Chapter 6 The Trade-Off Between Risk and Return

Chapter Overview

The *What Companies Do* opening feature looks at a report produced by an Australian financial advisory firm – Wealth Foundations. The authors of the report studied a portfolio invested entirely in Australian shares and compared it to a portfolio of international shares. While the portfolio of Australian shares had higher returns, it also had higher standard deviation or volatility. This report supports what finance textbooks have been saying for years – diversification is beneficial to investors.

***What Companies Do* Discussion Question:**

1. What determines whether an investor chooses a high risk or a low risk portfolio? Note that this is an opinion question, and the discussion can bring out factors that might influence this decision. For example, retirees would be expected to have more conservative investments, since they want to preserve capital to use during their retirement. A very wealthy individual might be willing to put some assets in very high risk ventures, knowing that even if this investment lost money, he/she would still have sufficient wealth remaining.
2. Have the students discuss the advantages and disadvantages of ETFs. What about an ETF based on just technology shares? How does this support the idea of the risk/return trade-off?

This chapter discusses:

6-1 Understanding Returns
6-2 The History of Returns (or How to Get Rich Slowly)
6-3 Volatility and Risk
6-4 The Power of Diversification

Technology

1. **Smart Video** quotes Elroy Dimson, London Business School, concerning the equity risk premium – how much stocks are expected to return above the risk-free rate.

2. **Smart Video** quotes Utpal Bhattacharya of Indiana University concerning insider trading. He points out that the cost of equity for companies goes up when insider trading laws are not enforced, because uninformed investors are taking on greater risk. In other words, the absence of enforcement of insider trading laws is a source of systematic risk for investors. Investors demand higher returns, and companies face higher capital costs when they raise money.

3. **Smart Concepts.** See key risk and return concepts explained step by step..

4. **Smart Solutions** shows step-by-step solution to Problem 6-5.

After studying this chapter, you should be able to:

- calculate an investment's total return in dollar or percentage terms, identify the components of the total return and explain why total return is a key metric for assessing an investment's performance
- describe the historical performance of asset classes such as Treasury bills, Treasury bonds and ordinary shares, and articulate the important lessons that history provides
- calculate the standard deviation from a series of historical returns
- distinguish between systematic and unsystematic risk, explain why systematic risk is more closely linked to returns than is unsystematic risk and illustrate how diversification reduces volatility.

Lecture Guide

This chapter details the relationship between risk and return. It looks at individual security risk and portfolio risk and introduces the Capital Asset Pricing Model. This chapter looks at the questions:

- What kinds of risk exist?
- How are they measured?
- What is relevant risk?
- How is risk related to return?

Fig. 6.1 The Trade-off between Risk and Return

6-1 Understanding Returns

The basic relationship between risk and return is that return depends on risk and the greater the risk, the greater the required return. Note the difference between risk and uncertainty. Uncertainty is unquantified risk. If I buy a lottery ticket, I hope I win the lottery. Risk quantifies this uncertainty – I have a 0.00000001 chance of winning the lottery.

One of the main goals in finance is to determine if an investment will be wealth increasing. This chapter provides the framework for making this determination. In the long run, investors will be compensated for the risks they bear.

Risk taking is not necessarily bad – people have different levels of risk aversion. Some people are less risk averse than others, and some people are actually risk lovers (people who go to Las Vegas with the expectation of winning big).

Two of the main functions of a financial manager are determining what assets to buy and how to finance those assets. A manager must be able to assess the assets' risks in order to determine their value. This chapter provides an important piece of the valuation process – determining risk level, which in turn is part of determining the appropriate discount rate at which to value risky assets.

- Student Interaction: Students can be asked about the form of returns from various investments. How do equities provide return? What happens in down markets when expected price appreciation fails to occur? How do bonds, real estate, collectibles, futures, etc. provide value? How certain are returns from each of these investments?

6-1a The Components of Total Return

An investment's total return consists of two components. The first part is the income stream from interest or dividends. The second part is the capital gain or loss. One must remember to focus on the *total return* when evaluating an investment.

6-1b Dollar Returns and Percentage Returns

Return on a stock is the sum of its dividend yield plus its capital gains yield. Dollar returns are simply the income + the capital gain or loss. The concept of return must be divided into these two types – students must understand whether they are dealing with dollar returns or the percentage return of an investment.

- Student Interaction: Ask students which is riskier, a share that pays dividends or a share that does not pay dividends and only has capital gains? Most will say that the capital gains only stock is riskier, since all of its yield is uncertain, whereas the dividend paying share at least has a reasonably certain dividend yield. The yield on an investment is impacted by price. If price increases, yield decreases and vice versa. Suppose a firm has a $1 dividend and a $10 share price. The dividend amounts to 10% of the share's value. Suppose instead the share price was $50. Now the dividend only accounts for 2% of the share's value. A higher price means a lower yield.
- A detailed example can help students see the concepts of returns. Suppose Terrell continued to hold Micro-Orb for an additional year, and then sold the shares for $35 a share and received an additional $1 dividend at the end of year 2. Dollar returns are now:

Year 0	Year 1	Year 2
–$25	$1 dividend	$1 dividend plus $35 share price, a capital gain of $10

The dollar return is $1 in year 1 and $11 in year 2. The per cent return can be calculated using Chapter 3's present value techniques. The IRR of the cash flows above is 22%. Terrell received a 22% return each year.

6.2 The History of Returns: (Or How to Get Rich Slowly)

6-2a Nominal and Real Returns on Shares, Bonds and Bills

Fig. 6.2 The Value of $1 Invested in Shares, Treasury Bonds, and Bills, 1900–2010

Fig. 6.3A The Real Value of $1 invested in US Shares, US Treasury Bonds and US Bills, 1900-2010

Fig. 6.3B The Real Value of $1 invested in Australian Shares, Australian Treasury Bonds and Australian Notes, 1900-2011

6.2b The Risk Dimension

Table 6.1A Percentage Returns on US Bills, US Bonds, and US Stocks, 1900–2010

In most time periods, stocks have outperformed bonds. An exception was during the Depression decade. Bonds have sometimes had negative real returns, which means that bond income has not kept pace with inflation and investors in bonds lost purchasing power in those time periods. A recent study by Wharton professor Jeremy Siegel found that stocks are not as risky when held over the very long term. He looked at 200 years of trading stocks and bonds and found that in the worst 20 year period for stocks, stocks rose 20%. In the worst 20 year period for bonds, bonds lost 60%. So, while bonds are less risky than stocks in the short run, stocks return more over time.

- Student Interaction: Ask students to look at the Table 6.1. Students should make note of how far different securities vary from the mean. Small cap stocks have the widest dispersion from the mean. They provide the highest potential rewards, but also the most risk. US Treasury bills have returned about the same amount as inflation. In other words, if you invested solely in treasury bills, you would have just kept pace with inflation. Also have students examine Table 6.2 and see if the risk premiums meet their preconceived notions of how risky shares, bonds and bills are. Ask the students to look at the difference between shares and bonds fromtoday – what do they notice?

Table 6.1B Percentage Returns on Australian Shares, 1900–2010

- Student Interaction: Ask students to compare Australian and US share performance (comparing Table 6.1A and Table 6.1B).

Fig. 6.4 Nominal Returns on Stocks, Treasury Bonds, and Bills, 1900–2010

Table 6.2 Risk Premiums for US Stocks, US Bonds, and US Bills, 1900–2010

Table 6.3 Australian Asset Class Returns (After Inflation) to December 2011

6.3 Volatility and Risk

6.3a The Distribution of Historical Stock Returns

Take a moment to review the statistical concepts of the bell curve or normal distribution and notice that stocks will follow the normal distribution in the long run.

- Student Interaction: Ask students to examine the data in Figure 6.5. What do they first notice?

Fig. 6.5 Histogram of Nominal Returns on US Equities, 1900–2006

6.3b The Variability of Equity Returns

We can't make decisions about investments by looking at returns alone. We also need to look at the risk of the security. Investors want to know if they are getting a sufficient return for the level of risk of the security. Expected return suggests the level of rewards from an investment. We also want a measure of the riskiness of those rewards. Daily equity returns roughly follow a normal distribution. We can completely describe a normal distribution through mean and standard deviation. Note that to calculate standard deviation, we first square the differences from the mean and then take the square root of those deviations.

- Student Interaction: Ask students why. Most will say that the reason for squaring is to make sure that positive deviations aren't cancelled out by negative deviations. The reason for using standard deviation is that standard deviation gives an answer in per cent, while variance is in per cent squared. Most people understand per cent but not the meaning of per cent squared.

Table 6.4 Estimating the Variance of US Share Returns from 1993-2010

Table 6.5 Average Returns and Standard Deviation for Equities, Bonds, and Bills, (1900–2010)

Fig. 6.6 The Relationship Between Average (Nominal) Return and Standard Deviation for Shares, Treasury Bonds, and Bills, 1900 – 2010

As expected, shares have higher standard deviations than bonds or Treasury securities. But, they also give investors higher returns to compensate for their higher risk. Asset classes that display greater volatility pay higher returns on average.

Over time, there has been a linear relationship between risk and return. Investors appear to be requiring about the same amount of reward to take on an additional unit of risk.

While shares in general consistently return more than bonds which return more than Treasury bills, it is much harder to see a clear relationship between return and standard deviation among individual shares.

6.4 The Power of Diversification

While portfolio risk is the weighted average of the risks of the securities in the portfolio, portfolio variance is not a simple weighted average. One concept that is sometimes difficult for students to understand is that high risk assets can be combined in a portfolio to create a low risk portfolio. This works if security returns move in opposite directions.

Focus on the equation for the variance of a two-asset portfolio. Note that the first two terms must be positive because each variable is squared and a squared number must be positive. In the third term of the equation, 2 is positive, the two standard deviations are positive and the weights are positive. The only term that doesn't have to be positive is the correlation coefficient. When the correlation coefficient is +1, perfect positive correlation, then portfolio variance is at its maximum. If assets are positively correlated, as most are, and have a positive correlation, then portfolio variance will be reduced. If the correlation coefficient is zero, then the third term disappears altogether. If correlation is negative, then an amount is subtracted from portfolio variance. This illustrates how important the correlation coefficient is. It would be possible to create a risk free portfolio.

As you add more securities that are not perfectly positively correlated to a portfolio, you will reduce portfolio risk. It paints a very dramatic picture to show students the equations for variance for a three-asset portfolio (3 variance terms and 6 covariance terms), a four asset portfolio (4 variance terms and 12 covariance terms), a five asset portfolio (5 variance terms and 20 covariance terms), a six asset

portfolio (six variance terms and 30 covariance terms) and a seven asset portfolio (seven variance terms and 42 covariance terms). This shows how exponentially the number of covariance terms is increasing relative to the number of variance terms and how important this is for portfolio risk. Eventually portfolio variance approaches the average covariance of the portfolio. If average portfolio covariance were zero, then the portfolio would be riskless. However, most equities are positively correlated.

This leads to the concept of diversification, the process of reducing risk by developing a portfolio of imperfectly correlated stocks. By adding sufficient stocks to your portfolio, you can diversify away a large part of total risk, leaving only market risk. Note that diversification is more than just spreading risk around. It is actually a way of reducing risk.

Diversification is an old concept. A 1774 document tells a Dutch portfolio manager to hold a portfolio of Russian government bonds, Bank of Vienna bonds, English colonial securities, government loans from Germany and Spanish Canal loans. This created a portfolio with international diversification! Sometimes diversification can be of benefit to investors but is impossible to accomplish. For example, markets of countries at war will have negatively correlated markets. During World War II, the German and French markets were indeed negatively correlated. But it is unlikely that investors could benefit from this – markets were closed, it would have been unpatriotic to own securities of an enemy country and it would have been difficult to accomplish the transactions even if desired.

- Student Interaction: Ask students if diversification is useful for investors or companies or both. Most students will agree that diversification is very useful for individuals. There may be more debate about the usefulness of diversification for companies. Since individuals can diversify easily they will not reward companies that diversify for diversification's sake. If diversification were valuable on its own account, then conglomerates would trade at a premium. Instead, they trade at a discount. There is no value added for a company to diversify unless there are synergies – real cash flow benefits – from the divisions being added.

6.4a Systematic and Unsystematic Risk

Table 6.6 Average Returns and Standard Deviations for 10 Shares from 1993-2010

Figure 6.7 Annual Returns on Coca-Cola and Archer Daniels Midland (ADM)

Figure 6.8 The Relationship Between Portfolio Standard Deviation and the Number of Shares in the Portfolio

- Student Interaction: Students can be asked for examples of systematic risk (inflation, changes in country growth) and unsystematic risk (unions strike, hurricane damage to Florida citrus crops).

Several studies have shown that individuals are not as diversified as they should be. One study found that income from entrepreneurial ventures is highly correlated with the overall market (as evidenced by all the new dot.coms that ran into difficulty when the market declined). Entrepreneurs may find it hard to diversify away all of this risk since so much of their wealth is tied up in the business. Entrepreneurs tend to hold less equity assets than similarly wealthy households, probably due to the higher total risk they face because of their non-diversifiable personal business risk. Even for a non-entrepreneur, it may be difficult to diversify. A person's human capital is tied up in the company and the industry they work in. An employee may also hold large amounts of company shares either because of generous employee purchase plans or share options or grants. A person whose human capital is tied up in a particular business should diversify his or her portfolio into other industries as much as possible.

Another study of brokerage accounts found that investors are not as diversified as they should be. In particular, low income people and people in non-professional jobs tend to have the least diversified portfolios. Younger, more active investors also tend to have under-diversified portfolios, while older and wealthier investors tend to have the most diversified portfolios. Active portfolios, in other words, those

with the most turnover in stocks, had the lowest returns. This study looked at 40,000 portfolios of a large brokerage firm over a five-year period. The study found that 25% of the portfolios at the brokerage contained one share and over 50% contained only three shares or less. About 5-10% of the portfolios contained 10-15 shares.

An investor can also diversify by investing in both shares and bonds. A portfolio with 80% in equities and 20% in bonds gets about 97% of the S&P 500 return with 85% of the risk. A portfolio of 20% in equities and 80% bonds provides 110% of the return of an all bond portfolio with 95% of the risk.

- Student Interaction: Ask students if they will be compensated for all the risk they bear if they hold a single stock portfolio. Most will say no, they will not be compensated. Ask students how difficult or easy it is to diversify. Most will know about mutual funds, which own large numbers of stocks and may require small minimum investments.
- Student Interaction: Ask students if a share can have a high total risk and a low market risk. While most of the time shares with high total risk also have high market risk, there are exceptions. For example, Holly Sugar has high total risk and low market risk. It has high total risk because it depends on an agricultural commodity, which in turn depends on weather and growing conditions. Yet, even in bad times, if the sugar price increases, consumers will still purchase about the same amount of sugar, making Holly Sugar a very low beta company.

International diversification can further reduce portfolio risk. The standard deviations of a portfolio of US stocks only is 5 to 33% higher than the volatility of a globally diversified portfolio. The benefits of international diversification depend on the time period. In the 1990s, US stocks outperformed developed foreign market shares in Europe and Asia. International diversification paid off more in the 1970s when the US was in an extended down market. An investor heavily invested in European and Japanese shares did better in the 1970s.

Despite the benefits of international diversification, most people invest heavily in their domestic securities. For example, Americans' portfolios are about 93% invested in US securities. Japanese investor portfolios are 98% invested in Japanese shares. There is a home bias, in other words, people want to invest in companies they are familiar with. One US study found that in every state except Montana, residents held large amounts of their particular local Bell telephone company stock in their portfolio. In another example, 16% of Coca-Cola stock is held by Georgia residents. Georgia is the home state of Coca-Cola.

It is both harder and easier to diversify internationally. It is easier because there are more vehicles for international diversification: international, regional and country mutual funds, American depository receipts, and multinational corporations. It is harder to diversify internationally because international economies are more correlated today than they have been in the past.

- Research: One study found that the correlations of emerging markets with the US economy were .3 in the late 1970s and .53 in the early 1990s. Some had an even more dramatic increase in correlation. For example, the correlation between Brazil's market and the US market was .09 in the late 1970s and .67 in the early 1990s. The markets of developed countries continued to be highly correlated throughout the time period of the study.

6.4b Risk and Return Revisited

Figure 6.9 Average Return and Standard Deviation for ten Shares, 1993-2010

Figure – Real Equity Returns and Risk Premiums Around the World 1900–2010

Summary

Chapter 6 Resource Articles

'Searching for Perfection,' *Money Management*, 5 May 2011. This article discusses the need for diversification in today's volatile investment climate. It discusses the best way to correlate investments to move in varying directions and the complexities of this in today's difficult market. Very practical article on correlation impacting factors.

'Dangers of Not Diversifying Hit Investors,' *Wall Street Journal*, 15 February 2002. This article points out that investors are not as diversified as they could and should be. Most 401(k) plans offer multiple investing options, but a large percentage of value is in company stock.

'Mutual Fund Trend: Overseas is Less Painful,' *Wall Street Journal*, 20 December 2002. This article looks at the benefits of diversifying internationally. Mutual funds that invested in foreign stocks were down, but now as much as the decline in value in diversified US-only stock funds.

Enrichment Exercises

1. Illustrate the concept of risk aversion using a jar with slips of paper. Tell students you have a jar with 20 pieces of paper. One says 'you win $100' and the other 19 say 'sorry, you lose.' Ask how many students will pay you $10 for the right to draw one slip of paper from the jar. You probably will not get many takers. Then remove 10 slips of paper so you now have one winning slip and 9 losing slips. Ask how many will pay you $10 for this bet. You probably will get some takers. Then remove more slips, and see how many will pay $10 for a one in 5 chance of winning $100 or a 1 in 2 chance of winning. You probably will have the entire class by the time the bet is at 1 in 2 for $10. Tell the students that this illustrates various degrees of risk aversion. Few, if any students were risk lovers, willing to pay $10 for an expectation of $5 (5% x $100). Some were willing to take a fair bet, paying $10 for an expectation of winning $10. More will pay $10 for a 20% chance of winning $100 and just about everyone will see that paying $10 for a $50 expected value is a good deal. This illustrates various degrees of risk aversion – most or all students are risk averse, but some are more risk averse than others.

2. Ask students if the share market and individual shares are more volatile today than in the past. Give them a few minutes to discuss this issue. Most will believe individual shares are more volatile and there may be some debate about whether the market as a whole is more volatile. After the discussion, present information from a recent study by Campbell, Lettau, Malkiel and Xu. This study looked at 9,000 firms from 1962-97. They decomposed the stock into market-wide, industry-wide and firm-specific volatility. They found that while there were periods of increased volatility, for example, during the oil crisis in the 1970s, average market volatility, as measured by standard deviation has remained relatively stable over time – 14% in the 1970s, 16% in the 1980s and 11% in the 1990s. Industry volatility has also remained stable over time. Firm specific volatility, on the other hand, more than doubled from 1962 to 1997, the period of the study. The most volatile shares moved 25% in a single day. Firm-specific risk accounts for a greater percentage of firm total risk. Firm-specific volatility was 65% of total volatility in 1962 and 76% in 1997. Ask students how individual shares can be more volatile, yet not the market as a whole. The answer relates to correlations. If correlations between individual shares have declined, the overall market volatility can remain stable. The study found that individual share correlations declined from 0.28 in the early 1960s to 0.08 in 1997. The benefits of portfolio diversification increase with declining correlations. From 1963 to 1985, a portfolio of 20 shares brought portfolio standard deviation down to 10%, which is considered to represent complete diversification. From 1986 to 1997, a portfolio of 50 shares was needed to achieve a standard deviation of 10%. A University of Nevada study at about the same time found that 100 shares were needed to achieve complete diversification. The University of Nevada study found that the main culprits advocating too few shares for diversification were textbooks, professional journals and the *Wall Street Journal* (which has since printed a story about this study.) Some individuals choose to hold portfolios with a smaller number of shares because it is

difficult to research a large number of shares. Why are individual shares more volatile? Some reasons advanced for this include:

- Conglomerates were more common in the past than today. Conglomerates are naturally diversified and less volatile, representing mini-portfolios of unrelated businesses. Now the emphasis is on focusing on a core business rather than a number of unrelated businesses.
- Large stocks tend to be increasingly held by institutions, investors who tend to behave similarly. Managers tend to buy and sell the same shares at the same time. A related study by Malkiel and Xu found that some shares are more volatile when the proportion of institutional investors is high.
- Day trading, which didn't exist until a few years ago.

Why do investors think the market as a whole is more volatile? Investors should measure percentage movements in equity indices, rather than absolute ones. For example, the largest one day gain, a 500 point gain is not even in the top 35 in terms of percentage moves between 1962 and 1997. In addition, investors may form their opinions about overall market behaviour by looking at movements in individual shares.

Answers to Concept Review Questions

1. The coupon is a dollar return measure that focuses only on the income component – on only one component of total return. The coupon rate and coupon yield are percentage return measures that focus strictly on the income component – once again, they look at only one aspect of total return. The YTM is a percentage return measure that includes both components of return, and therefore is a way of measuring a bond's total return.

2. The total dollar return on the share you bought for $40 is $6 – $4 for the price increase and $2 for the dividend. The total percentage return is 15%; the dividend yield is 15%, and the capital gain is 10%, which sum to the total return of 15%.

3. Investors need to pay attention to both real and nominal returns because, while nominal returns measure the dollar value increase in an investment, only real returns can measure the increase in purchasing power the investment represents over time. If investors care about how much they can buy with the money that they accumulate, then real returns are far more important than nominal returns. Nominal returns are important as well – for example, investors pay taxes based on nominal returns.

4. Examining Figure 6.3A with its logarithmic vertical scale, it appears that stocks performed best from 1920-1930, but bonds performed best in real terms from 2000-2010.

5. Table 6.1A shows that sometimes, though not often, an asset's nominal return may be higher than its real return. When inflation is positive, the nominal return is always higher than the real return. However, if prices are falling rather than rising, we have deflation rather than inflation, and real returns are higher than nominal returns. From Figure 6.2 you can see that there were periods of falling prices in the early 1920s until the mid-1930s. Notice that starting in 1920 and moving forward, the slope of the equity line is steeper in Figure 6.3A than it is in Figure 6.2. This illustrates that during deflation, real returns are higher than nominal returns.

6. A perusal of Figure 6.5 gives us an estimate that stocks earned 20 per cent or more in 43 out of 111 years, suggesting a probability of about 39 per cent.

7. If nominal bond returns approximately follow a normal distribution, 95 per cent of bond returns should fall within two standard deviations of the mean. Using data from Table 6.5, lower endpoint of the range for bond returns is −11.0% (5.6% $-$ 2 $\times$ 8.3%) and the upper endpoint is 22.2% (5.6% + 2 $\times$ 8.3%). Only four years show bond returns that fell outside that range, which is somewhat less

frequent than expected. In addition, we would expect a few years with bond returns above the range and a few years with returns below the range, but all of the years falling outside the range were at the upper end. Very high returns on bonds occur more frequently and very low returns occur less frequently than we'd expect if bond returns were normally distributed.

8. A standard deviation halfway between the standard deviation of shares and bonds would be about 14%. Finding 14% on the horizontal axis of Figure 6.6 and moving up to the trendline, we would predict an average return for this asset class of about 8.5%.

9. Individual assets contain both systematic and unsystematic risk. When we combine these assets in a portfolio, the unsystematic risks cancel out, leaving only the systematic risk. Therefore, a portfolio's standard deviation will be smaller than the standard deviations of the individual assets in the portfolio.

10. Figure 6.8 declines steeply at first and then flattens out because as we add more shares to a portfolio, the unsystematic risks of the individual shares begin to cancel out. This effect is quite pronounced when diversification begins (i.e., when we have two shares rather than one or three shares rather than two). However, as we add more and more shares to the portfolio, the incremental diversification benefit becomes very small. In Figure 6.8 we show that with just 11 shares we can achieve a portfolio that has a standard deviation almost as low as the entire market's standard deviation. Notice that our 11 shares are drawn from several different industries. We are sampling from many different sectors of the economy. Suppose we doubled the size of this portfolio to 22 shares, but we did so by adding one more share from each of the industries already represented. This would provide very little additional diversification.

11. The dots in Figure 6.9 appear to be almost randomly scattered because these dots represent individual shares' risks. The market should reward riskier investments with higher returns, but only if by the term 'riskier' we mean 'systematically riskier.' The unsystematic risk of a given investment doesn't matter because investors can eliminate that risk at virtually no cost by diversifying. Therefore, the market will not reward investors who choose to bear unsystematic risk unnecessarily. In Figure 6.9, the vertical axis measures returns and the horizontal axis measures standard deviation. Because Figure 6.9 is focused on individual shares rather than on portfolios, the risk measure we are plotting includes both systematic and unsystematic risk. This clouds the underlying relationship between risk and return because our horizontal axis is not using a 'clean' risk measure.

Answers to Self-Test Problems

ST6-1. Using Table 6.4, calculate the standard deviation of equity returns from 2006-2010. Over the last five years, were shares more or less volatile than they were over the last eighteen years?

A: The table below illustrates the calculations need to solve this problem. First, calculate the average return. Next, subtract that average from each year's actual return, then square that difference. Add up the squared differences and divide by five to get the variance, and take the square root of the variance to get the standard deviation.

For these years the average return is 6.0%. Subtract this from each year's return, then square the difference and sum up. Dividing the sum of squared differences by 5 gives us the variance ($518.4\%^2$), and taking the square root of that yields the standard deviation of 22.8%%. Returns were a little more volatile from 2006-2010 than they were from 1993-2010.

Year	Return (%)	Return – Average	Squared Difference
2006	15.8	9.84	96.83
2007	5.6	–0.36	0.13
2008	–37.2	–43.16	1862.79
2009	28.5	22.54	508.05
2010	17.1	11.14	124.10
Sum	29.8		2591.90
Average Return (%)	6.0		
Variance			518.4
Standard Dev. (%)			22.8

ST6-2. Table 6.4 shows that the average return on shares from 1993-2010 was 10.3 per cent. Not shown in the table are the average returns on bonds and bills over the same period. The average return on bonds was 10.0 per cent, and for bills the average return was 3.3 per cent. From these figures, recalculate the risk premiums for 1993-2010 and compare recent history to the long-run numbers.

A: From 1993-2010, the risk premium on shares vs bonds was 10.3%− 10.0% or 0.3%. The risk premium on shares vs bills was 10.3%− 3.3% or 7.0%. Finally, the premium on bonds vs. bills was 10.0%− 3.3% or 6.7%. Comparing these numbers to the long-run values in Table 6.2, we see that from 1993-2010 the risk premium on bonds vs. bills was a higher compared to the long-run average. However, from 1993-2010, the risk premium on shares vs. bonds and shares versus bills was lower than the long-run average

Table 6.2 (Revised) – A Comparison of Risk Premiums

	Risk Premium	
Comparison	**1900-2003 (from Table 6.2)**	**1993-2010**
Stocks – Bills	7.5%	7.0% (10.3%− 3.3%)
Stocks – Bonds	5.8%	0.3% (10.3%− 10.0%)
Bonds – Bills	1.7%	6.7% (10.0%− 3.3%)

ST6-3. Suppose that Treasury bill returns follow a normal distribution with a mean of 4.1 per cent and a standard deviation of 2.8 per cent. This implies that 68 per cent of the time, T-bill returns should fall within what range?

A: For any normal distribution, 68 per cent of the observations should fall within plus or minus one standard deviation of the mean. This means 68 per cent of annual T-bill returns should fall within 1.3% and 6.9%.

Answers to End-of-Chapter Questions

Q6-1. Why is it important to focus on total returns when measuring an investment's performance?

A6-1. The total return measures the increase or decrease in wealth that an investor achieves from holding a particular investment. Focusing on only the income component or the capital gain or loss component can potentially miss an important determinant of an investor's wealth.

Q6-2. Why do real returns matter more than nominal returns?

A6-2. If the reason that people invest is to have more money to spend later in life, then the real return measures the increase in spending power over time. It is not how much money you have that counts, it is how much you can buy with that money.

Q6-3. Under what conditions will the components of a bond's return have the opposite sign?

A6-3 A bond's return consists of the interest payment and the capital gain or loss. The interest payment can never be negative, so the only way that these two components can have an opposite sign is if the interest component is positive and the capital gain/loss part is negative. This means that the components will have the opposite sign when bond prices are falling, and that occurs when interest rates rise.

Q6-4. Explain why dollar returns and percentage returns can sometimes send conflicting signals when you are comparing two different investments.

A6-4. If the two investments require the same amount of money up front, this will not usually be a problem. However, if one investment is much larger than another, then the larger investment can generate a higher dollar return while the smaller one generates a higher percentage return. For example, suppose one person invests $100 and earns a total dollar return of $10, while another person invests $50 and earns a total dollar return of $6. Clearly the dollar return is larger on the first investment, but the percentage return is higher on the second.

Q6-5. Do the rankings of investment alternatives depend on whether we rank based on nominal returns or real returns?

A6-5. Nominal and real returns provide different measures of an investment's absolute returns, but the relative rankings do not change (as long as the measure of inflation used to convert nominal returns into real ones is the same for each investment).

Q6-6. Look at Table 6.1A. Compare the best and worst years for T-bills in terms of their nominal returns, and then compare the best and worst years in terms of real returns. Comment on what you find.

A6-6. The spread between the best and worst years is 14.7% in nominal terms and 34.8% in real terms. In part this is because the nominal return on Treasury bills has a 'floor' at zero per cent, but the real return can be, and often has been negative. This occurs when the inflation rate is higher than the nominal interest rate.

Q6-7. Over the last 111 years, 1981 was the top year for nominal bill returns and 1982 was the top year for nominal bond returns. Why do you think that these two years saw such high returns on bonds and bills?

A6-7. The answer is that the inflation rate was quite high at this time. Remember that the nominal return consists of the underlying real return plus the inflation rate. When inflation is high, nominal returns on bonds tend to be high as long as interest rates are not changing (rising rates would lead to falling bond prices which would cause the capital gain/loss component of total nominal bond returns to go negative). As it turns out, 1982 was also the best year for bond returns in real terms. Interest rates were beginning to fall from a high level, so in 1982 bonds earned a relatively high nominal interest rate and bond prices were rising. On the other hand, the best year for real returns on bills was 1921. In that year, the nominal rate on bills was 7%, but prices fell by double digits, increasing the real bill return to 19.7%. In real terms, the return on bills in 1981 was just 5.3%.

Q6-8. Table 6.2 calculates the risk premiums on shares and bonds relative to T-bills by taking the difference in average nominal total returns on each asset class. Would these risk premiums be much different if we calculated them using real rather than nominal returns?

A6-8. The risk premiums would be about the same. When we convert nominal returns into real returns, we (approximately) subtract the inflation rate from the nominal return to get the real return. The inflation rate is the same for each asset class, so the difference in nominal returns between shares and bonds will be essentially the same as the difference in real returns between shares and bonds (because you are subtracting inflation out of both numbers).

Q6-9. When measuring the volatility of an investment's returns, why is it easier to focus on standard deviation rather than variance?

A6-9. The units of measure in a variance calculation are per cent squared which is hard to interpret. For standard deviation, the units of measure are per cent, so we can easily compare the standard deviation to the average return.

Q6-10. Are there diminishing returns to risk taking?

A6-10. No. From Figure 6.6, it appears that the relationship between risk and return is linear. The more risk you take, the higher return you earn with no sign that the incremental return falls as risk increases. On the other hand, there are diminishing returns to wealth. That is, an extra $10,000 would mean a lot more to you than it would to a person as wealthy as Bill Gates. So even if the reward for bearing risk does not diminish, the utility of earning higher returns does diminish.

Q6-11. Notice in Table 6.6 that the average standard deviation among the ten shares is 31.4%, yet Figure 6.8 shows that a portfolio comprised of ten shares has a standard deviation of about 20%. Explain why these two figures are not equal.

A6-11. The standard deviation of a portfolio of shares will generally be less than the average standard deviation of the stocks in the portfolio. For a single share, the standard deviation captures both systematic and unsystematic risk, but the unsystematic risk of a portfolio declines as the number of shares increases. That is, the standard deviation of a well diversified portfolio will consist mainly, if not exclusively, of systematic risk, so a portfolio's standard deviation will not be as large as the standard deviation of a typical share.

Q6-12. Look at Figure 6.9. Suppose you had to invest all of your money in just one of these shares (excluding Intel). Which one seems most attractive and why? Which share seems least attractive?

A6-12. Ignoring Intel, Exxon seems to be the most attractive stock because of the remaining 9 stocks; it has the highest average return and the lowest standard deviation. Likewise, American Airlines seems to be the least attractive stock because it has a relatively high standard deviation and a very low average return.

Q6-13. Classify each of the following events as a source of systematic or unsystematic risk.

a. Ben Bernanke retires as Chairman of the Federal Reserve and Arnold Schwarzenegger is appointed to take his place.
b. Martha Stewart is convicted of insider trading and is sentenced to prison.
c. An OPEC embargo raises the world market price of oil.
d. A major consumer products firm loses a product liability case.
e. The US Supreme Court rules that no employer can lay off an employee without first giving 30 days' notice.

A6-13. a, c, and e are systematic risks because they affect most firms in the market. Item b primarily affects Martha Stewart's company, and likewise, d mainly affects the firm involved in the lawsuit, so these are unsystematic risks. However, one could argue that the Martha Stewart case has a systematic component if investors believe that by convicting Martha, the government has effectively deterred many other insider traders from trading.

Answers to End-of-Chapter Problems

Understanding Returns

P6-1. You purchase 1,000 shares of Spears Grinders stock for $45 per share. A year later, the stock pays a dividend of $1.25 per share and it sells for $49.
a. Calculate your total dollar return.
b. Calculate your total percentage return.
c. Do the answers to parts (a) and (b) depend on whether you sell the stock after one year or continue to hold it?

A6-1. a. $1{,}000 \times (\$1.25 + \$4) = \$5{,}250$

b. $(\$49 + \$1.25 - \$45)/\$45 = 0.1167$ or 11.67%.

c. The answer does not depend on whether you sell the stock or hold it.

P6-2. A financial adviser claims that a particular share earned a total return of 10 % last year. During the year the share price rose from $30 to $32.50. What dividend did the share pay?

A6-2. $0.10 = (\$32.50 + D - \$30)/\$30$ which implies that D = $0.50.

P6-3. D. S. Trucking Company shares pays a $1.50 dividend every year. A year ago the shares sold for $25 per share, and its total return during the past year was 20%. What do the shares sell for today?

A6-3. $0.20 = (P + \$1.50 - \$25)/\$25$, which implies that P = $28.50.

P6-4. Nano-Motors has shares outstanding which sells for $10 per share. Macro-Motors shares cost $50 each. Neither share pays dividends at present.
a. An investor buys 100 shares of Nano-Motors. A year later each share sells for $15. Calculate the total return in dollar terms and in percentage terms.
b. Another investor buys 100 shares of Macro-Motors. A year later the share price has risen to $56. Calculate the total return in dollar terms and in percentage terms.
c. Why is it difficult to say which investor had a better year?

A6-4. a. Total dollar return = $500. Total % return = 50%.

b. Total dollar return = $600. Total % return = 12%.

c. One investor had a higher % return while the other had a higher $ return, so you get a different relative performance ranking depending on which measure of returns you use.

P6-5. David Rawlings pays $1,000 to buy a five-year Treasury bond that pays a 6% coupon rate (for simplicity, assume annual coupon payments). One year later, the market's required return on this bond has increased from 6% to 7%. What is Rawlings' total return (in dollar and percentage terms) on the bond?

A6-5. After one year, the bond price will fall to $966.13. The total dollar return is ($966.13 + $60 − $1,000) = $26.13 and the percentage return is 2.613%. To solve for the $966.13 price of the bond, use the following calculator inputs:
N = 4 (Note that 4 is used, since one year has passed and there are four years remaining in the life of the bond)
PMT = 60 (6% × $1,000)
FV = $1,000
I = 7%
Solve for PV (bond price) =−$966.13

P6-6. G. Welch purchases a corporate bond that was originally issued for $1,000 several years ago. The bond has four years remaining until it matures, the market price now is $1,054.45, and the yield-to-maturity (YTM) is 4%. The bond pays an annual coupon of $55 with the next payment due in one year.

a. What is the bond's *coupon rate*? Its *coupon yield*?
b. Suppose Welch holds this bond for one year and the YTM does not change. What is the total percentage return on the bond? Show that on a percentage basis, the total return is the sum of the interest and capital gain/loss components.
c. If the yield-to-maturity decreases during the first year from 4% to 3.5 %, what is the total percentage return that year?

A6-6.

a. Coupon rate = 5.5% (55/1,000) and coupon yield = 5.22% (55/1,054.45)
b. At the end of one year if the YTM is still four per cent, the price will be $1,041.63. The total percentage return will be ($1,041.63 + $55 − $1,054.45)/$1,054.45 = 4%. That should not be a surprise. The bond provides a return that exactly equals the return required in the market (equal to the YTM). On a percentage basis, the interest component of the bond's return pays 5.22% but there is a capital loss equal to −1.22%, so the sum is 4%. Financial calculator inputs to solve for bond price are:
N = 3, PMT = 55, FV = 1,000, I = 4%. Solve for PV = −$1,041.63.
c. If the YTM declines to 3.5%, then after one year the bond will sell for $1,056.03 and the total percentage return is ($1,056.03 + $55 – $1,054.45) / $1,054.45 = 5.4%. If YTM declines, the bond will sell for more of a premium: N = 3, PMT = 55, FV = 1,000, I = 3.5%. Solve for PV = $1,056.03.

P6-7. In this advanced problem, let's look at the behaviour of ordinary Treasury bonds and inflation-indexed bonds, or TIPS. We will simplify by assuming annual interest payments rather than semiannual. Suppose over the next five years, investors expect 3 % inflation each year. The Treasury issues a five-year ordinary bond that pays $55 interest each year. The Treasury issues a five-year TIPS that pays a coupon rate of 2 %. With TIPS, the coupon payment is determined by multiplying the coupon rate times the inflation-adjusted principal value. Like ordinary bonds, TIPS begin with a par value or principal value of $1,000. However, that principal increases over time as inflation occurs. Assuming that inflation is in fact equal to 3 % in each of the next five years, then the cash flows associated with each bond would look like this:

	Inflation-Indexed Bond (TIPS)			
Year	T-Bond Pays	TIPS Pays	Inflation-Adjusted Principal (TIPS)	Coupon Payment Calculation
0 (cost)	–1,000.00	–1,000.00	–1,000.00	NA
1	55.00	20.60	1,030.00	1,000.00(1.03) × 2%
2	55.00	21.22	1,060.90	1,030.00(1.03) × 2%
3	55.00	21.85	1,092.73	1,060.90(1.03) × 2%
4	55.00	22.51	1,125.51	1,092.73(1.03) × 2%
5	1,055.00	1,182.46	1,159.27	1,125.51(1.03) × 2%

In the last row of the table, notice that the final TIPS payment includes the return of the inflation-adjusted principal ($1,159.27) plus the final coupon payment.

a. Calculate the *yield to maturity* (YTM) of each bond. Why is one higher than the other? Show that the TIPS YTM equals the product of the real interest rate and the inflation rate.
b. What is the *real return* on the T-bond?
c. Suppose the *real return* on the T-bond stays constant, but investors expect 4 % inflation rather than 3 %. What happens to the required return on the T-bond in nominal terms?
d. Imagine that during the first year, the inflation that actually occurred was 3 % as expected. However, suppose that by the end of the first year, investors had come to expect 4 % inflation for the next four years. Fill out the remaining cash flows for each bond in the table below.

Inflation-Indexed Bond (TIPS)

Year	T-Bond Pays	TIPS Pays	Inflation-Adjusted Principal (TIPS)	Coupon Payment Calculation
0 (cost)	–1,000.00	–1,000.00	–1,000.00	NA
1	55.00	20.60	1,030.00	1,000.00(1.03) × 2%
2				
3				
4				
5				

e. Now calculate the market price of the Treasury bond as of the end of the first year. Remember to discount the bond's remaining cash flows using the nominal required return that you calculated in part (c). Given this new market price, what is the total return offered by the T-bond the first year?

f. Next, calculate the market price of the TIPS bond. Remember, at the end of the first year, the YTM on the TIPS will equal the product of one plus the real return (2%) and one plus the inflation rate (4%). What is the total nominal return offered by TIPS the first year?

A6-7. a. The YTM of the T-bond is 5.5% and the YTM of the TIPS is 5.06%. (Note that the YTM for the TIPS is the IRR of the cash paid column.) Another way of looking at TIPS yield is: (1.02)(1.03) – 1 = 0.0506. The T-bond offers a higher yield because it does not enjoy protection from inflation risk as the TIPS bond does. An investor who buys a T-bond must receive compensation for bearing this risk, while a TIPS investor does not require compensation for inflation risk.

b. The real return on the T-bond is found by solving this equation: (1+0.055) = (1 + 0.03)(1+ x). Solving we find that x = 2.43%. This is approximately equal to the nominal rate, 5.5%, minus the inflation rate, 3%. Notice that the real rate offered by the T-bond is higher than the 2% real rate offered by TIPS. The reason is given in part (a.).

c. The required return on the T-bond if inflation expectations go up is 6.53% which is found by solving for x in this equation: (1 + x) = (1 + 0.04)(1 + 0.0243).

d. The missing values are filled in below:

Inflation-Indexed Bond (TIPS)				
Year	T-Bond Pays	TIPS Pays	Inflation-Adjusted Principal (TIPS)	Coupon Payment Calculation
0 (cost)	–1,000.00	–1,000.00	–1,000.00	NA
1	55.00	20.60	1,030.00	1,000.00(1.03) × 2%
2	55.00	21.42	1,071.20	1,030.00(1.04) × 2%
3	55.00	22.28	1,114.05	1,071.20(1.04) × 2%
4	55.00	23.17	1,158.61	1,114.05(1.04) × 2%
5	1,055.00	1,229.05	1,204.95	1,158.61(1.04) × 2%

e. The market price of the Treasury equals $964.74. This is found by discounting four more years of $55 coupons plus the principal at a nominal rate of 6.53%.
(Calculator inputs: N = 4, PMT = 55, I = 6.53%, FV = 1,000 and solve for PV =−$964.74).
The total return of this bond the first year is $19.74 or 1.974%.
Return is (55 + 1,000–964.74)/1,000 = 1.974%.

f. To calculate the market price of TIPS, you first have to calculate the nominal interest rate used to discount cash flows. Solve for x: (1 + x) = (1.02)(1.04) so x = 0.0608 or 6.08%. Now discount the cash flows over the last four years as determined in part (d) at this rate and you get the price of TIPS, $1,030. In other words, the price of the TIPS bond is currently equal to its inflation-adjusted par value. The total return on TIPS the first year is ($1,030 + $20.60 − $1,000) $50.60 or 5.06%, exactly the YTM calculated in part (a). In this problem, interest rates changed because inflation rose. The increase in inflation did not affect the first-year return on TIPS, but it did affect the first-year return on T-bonds.

The History of Returns (or How to Get Rich Slowly)

P6-8. Refer to Figure 6.2. At the end of each line, we show the nominal value in 2010 of a $1 investment in shares, bonds, and bills. Calculate the ratio of the 2010 value of $1 invested in bonds divided by the 2010 value of $1 invested in bills. Now recalculate this ratio using the real values in Figure 6.3A.

A6-8. In nominal terms, this ratio is 21,481/294 = 73.1, and in real terms, 842/8.6 = 97.9

P6-9. The US stock market hit an all-time high in October 1929 before crashing dramatically. Following the market crash, the US entered a prolonged economic downturn dubbed the Great Depression. Using Figure 6.2, estimate how long it took for the stock market to fully rebound from its fall which began in October 1929. How did bond investors fare over this same period? (Note: A precise answer is hard to obtain from the figure, so just make your best estimate.)

A6-9. It was not until 1943-44 that the US market regained its pre-depression level, so investors went more than a decade without earning positive returns. From the end of 1929 to the end of 1943, bond investors earned a total return of about 82%.

P6-10. Refer again to Figure 6.2, which tracks the value of $1 invested in various assets starting in 1990. At the stock market peak in 1929, look at the gap that exists between equities and bonds. At the end of 1929, the $1 investment in shares was worth about five times more than the $1 investment in bonds. About how long did investors in shares have to wait before they would regain that same performance edge? Again, getting a precise answer from the figure is difficult, so make an estimate.

A6-10. At the end of 1929, a $1 investment in shares (starting in 1900) was almost 5 times more valuable than a $1 investment in bonds. Stocks did not regain this relative performance margin

again until 1949. This means that an investor who bought shares in 1929 would have to wait about 20 years to outperform an investor who bought bonds in 1929.

P6-11. The *nominal return* on a particular investment is 11% and the inflation rate is 2%. What is the *real return*?

A6-11. (1+0.11) = (1+0.02)(1+x), so x = 0.0882, or 8.82%.

P6-12. A bond offers a *real return* of 5%. If investors expect 3% inflation, what is the *nominal rate of return* on the bond?

A6-12. (1+x) = (1.05)(1.03), so x = 0.0815 or 8.15%.

P6-13. If an investment promises a nominal return of 6% and the inflation rate is 1%, what is the real return?

A6-13. (1.06) = (1.01)(1+x), so x = 0.0495 or 4.95%.

P6-14. The following data shows the rate of return on shares and bonds for several recent years. Calculate the risk premium on equities versus bonds each year, and then calculate the average risk premium. Do you think that at the beginning of 2007investors expected the outcomes we observe in this table?

Year:	**2007**	**2008**	**2009**	**2010**
Return on shares (%)	5.6	–37.2	28.5	17.1
Return on bonds (%)	9.9	25.9	14.5	6.4
Risk premium (%)				

A6-14. The risk premiums are −4.3, −63.1, +14.0, and +10.7. Overall the average risk premium is –10.7%. Investors surely did not anticipate these outcomes, particularly not the negative risk premiums in 2007 and 2008. If investors expected such poor performance from shares relative to bonds at the start of the year, then money would have flooded out of the share market, causing prices to plummet, and money would have poured into the bond market, causing prices to rise. Of course bonds can outperform equities after the fact, resulting in negative risk premiums. If equities always outperformed bonds, then we could hardly say that equities were riskier than bonds.

P6-15. The table below shows the average return on US shares and bonds for 25-year periods ending in 1925, 1950, 1975, and 2000. Calculate the *equity risk premium* for each quarter century. What lesson emerges from your calculations?

	1925	**1950**	**1975**	**2000**
Shares	9.7%	10.2%	11.4%	16.2%
Bonds	3.5%	4.1%	2.4%	10.6%
Premium	?	?	?	?

A6-15. The risk premiums in each decade are 6.2%, 6.1%, 9.0%, and 5.6%. The main lesson is that the observed equity risk premium is not constant through time.

P6-16. The current yield to maturity on a one-year Treasury bill is 2 %. You believe that the expected risk premium on shares vs bills equals 7.7 %.

a. Estimate the expected return on the share market next year.
b. Explain why the estimate in part (a) may be better than simply assuming that next year's share market return will equal the long-term average return.

A6-16. a. 2% + 7.7% = 9.7%.

b. This may be a better estimate because it reflects current market interest rates and inflation expectations.

Volatility and Risk

P6-17. Using Figure 6.5, how would you estimate the probability that the return on the share market will exceed 30 % in any given year?

A6-17. The figure shows that 18 out of the last 111 years saw a market increase of 30% or more, so from those figures we would estimate a probability of 18/107 = 16.8%.

P6-18. In this problem we will use Figure 6.5 to estimate the expected return on the share market. To estimate the expected return, create a list of possible returns and assign a probability to each outcome. To find the expected return, multiply each possible return by the probability that it will occur, and then add up across outcomes. Notice that Figure 6.5 divides the range of possible returns into intervals of 10 per cent (except for very low or very high outcomes). Create a list of potential future equity returns by taking the midpoint of the various ranges as follows:

Possible equity returns (%)									
−35	−25	−15	−5	5	15	25	35	45	55
3/111	4/111							3/111	2/111
Expected return = (3/111)(–35) + (4/111)(–25) +….+(3/111)(45) + (2/111)(55) =?									

Figure 6.5 shows that four out of 111 years had returns of between −20% and −30%. So let us capture this fact by assuming that if returns do occur inside that interval that the typical return would be −25% (in the middle of the interval). The probability associated with this outcome is 4/111 or about 3.6%. Fill in the missing values in the table and then fill in the missing parts of the equation to calculate the expected return.

A6-18. Expected return = (3/111)(–35) + (4/111)(–25) + (10/111)(–15) + (12/111)(–5) + (21/111)(5) + (18/111)(15) + (25/111)(25) + (13/107)(35) + (3/107)(45) + (2/107)(55) = 11.6%.

P6-19. Here are the nominal returns on shares, bonds, and bills for the 1920s and 1930s. For each decade, calculate the standard deviation of returns for each asset class. How do those figures compare with more recent numbers for shares presented in Table 6.4 and the long-run figures for all three asset types in Table 6.5?

Nominal Returns (%) on Shares, Bonds, and Bills

1920s			1930s		
Shares	**Bonds**	**Bills**	**Shares**	**Bonds**	**Bills**
–17.9	5.8	7.6	–28.3	4.7	2.4
11.6	12.7	7.0	–43.9	–5.3	1.1
30.6	3.5	4.7	–9.8	16.8	1.0
3.0	5.7	5.2	57.6	–0.1	0.3
27.0	6.4	4.1	4.4	10.0	0.2
28.3	5.7	4.1	44.0	5.0	0.2
9.5	7.8	3.3	32.3	7.5	0.2
33.1	8.9	3.1	–34.6	0.2	0.3
38.7	0.1	3.6	28.2	5.5	0.0
–14.5	3.4	4.7	2.9	5.5	0.0

A6-19. The standard deviations are as follows.
1920s: shares 20.0%, bonds 3.4%, bills 1.5%

1930s: shares 34.7%, bonds 6.0%, bills 0.7%
In the 1920s, shares were about as volatile as their recent history and as their long-run average, but in the 1930s they were much more volatile than that. Both bonds and bills were less volatile in the 20s and 30s than they were over the whole 20th century.

P6-20. Use the data below to calculate the standard deviation of *nominal* and *real* Treasury bill returns from 1972-1982. Do you think that when they purchased T-bills investors expected to earn negative real returns as often as they did during this period? If not, what happened that took investors by surprise?

Year	Nominal Return (%)	Real Return (%)
1972	3.8	0.4
1973	6.9	–1.7
1974	8.0	–3.7
1975	5.8	–1.1
1976	5.1	0.3
1977	5.1	–1.5
1978	7.2	–1.7
1979	10.4	–2.6
1980	11.2	–1.0
1981	14.7	5.3
1982	10.5	6.4

A6-20. The standard deviations are 3.3% in nominal terms and 3.2% in real terms. The negative real return periods are times when actual inflation exceeded expected inflation. Investors had not anticipated higher inflation and failed to require sufficient compensation for inflation during those times.

P6-21. Based on Figure 6.6, about what rate of return would a truly risk-free investment (i.e., one with a standard deviation of zero) offer investors?

A6-21. Just projecting where the line would hit the y-axis, the risk-free rate would be about 2%.

The Power of Diversification

P6-22. Troy McClain wants to form a portfolio of four different shares. Summary data on the four shares follows. First calculate the average standard deviation across the four shares, and then answer this question: If Troy forms a portfolio by investing 25% of his money in each of the shares in the table, is it very likely that the standard deviation of this portfolios return will be (more than, less than, equal to) 43.5%?

Share	Return	Standard Deviation
1	14%	71%
2	10%	46%
3	9%	32%
4	11%	25%

A6-22. The average of the four standard deviations is 43.5%. If Troy diversifies across all four shares, then the standard deviation of his portfolio's returns will very likely be less than the 43.5%, and it may even be less than 25%, the lowest standard deviation of any share in the portfolio.

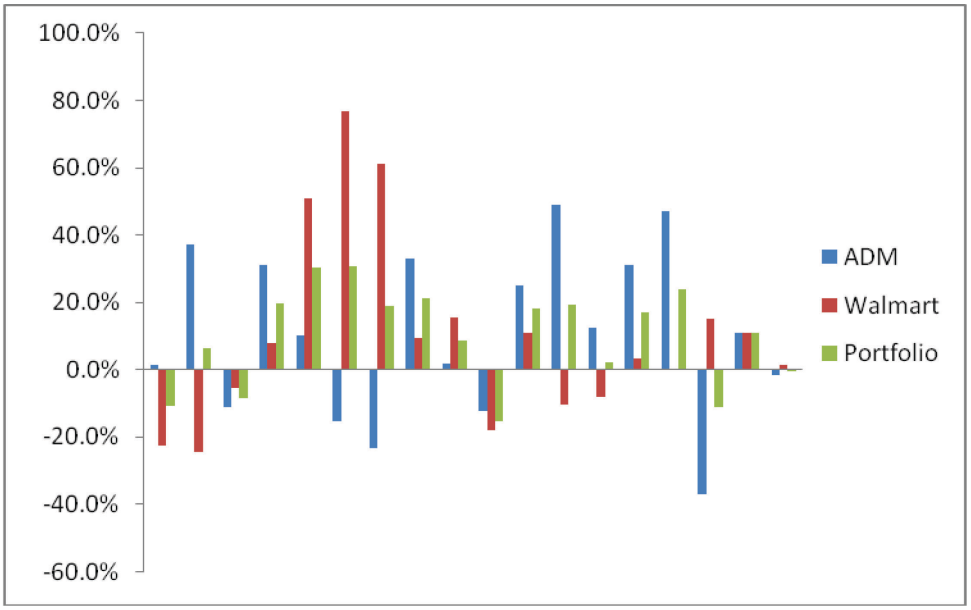
P6-23. The table below shows annual returns on Archer Daniels Midland (ADM) and Walmart

The last column of the table shows the annual return that a portfolio invested 50% in ADM and 50% in Walmart would have earned in 1993. The portfolio's return is simply a weighted average of the returns of ADM and Walmart.

Year	AMD	Walmart	**50-50 Portfolio**
1993	1.5%	–22.7%	–10.6% = (0.5 X 1.5% + 0.5 X –22.7%)
1994	37.4%	–24.6%	
1995	–11.2%	–5.5%	
1996	31.1%	8.0%	
1997	10.0%	50.7%	
1998	–15.3%	76.8%	
1999	–23.5%	61.2%	
2000	32.9%	9.5%	
2001	1.9%	15.6%	
2002	–12.1%	–18.1%	
2003	25.1%	11.1%	

a. Plot a graph similar to Figure 6.7 showing the returns on ADM and Walmart each year.
b. Fill in the blanks by calculating the 50-50 portfolio's return each year from 1994-2010 and then plot this on the graph you created for part (a). How does the portfolio return compare to the returns of the individual shares in the portfolio?
c. Calculate the standard deviation of ADM, Walmart, and the portfolio and comment on what you find.

A6-23 a. The graph below shows returns each year on the two shares and on the portfolio. In general, the return on the portfolio each year falls between the returns on the stocks. The standard deviation of the portfolio is much less than the standard deviation of either share in the portfolio.



b. & c.

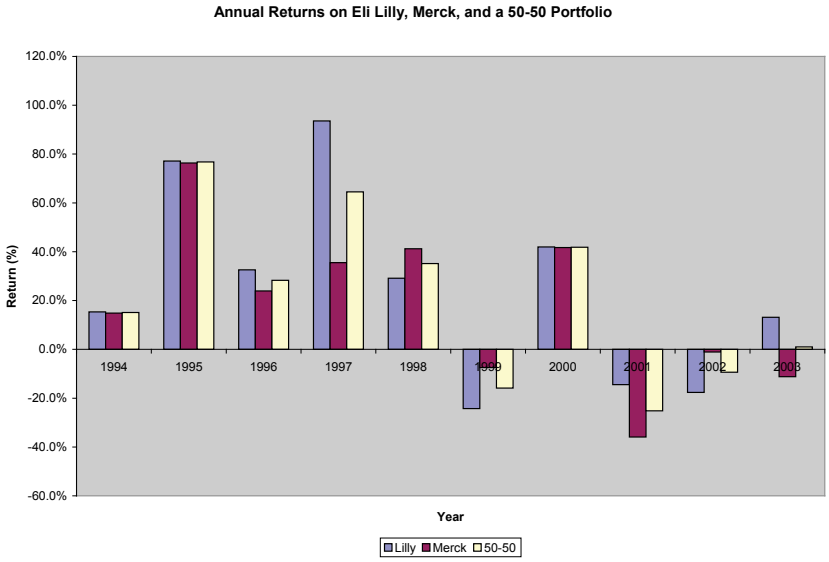
Year	ADM	Walmart	50-50
1993	1.5%	–22.7%	–10.6%
1994	37.4%	–24.6%	6.4%
1995	–11.2%	–5.5%	–8.3%
1996	31.1%	8.0%	19.6%
1997	10.0%	50.7%	30.4%
1998	–15.3%	76.8%	30.7%
1999	–23.5%	61.2%	18.8%
2000	32.9%	9.5%	21.2%
2001	1.9%	15.6%	8.7%
2002	–12.1%	–18.1%	–15.1%
2003	25.1%	11.1%	18.1%
2004	49.1%	–10.5%	19.3%
2005	12.3%	–8.2%	2.0%
2006	31.0%	3.3%	17.2%
2007	47.2%	0.3%	23.7%
2008	–36.9%	15.0%	–10.9%
2009	10.8%	10.9%	10.9%
2010	–1.5%	1.4%	0.0%
Std. dev	24.81%	27.71%	14.43%

P6-24. The table below shows annual returns for Merck and one of its major competitors, Eli Lilly. The final column shows the annual return on a portfolio invested 50% in Lilly and 50% in Merck. The portfolio's return is simply a weighted average of the returns of the shares in the portfolio as shown in the example calculation at the top of the table.

Year	Eli Lilly	Merck	50-50 Portfolio
1	15.4%	14.9%	15.1% (0.5 x 15.4% + 0.5 x 14.9%)
2	77.2%	76.4%	
3	32.6%	24.0%	
4	93.6%	35.5%	
5	29.1%	41.2%	
6	–24.3%	–7.4%	
7	41.9%	41.7%	
8	–14.4%	–35.9%	
9	–17.6%	–1.1%	
10	13.1%	–11.2%	
Std. Dev.			

a. Plot a graph similar to Figure 6.7 showing the returns on Merck and Lilly each year.
b. Fill in the blanks by calculating the 50-50 portfolio's return each year from year 2 to year 10, and then plot this on the graph you created for part (a). How does the portfolio return compare to the returns of the individual shares in the portfolio?
c. Calculate the standard deviation of Merck, Lilly, and the portfolio and comment on what you find.

A6-24. a.



Notice how similar the return on Merck and Lilly are just about every year. This is not too surprising because they operate in the same industry and are subject to many of the same risks. A portfolio invested in these two shares will provide much lower diversification benefits than a portfolio invested in two companies in different industries (such as Merck and AMD).

b. The portfolio returns starting in year 2 and going to year 10 are: 15.15%, 76.8%, 28.3%, 64.55%, 35.15%, –15.85%, 41.8%, –25.15%, –9.35%, 0.95%.

c. The standard deviations of Lilly, Merck, and the portfolio are 39.2%, 32.7%, and 34.2%. Notice that the portfolio's standard deviation is very similar to the standard deviations of the shares in the portfolio. In fact, it is very close to the average of the standard deviation for Merck and Lilly. Again, this is unsurprising since they are both in the same industry and likely to be subject to similar risks.

P6-25. In this problem you will generate a graph similar to Figure 6.8. The table below shows the standard deviation for various portfolios of shares listed in Table 6.6. Plot the relationship between the number of shares in the portfolio and the portfolio's standard deviation. Comment on how the resulting graph is similar to Figure 6.8 and how it is different from that figure.

Shares in the Portfolio	**Std. Deviation (%)**
Exxon	16.6
Exxon + P&G	15.2
Exxon + P&G + Coke	15.4
Exxon + P&G + Coke + ADM	14.7
Exxon + P&G + Coke + ADM + Wal-mart	12.5
Exxon + P&G + Coke + ADM + Wal-mart + Wendy's	14.5

A6-25. The line doesn't always decline when a new share is added to the portfolio, though the portfolios with more shares tend to be less volatile than the individual shares. The reason that the line does not always decline is that each time we add a share, we are adding one that is more volatile than the shares already in the portfolio.

Answer to MiniCase

The Trade-Off Between Risk and Return

Assignment

Use the following information to compare the recent performance of the S&P 500 Index, the Nasdaq Index, and the Treasury Bill Index from 1983-2003. Each of these index numbers is calculated in a way that assumes that investors reinvest any income they receive, so the total return equals the percentage change in the index value each year. The last column shows the level of the Consumer Price Index (CPI) at the end of each year, so the percentage change in the index indicates the rate of inflation for a particular year. Note that because the data start on 31 December 1983, it is not possible to calculate returns or an inflation rate in 1983.

For the S&P500, the Nasdaq, and the T-bill series calculate (a) the cumulative return over twenty years, (b) the average annual return in nominal terms, (c) the average annual return in real terms, and (d) the standard deviation of the nominal return. Based on these calculations, discuss the risk/return relationship between these indexes. Which asset class earned the highest average return? For which asset class were returns most volatile? Plot your results on a graph with the standard deviation of each asset class on the horizontal axis and the average return on the vertical axis.

Date	S&P 500	Nasdaq	T-Bills	CPI
31/12/1983	164.93	278.60	681.44	101.3
31/12/1984	167.24	247.35	748.88	105.3
31/12/1985	211.28	324.39	806.62	109.3
31/12/1986	242.17	348.81	855.73	110.5
31/12/1987	247.08	330.47	906.02	115.4
31/12/1988	277.72	381.38	968.89	120.5
31/12/1989	353.40	454.82	1050.63	126.1
31/12/1990	330.22	373.84	1131.42	133.8
31/12/1991	417.09	586.34	1192.83	137.9
31/12/1992	435.71	676.95	1234.36	141.9
31/12/1993	466.45	776.80	1271.78	145.8
31/12/1994	459.27	751.96	1327.55	149.7
31/12/1995	615.93	1052.13	1401.97	153.5
31/12/1996	740.74	1291.03	1473.98	158.6
31/12/1997	970.43	1570.35	1550.49	161.3
31/12/1998	1229.23	2192.68	1625.77	163.9
31/12/1999	1469.25	4069.31	1703.84	168.3
31/12/2000	1320.28	2470.52	1805.75	174.0
31/12/2001	1148.08	1950.40	1865.85	176.7
31/12/2002	879.82	1335.51	1895.83	180.9
31/12/2003	1111.92	2003.37	1915.29	184.3

Answer:

Date	S&P 500		NASDAQ		T-Bills		CPI	
31/12/1983	164.93		278.60		681.44		101.3	
31/12/1984	167.24	1.4%	247.35	–11.2%	748.88	9.9%	105.3	3.9%
31/12/1985	211.28	26.3%	324.39	31.1%	806.62	7.7%	109.3	3.8%
31/12/1986	242.17	14.6%	348.81	7.5%	855.73	6.1%	110.5	1.1%
31/12/1987	247.08	2.0%	330.47	–5.3%	906.02	5.9%	115.4	4.4%
31/12/1988	277.72	12.4%	381.38	15.4%	968.89	6.9%	120.5	4.4%
31/12/1989	353.40	27.3%	454.82	19.3%	1050.63	8.4%	126.1	4.6%
31/12/1990	330.22	–6.6%	586.34	–17.8%	1131.42	7.7%	133.8	6.1%
31/12/1991	417.09	26.3%	586.34	56.8%	1192.83	5.4%	137.9	3.1%
31/12/1992	435.71	4.5%	676.95	15.5%	1234.36	3.5%	141.9	2.9%
31/12/1993	466.45	7.1%	776.80	14.8%	1271.78	3.0%	145.8	2.7%
31/12/1994	459.27	–1.5%	751.96	–3.2%	1327.55	4.4%	149.7	2.7%
31/12/1995	615.93	34.1%	1052.13	39.9%	1401.97	5.6%	153.5	2.5%
31/12/1996	740.74	20.3%	1291.03	22.7%	1473.98	5.1%	158.6	3.3%
31/12/1997	970.43	31.0%	1570.35	21.6%	1550.49	5.2%	161.3	1.7%
31/12/1998	1229.23	26.7%	2192.68	39.6%	1625.77	4.9%	163.9	1.6%
31/12/1999	1469.25	19.5%	4069.31	85.6%	1703.84	4.8%	168.3	2.7%
31/12/2000	1320.28	–10.1%	2470.52	–39.3%	1805.75	6.0%	174.0	3.4%
31/12/2001	1148.08	–13.0%	1950.40	–21.1%	1865.85	3.3%	176.7	1.6%
31/12/2002	879.82	–23.4%	1335.51	–31.5%	1895.83	1.6%	180.9	2.4%
31/12/2003	1111.92	26.4%	2003.37	50.0%	1915.29	1.0%	184.3	1.9%
Total return		225.17%		290.52%		106.50%		
Average yearly return		11.26%		14.53%		5.32%		3.04%
Real average yearly return		8.21%		11.48%		2.28%		
Standard deviation		16.58%		31.24%		2.20%		

There is a positive relation between average return and standard deviation obtains in these figures. NASDAQ earned the highest average returns, but had the highest volatility as well. T-bills varied the least, but they earned the lowest returns.