the geometric average tends to be too high, and the arithmetic average too low, how can we best estimate returns?
- Blume’s formula gives an unbiased estimate
- Suppose we calculate from N years of data and we wish to forecast future returns over T years. Then forecasted returns $R(T)$ are estimated as:

$$R(T) = \text{geometric mean} \times \frac{(T-1)}{(N-1)} + \text{arithmetic mean} \times \frac{(N-T)}{(N-1)}$$
Risk and Return

- The risk-free rate represents compensation for just waiting.
- Therefore, this is often called the *time value of money*.
- **First Lesson**: If we are willing to bear risk, then we can expect to earn a risk premium, at least on average.
- **Second Lesson**: Further, the more risk we are willing to bear, the greater the expected risk premium.
Historical Risk and Return Trade-Off

**FIGURE 1.10** Risk-Return Trade-Off

The graph illustrates the relationship between average annual return (%) and annual return standard deviation (%). It shows that as the risk (standard deviation) increases, the expected return also increases. The trade-off between risk and return is evident, with T-bills having the lowest risk and return, followed by T-bonds, and then large-company stocks and small-company stocks having progressively higher risk and return.

- **T-bills** have the lowest risk and return.
- **T-bonds** have a slightly higher risk and return than T-bills.
- **Large-company stocks** have a moderate level of risk and return.
- **Small-company stocks** have the highest risk and return, indicating a higher potential for both gain and loss.

This diagram helps in understanding the trade-off that investors face when making investment decisions, balancing the desire for higher returns with the need to manage risk.
A Look Ahead

• This text focuses exclusively on financial assets: stocks, bonds, options, and futures.

• You will learn how to value different assets and make informed, intelligent decisions about the associated risks.

• You will also learn about different trading mechanisms, and the way that different markets function.
Useful Internet Sites

• cgi.money.cnn.com/tools/millionaire/millionaire.html (millionaire link)

• finance.yahoo.com (reference for a terrific financial web site)

• www.globalfindata.com (reference for historical financial market data—not free)

• www.robertniles.com/stats (reference for easy to read statistics review)
Chapter Review, I.

• Returns
  – Dollar Returns
  – Percentage Returns

• The Historical Record
  – A First Look
  – A Longer Range Look
  – A Closer Look

• Average Returns: The First Lesson
  – Calculating Average Returns
  – Average Returns: The Historical Record
  – Risk Premiums
Chapter Review, II.

- **Return Variability: The Second Lesson**
  - Frequency Distributions and Variability
  - The Historical Variance and Standard Deviation
  - The Historical Record
  - Normal Distribution
  - The Second Lesson

- **Arithmetic Returns versus Geometric Returns**

- **The Risk-Return Trade-Off**