CHAPTER 2: Diversification, Correlation, & Asset Allocation

The previous chapter introduced several investment concepts, including:

- Risk: its definition(s) and measurement;
- Prudence: the exercise of care, skill and caution within a credible and achievable investment process;
- The efficient market hypothesis: the idea that financial asset prices reflect all information regarding the factors likely to affect a security's price movements; and;
- Investment policy: the clear articulation of investment goals and strategies to increase the probability of achieving them.

As we proceed, we shall revisit these topics from differing perspectives to elaborate how all investment decisions and activities incorporate viewpoints on these topics – whether an individual investor is explicitly aware of them, or not.

This chapter provides a first look at the subjects of portfolio design and investment selection. Initially, it takes up the subject of asset allocation – what type of investments should the portfolio own, and in what proportion(s) should it own them? It begins by contrasting a "bottom-up" method of finding investments – i.e., evaluating a stock or a bond primarily in terms of its likelihood of providing attractive return over the forthcoming period – to a "top-down" method of selecting investments – i.e., a method that focuses primarily on broad markets rather than on the securities of individual firms. In the terms used in Chapter One, a bottom-up approach seeks to find rewards in an investment context that allows for idiosyncratic risk by forming concentrated portfolios of securities forecasted to earn high returns; a top-down approach, by contrast, seeks to mitigate firm-specific risks by forming diversified portfolios comprising many firms operating across diverse geographic regions. In terms of the efficient market hypothesis, the bottom-up approach seeks to beat the market; the top-down approach seeks to capture the rewards offered by the market.

The decision whether to pursue a top-down or bottom-up portfolio strategy – and the prudence of each choice – forms a recurring theme throughout the book.

ASSET ALLOCATION BASICS

Asset Class Investing

Both bottom-up and top-down approaches use quantitative analysis to design and implement portfolios based on statistical measures of risk and reward. Initially, we assert that the bottom-up approach focuses the statistical measures of risk and reward at the individual security level, while the top-down approach focuses on statistical measures of risk and reward at the portfolio level. In the top-down investment context, a portfolio exhibiting 'efficient' risk/reward tradeoffs is deemed to be 'optimal' when it aligns with investor preferences – i.e., maximizes

investor utility.[1] This approach seeks to create broadly diversified portfolios with expected returns sufficient to meet the portfolio's future obligations, and with projected volatility that meets risk tolerance preferences. Portfolio analysis is complex, and requires different skill sets than those employed for individual stock/bond evaluation.

Until the start of the 21st century, limitations on computer capacity and availability of software applications limited a quantitative top-down approach primarily to institutional investors. With some admitted definitional ambiguity, one can equate the term 'institutional investing" with an approach that allocates pooled investments such as mutual funds and exchange traded funds. Institutional investing stands in contrast to an approach that selects individual securities evaluated in isolation. As noted, this approach considers stocks one by one, according to a screening criterion designed to identify securities with above-average opportunities for future growth or income. This is not to suggest that individual securities are inappropriate investment vehicles for a portfolio, or that an asset class cannot be effectively proxied by a subset of individual stocks or bonds. Rather, the key difference lies in the approach to portfolio construction. By the latter half of the twentieth century, investing bifurcated into Institutional-style investing – largely an integrated, top-down approach – and individual stock-selection – a largely segregated, bottom-up approach.

For investors managing portfolios under a top-down asset allocation approach, it is important to have familiarity with several topics:

- What is the definition of asset allocation?
- What is the purpose of asset allocation?
- What is the relationship between asset allocation and risk control?

Asset allocation is the process of combining various asset classes into a portfolio with risk and reward characteristics suitable for the investor's risk tolerance and investment objectives. Asset classes are the building blocks of the portfolio. Each asset class may enter the portfolio either through an indexing approach seeking to replicate the risk and return of an asset class, or through an actively managed approach seeking to add value over and above a passive index. An asset class is a group of securities that share common legal, economic and statistical characteristics. For example, the asset class of U.S. small stocks differs from the class of U.S. large stocks in several respects, including fundamental characteristics such as market capitalization, and statistical characteristics such as the expected volatility of return.

Investors may prefer asset class building blocks (e.g., an index of large company stocks such as the S&P 500) to individual securities primarily because the stock of a single company may be a poor representative of the class. Enron, for example, was not a typical energy stock. The unique risk of an individual security stands in contrast to the tendency of relatively homogeneous groups of securities – i.e., an asset class – to exhibit predictably common exposures to similar sets of risk factors.[2] Over the long run, a diversified portfolio's returns are primarily associated with exposures to systematic risk factors. Thus, the primary purpose of asset allocation is to set the investor's long-term exposure to systematic risks.

[1] Utility is a technical term for the concept of satisfaction or happiness. An investor who is happy with his or her portfolio will not be inclined to make major changes in it. Utility is not strictly measured in economic terms. For example, a portfolio that owns a cattle ranch may provide a high level of satisfaction for investors longing to become cowboys or cowgirls. Wealth is an asset that pays consumption – a "lifestyle" – as its dividend. Campbell, John Y. & Viceira, Luis M., Strategic Asset Allocation: Portfolio Choice for Long-Term Investors, Oxford University Press (2002). Utility, and the closely related topic of risk aversion, form the subject matter for Chapter Seven.

[2] Chapter Three details how some risk factor exposures are "priced" in the marketplace; and, therefore, how risk factors are sources of investment return.

Systematic risk is also termed "priced risk." It is a risk that reflects the consensus view of profit opportunities offered by the general market – as opposed to a risk that is unique to specific companies. An easy way to see the importance of this distinction is to note that the risk of owning two stocks from the energy-dependent transportation sector – an airline and a trucking company – is much higher than the risk of owning one stock from the transportation sector and one from the energy sector – say, an oil company. ***Either way, the investor pays the market price to acquire the stocks. In the diversified portfolio the investor pays full price and has lower risk; in the transportation-focused portfolio, the investor pays full price but receives no risk-control benefits.*** Although the investor might think that the transportation sector offers a higher return than the energy sector – a conditional return forecast – it is undeniable that the investor has overpaid for each unit of return when adjusted for the risk associated with it – an unconditional fact.[3]

A Graphical Approach to Understanding Risk and Asset Allocation

The phrase 'setting exposures to systematic risks' sounds complicated. Graphically, however, it is easier to understand. Intuitively, most investors agree that the price volatility of government-guaranteed, short-term Treasuries is considerably less than that of the S&P 500 U.S. Stock Index. At least in the short run, government guaranteed T-Bills[4] are a safer asset than stocks.

The expected behavior of a portfolio allocated 20% to T-Bills and 80% to stock should differ greatly from that of a portfolio allocated 80% to T-Bills and 20% to stock. **FIGURE 2-1** illustrates a hypothetical range of annual returns generated by each portfolio. The red curve traces returns from the portfolio allocated 80% to T-Bills, the blue curve traces returns from the portfolio allocated 80% to stocks.

DISTRIBUTION OF RETURNS FROM DIFFERENT ASSET ALLOCATIONS

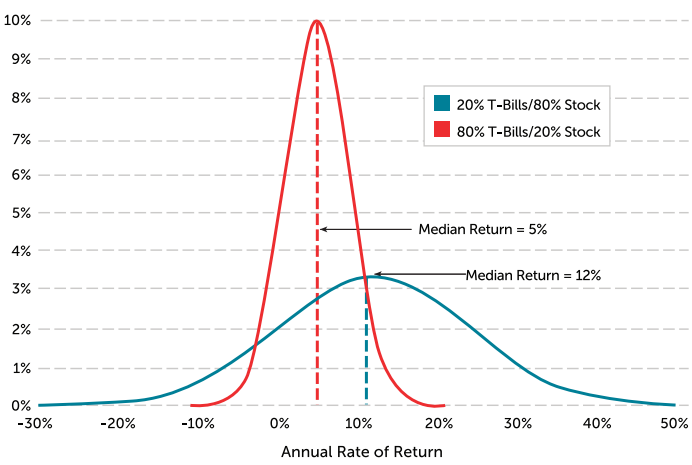

FIGURE 2-1

Figure 2-1 depicts risk as the shape of the return distribution curve.[5] The more narrow the shape, the more certain the final outcome; the wider the shape, the greater the range of possible returns and, therefore, the less certain the final outcome. Narrower shapes exhibit lower expected returns and wider shapes exhibit higher expected returns because investors expect to be compensated for risk. Asset allocation determines the shape of portfolio returns and acts as a mechanism for risk control.

[3] As stated, more money is better than less. As the investor seeks to acquire more money, the danger is that he or she pays too much for each unit of risk. Although most consumers have an unfavorable view of overpayment because it prevents them from making more money, they may paradoxically lose sight of this truism when seeking high investment return.

[4] Although "Treasury Notes" is the technically correct term for short-term instruments, we prefer the term "T-Bills" because it is commonly used in less formal contexts.

[5] The chart is used for pedagogical purposes only – it is neither a market prediction nor a replication of an historical return series.

Asset Allocation and the Risk/Return Tradeoff

Although investors cannot control returns,[6] they can pick an allocation that produces a shape of return that is appropriate for them. Here is the important part: a basic tenet of capital market theory is that there is an approximately linear relationship between systematic risk and expected long-term return. Simply put, if you diversify the portfolio so it reflects market risk rather than unique company risk, then the risk and reward should line up over the long run. In any stretch of time, you may get returns from the left side of the distribution range – a bear market – or from the right side – a bull market. However, both bull and bear returns are included in the distribution described by the curve; and, if you maintain your asset allocation, ultimately you can expect to receive a return close to the long-term average. This is the logic underlying the advice to "stay the course" if you are a long-term investor.[7] It is also the logic that suggests that focused portfolios comprising only a few securities are not safe. The unique risk of each position overwhelms the systematic risk of the aggregate portfolio, making both the short-term and long-term risk/return alignment dangerously unpredictable.

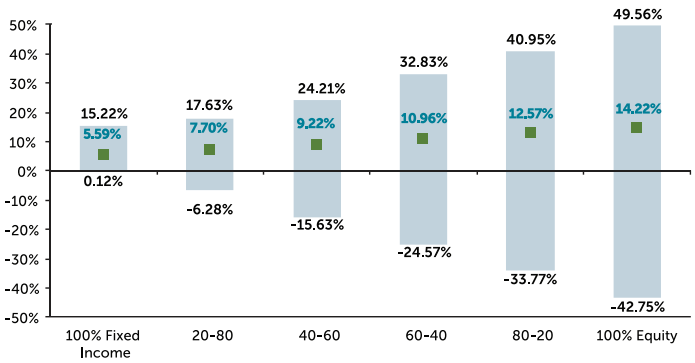

FIGURE 2-2

FIGURE 2-2 illustrates the historical risk/reward tradeoff of various asset allocations. It depicts the best, worst and average annual returns from different allocations. An allocation to 100% T-Bills generated the lowest realized return over the period 1973 through 2015. As risk (uncertainty of return) increases, long-term reward becomes greater. A 100% equity allocation (before expenses) generated an annual returns of 14.22% compared to the all T-Bill returns of 5.59%.[8]

Asset Allocation and Portfolio Preferencing Criteria

The institutional approach to portfolio design does not define the best allocation as the one with the highest expected long-term return. Rather, it selects portfolios based on a lengthy list of preferencing criteria.

Suppose that an investor evaluates six portfolios. The first preferencing criterion eliminates all portfolios that aren't expected to generate the required return. These portfolios might be very "safe," but are hardly prudent choices, because they are likely to fall short of the dollar amounts required to fund investment goals. Assume that the required return preferencing criterion eliminates three of the six candidate portfolios.[9]

The second preferencing criterion is risk – the investor doesn't want to take more risk than needed for long-term success. In other words, he or she does not wish to create a "risk gap." In this case, we define risk in terms of the magnitude and likelihood of a shortfall in actual future dollar wealth despite the fact that the expected future dollar wealth satisfies the

[6] Future returns are 'random variables,' the values of which are not yet known.

[7] These propositions are re-examined in part three of this chapter, and are revisited throughout the book.

[8] T-Bills are proxied by Ibbotson Associates. One-Year Constant Maturity T-Bill Index and equities are proxied by the S&P 500 Stock Index.

[9] The investor would like to have these three safe portfolios but cannot afford to have them. Safety is expensive. Insurance companies, for example, do not provide protection for free.

portfolio's funding requirements. For example, if the investor cannot accept more than a 20% risk of future shortfall, this criterion eliminates any portfolio likely to violate risk tolerance guidelines.

Assume that two portfolios pass both the return and risk preference tests. Of the remaining candidates, one portfolio comprises eight asset class building blocks; the other portfolio holds ten. Candidate one exposes 25% of the portfolio to the risks and returns of a single asset class; candidate two's maximum exposure to a single asset class is 21%. Both portfolios have equal liquidity and marketability. Consequently the investor may wish to choose the second remaining candidate based on a diversification preferencing criterion.

By thoughtful and systematic application of preferencing criteria the investor arrives at a portfolio appropriate for his or her economic objectives and risk preferences. Asset allocation has controlled risk and provided the best opportunity for a successful long-term outcome. This is the good news. The bad news is:

- The allocation is myopic; and,
- It is statistically valid only if there are no cash flows into or out of the portfolio.

"Stay-The-Course" vs. Dynamic Asset Allocation

Operating a strict stay-the-course asset allocation on a period-by-period basis is like driving an automobile towards a destination by making directional decisions one street at a time. By contrast, a dynamic allocation is like understanding the interconnection of streets throughout the entire trip and plotting a course accordingly. The latter approach avoids dead ends, traffic lights, and other impediments to efficient travel.

The right asset allocation suggests that "on average" you should succeed in creating sufficient dollar wealth. However, whenever cash enters or leaves the portfolio, the concept of "average" disappears. Assume that an investor wants to design a portfolio to provide a sustainable yearly income of $120,000. The portfolio is currently worth $3,000,000. The investor makes the following calculations:

- The portfolio should be able to earn 8% after costs over the long-term.
- Inflation should average 3% over the long- term.
- The portfolio needs to distribute 4% per year ($120,000 ÷ $3,000,000).
- 4% + 3% = 7%, which is less than 8%.
- The portfolio should be sufficient to fund the target income on an inflation-adjusted basis in perpetuity.

Unfortunately, the conclusion is correct only under the improbable condition that the portfolio earns exactly 8% every year under an inflationary environment of exactly 3% every year.

The investor failed to consider the variability of future inflation, future investment returns, and the complex interactions between these factors. Withdrawals during periods of below-average returns compound their deleterious effects on dollar wealth. But withdrawals during periods when returns are above average vitiate their positive effects on dollar wealth. Constantly compounding the negative consequences of bad returns and capping the positive consequences of good returns renders the concept of "average" return meaningless.[10]

Although asset allocation is a critical component of prudent portfolio design, it is not the final step in the path towards investment success. In general, the prudent investor cannot simply set an asset allocation and blindly stay the course. The missing ingredient is asset management, which includes the process of periodically evaluating whether current assets are likely to fund anticipated liabilities. Substantial changes in wealth – positive or negative – require rethinking of

[10] This discussion is a variation on the topic of 'variance drain' found in Chapter 1.

goals and strategies. One challenge to effective asset management is to move from a single-period asset allocation structure to a dynamic multi-period structure that acknowledges changes in investor wealth and risk aversion. The asset allocation decision remains an important step in the investment process; but, if it is a necessary condition, it should not also be viewed as a sufficient condition for maximizing the probability of long-term success. Prudent investing requires familiarity with two additional topics central to the asset allocation process: diversification and correlation.

A maximum return approach asks "how much money can I earn;" the institutional approach asks "how much money do I need to earn/how much risk do I need to take."

DIVERSIFICATION

Unlike investment approaches that select investments based primarily on forecasts of future security price changes, the institutional investing approach often starts the portfolio design process from the liability side – e.g., investing to fund identifiable goals. An institutional approach selects investments based on their contributions to overall portfolio return requirements and risk constraints. In general, institutional investing approaches move towards diversified portfolios designed to create a suitable return at the appropriate level of systematic risk rather than towards focused "maximum return" portfolios comprising only a few securities.

Asset class investments are broadly diversified investments in distinct capital markets. They generally "wash out" some of the major risks associated with ownership of just a few securities. By contrast, focused, performance-seeking portfolios often jump from security to security (or sector to sector) with only a passing nod to risk control on a macro portfolio level. Rather, a portfolio is deemed to be safe if either most or all of its securities are low risk – e.g., principal guaranteed – or if its securities are attractively valued and represent ownership in solid companies. After all, how risky can it be to own a portfolio of seasoned, blue-chip, well-admired S&P 500 companies like Enron, GM, Lehman Brothers, Kodak, Yahoo, and Citibank?

The Performance Seeking Portfolio: A Case Against Diversification

The concept of investment diversification is often misunderstood, and diversification strategies are sometimes maligned. Buying a broad cross-section of stocks and bonds in capital markets seems like a foolish and speculative investment strategy. The portfolio is packed with securities of firms about which the investor knows little or nothing. Many non-U.S. securities trade on exchanges that are open only during hours in which the U.S. investor is asleep. Inevitably, the investor ends up owning worthless securities in some portion of the portfolio as companies succumb to competitive pressures. Owning small positions in dozens of securities contributes to a failure to pay attention to important developments within each firm. The investor, fooling himself into believing that small losses do not matter in the context of his overall wealth, may develop habits of neglect and inattention that undermine long-term goals. Conversely, real fortunes are built by concentrating intellectual focus and capital resources. In the words of Andrew Carnegie:

> *Put all your eggs into one basket and then watch that basket, do not scatter your shot.*

Even worse, ownership of securities with uncertain dividend payments is a speculative venture. Protection of principal and security of income has, for generations, formed core principles of investment.

If speculation is imprudent, then purchasing

speculative investments such as raw land, securities of unseasoned companies, or any other undervalued or untried venture is also inappropriate. For several generations, investment commentators viewed diversification across capital markets unfavorably. Conventional wisdom told investors to avoid unsafe investment categories. Ultimately, even purchase of "blue chip" stocks became questionable. Investment and Speculation, a book co-authored by L. Chamberlain and William Wren Hay in 1931, provides a post-1929 stock market crash point of view:

> *Common stocks, as such, are not superior to bonds as long-term investments, because primarily they are not investments at all. They are speculations.*[11]

The sentiment against diversification, and in favor of a concentrated portfolio, echoes forcefully today. Many investors hire star investment managers to locate a few undervalued firms that are diamonds in the rough. One need only consider Warren Buffett's investment philosophy, wherein he recommends a value-investing style characterized by a portfolio of carefully selected, undervalued companies offering investors an opportunity for above average future growth.[12] The tenets of Buffettology, however, exist somewhat uncomfortably with the alternative philosophy advanced by Vanguard's John Bogle:

> *The winning formula for success in investing is owning the entire stock market through an index fund, and then doing nothing. Just stay the course.*[13]

How did this modern-day divergence of opinion come about? Which opinion is correct? Is it possible to reconcile the competing points of view? We consider these questions next.

The Most Important Investment Book Ever Written

If a time machine transported you back to 1938, you might notice a book entitled The Theory of Investment Value written, originally, as a Ph.D. thesis at Harvard, by John Burr Williams. This book is perhaps the most important and influential investment text ever published. Not only does it establish the foundation for much of the mathematics currently employed by bond analysts, it is the first book to fully develop the theory of discounted cash flow analysis which underpins much of today's investment valuation modeling and stock price forecasting methods. Discounted cash flow analysis holds that the justified price of a stock reflects the present value of dividends paid from the company's projected future earnings and profits.

To some extent, Burr Williams sought to counter certain investment strategies advocated by the prominent contemporary economist John Maynard Keynes. Keynes argued that proper assessment of a stock's prospects should incorporate an analysis of political, military, and macro-economic trends. The astute stock analyst must not only identify and monitor important macro trends, but must also consider industry-by-industry developments, a firm's competitive position within its industry, management capabilities, and other important factors that influence how the marketplace will assess the firm's future prospects. Care and skill needed to select and monitor stocks demands full-time effort and attention. As a consequence, even the most diligent portfolio manager quickly faces limits on the number of securities he can safely include in the portfolio. Keynes was a powerful voice articulating the merits of a focused portfolio owning securities of a few companies exhibiting good prospects for future

[11] Chamberlain, Lawrence and Hay, William Wren, Investment and Speculation: Studies of Modern Movements and Basic Principles. Henry Holt (New York, 1931), p. 57.

[12] In all fairness, however, Buffett has repeatedly stated that most investors should invest in broadly diversified portfolios consisting of passively managed index funds.

[13] Bogle, John C., The Little Book of Common Sense Investing. John Wiley & Sons, Inc. (Hoboken, New Jersey, 2007).

share-price appreciation. The Janus Twenty Fund or the Sequoia Fund reflect a Keynesian investment approach in today's market place.

The Keynesian approach disturbed Burr Williams because, in part, he recognized that a portfolio owning only a few securities was vulnerable to catastrophic losses. Irrespective of how closely the manager monitored macro-trends, industry developments, and individual firm financials, unforeseeable events might wreak havoc. Today, this phenomenon is well known to investors in Enron, the Madoff proprietary fund, and such infamous investments as Executive Life (a casualty of Michael Milken's junk-bond manipulations), ZZZ-Best (a high-flying stock of a mob-owned company), and in other firms.

Burr Williams offered an alternative strategy based on the concept of diversification. Rather than owning just a handful of stocks, the savvy investor should own a broad cross-section of securities from economic sectors that seem most promising. For example, if trends appeared favorable for railroads, an investor in the late 1930s might wish to own positions across the entire industry. Railroads in the Midwest generate profits transporting agricultural products, Southern railroads transport cotton and fruits, Northeastern railroads transport industrial products, Mid-Atlantic railroads transport coal and steel, and so forth. A portfolio owning just a few railroad securities from a single region might be devastated by bad weather, labor conflicts, or other unanticipated surprises. Owning a cross-section of railroad securities, however, protects the portfolio from unacceptable downside loss. Sector funds reflect the Burr Williams investment view in today's market place. In many ways, Burr Williams is the intellectual grandfather of the Fidelity Select Funds.

In 1952, a University of Chicago graduate student, working under economist and statistician Professor L.J. Savage, read John Burr William's book. The student, Harry Markowitz – a future Nobel Prize winner in Economics – agreed with Burr Williams that focused or concentrated portfolios subject investors to risk of catastrophic loss. However, Markowitz disagreed with Burr Williams' alternative strategy. Although the concept of diversification appealed to Markowitz, he recognized that owning 100 railroad stocks was not the same as owning 100 stocks across all industry groups. Rather than having 100 independent earnings events (statistical trials), the Burr William portfolio is the equivalent of a single trial. In statistical terms, although the Burr Williams portfolio owns many securities, their returns are highly correlated. There is a tendency for all investments to move in lockstep – which is wonderful if forecasted profits are realized; but disastrous if they are not. In a nutshell, Burr Williams' solution exacerbates the risk of focused portfolios, rather than mitigating it.

Markowitz's "scientific diversification"[14] solution to the fundamental problem of portfolio design, however, was slow to catch on, because it is based on two "unobservable" statistical elements: volatility and correlation. Investors can only know the historical series of ***realized*** investment returns. Volatility and correlation values depend on measurement intervals and sampling periods. Annualized volatility – also known as annual standard deviation – differs according to whether price changes are measured on a daily, weekly or monthly basis. Correlation, in turn, is a function of volatility. Eventually, however, Markowitz's revised and expanded doctoral thesis, published in 1959, became the cornerstone of Modern Portfolio Theory.[15]

[14] This term is defined below.

[15] For an in-depth discussion of the history of research on portfolio diversification, see: Collins, Patrick J., "Diversification: Recent Legal and Academic Perspectives," California Trusts and Estates Quarterly (Summer, 2003). This is available on the Schultz Collins website.

Investments 101: A Pop Quiz

Most every introductory investment textbook starts a discussion of diversification by asking students to select investments for a simple and stylized portfolio. This book follows this tradition by presenting data on the following three investments:

- Investment X has an expected return of 6% and volatility of 15%
- Investment Y has an expected return of 7% and volatility of 20%
- Investment Z has an expected return of 4% and volatility of 25%.

The student is given the assignment of designing a portfolio with an expected return of 6% over the forthcoming period. The challenge is to pick the most efficient combination of investments for the portfolio. Many beginning students eliminate investment Z immediately for at least two reasons:

1. The return prospects for Z are relatively poor; and, including Z within the portfolio puts a drag on investment returns; and,
2. The volatility of Z is higher than the alternatives; and, including Z within the portfolio will increase the risk of unfavorable outcomes.

When considered in isolation, investment Z seems like a poor choice. It seems difficult to justify owning an investment that exhibits both high risk and mediocre return.

In the above example, the student might decide to allocate 100% to investment X. Investment X meets the target return (6%) at the lowest level of volatility. Alternatively, investment Y might seem to be a better choice because its expected return of 7% provides a cushion (margin of safety) although it may be more volatile. Perhaps, after some consideration, the student might opt for a combination of X and Y.

The Quiz Answer

The key input that the beginning student lacks is asset return correlation values. On a preliminary basis, we define correlation as a measure of the linear association between two investments. If the return of investment A tends to be above its long-term average at the same time that the return of investment B tends to be above its long-term average, then the two investments are positively correlated. If the return of one investment tends to be lower than its long-term average, while that of the other investment tends to be higher, then the two investments are negatively correlated. Finally, if the returns of each investment exhibit no linear association, the returns are not correlated. Uncorrelated returns have a correlation value of 0; returns that are perfectly correlated have a correlation value of +1; and returns that are perfectly negatively correlated have a correlation value of -1. Correlation can assume any value within the ±1 interval.

When considered individually, each investment within the portfolio is risky. Given an expected return for investment x of 6%, and a standard deviation of 15%, for example, creates an approximately 95% chance of a realized return in the forthcoming period between -24% and +36%, assuming a normal return distribution. However, if investments Y and Z are less than perfectly correlated with X, there may be an opportunity to use one or both to offset a portion of X's downside risk while preserving the feasibility of the 6% return target. Let's suppose that the pair-wise correlations are 0.7 for X and Y, -0.4 for X and Z, and 0.8 for Y and Z. Some matrix algebra indicates that the investor prefers to own the following portfolio:

- Investment X: 71.3%
- Investment Y: 19.1%
- Investment Z: 9.6%

This portfolio achieves an expected return of 6% at a standard deviation of 13.65%. It is a more efficient asset allocation because it incorporates both correlation values and volatility values in addition to expected returns. The focus on selecting investments for maximum return gives way to a focus on the asset

1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
14.77%	37.43%	35.27%	33.36%	28.58%	67.11%	26.37%	33.99%	19.49%	77.86%	32.11%	35.19%	35.11%	40.28%	10.89%	81.03%	30.46%	8.28%	19.70%	49.30%
8.06%	33.20%	23.07%	28.04%	20.33%	32.90%	10.12%	13.93%	9.84%	60.25%	31.58%	22.63%	35.06%	11.63%	5.08%	61.12%	29.10%	6.35%	18.89%	42.96%
5.23%	29.47%	19.26%	24.02%	15.30%	31.65%	6.27%	13.24%	3.82%	57.16%	28.11%	14.02%	26.86%	10.95%	2.01%	44.83%	27.95%	5.80%	18.14%	32.39%
3.17%	19.04%	18.04%	20.26%	10.24%	30.16%	1.59%	8.96%	2.02%	51.73%	21.10%	12.16%	26.32%	8.04%	-37.00%	44.04%	20.73%	2.11%	17.90%	23.58%
2.34%	15.33%	9.37%	7.87%	8.44%	27.30%	-9.10%	3.63%	-2.85%	39.17%	20.70%	6.77%	18.10%	7.39%	-37.60%	32.46%	20.64%	0.18%	17.34%	23.29%
1.31%	15.27%	6.36%	5.70%	5.17%	21.04%	-11.00%	1.77%	-3.94%	37.13%	16.70%	4.91%	16.17%	5.49%	-37.73%	27.99%	15.06%	-3.99%	16.80%	2.86%
-1.52%	11.55%	5.61%	2.06%	0.51%	5.07%	-12.26%	-0.99%	-13.86%	28.68%	10.88%	3.66%	15.79%	4.61%	-41.48%	26.46%	8.21%	-10.20%	16.00%	0.12%
-1.93%	6.13%	4.05%	0.23%	-8.17%	0.39%	-13.02%	-11.89%	-15.66%	14.91%	10.35%	3.59%	6.12%	-0.12%	-43.06%	5.24%	5.89%	-11.73%	3.89%	-0.57%
-3.14%	0.99%	3.62%	-14.55%	-17.50%	-4.27%	-13.96%	-16.75%	-21.58%	4.31%	3.04%	1.58%	4.94%	-7.94%	-47.11%	2.55%	5.17%	-15.59%	1.65%	-0.86%
-12.01%	-8.41%	2.80%	-14.74%	-22.01%	-4.62%	-31.76%	-21.21%	-22.10%	1.25%	1.82%	-6.88%	4.08%	-15.69%	-53.74%	0.47%	0.31%	-19.03%	0.17%	-4.00%

The table depicts ten asset class "building blocks" from which investors can design portfolios. The color coding is as follows:

- 1-Year T-Bills
- Foreign Large Company Stocks
- U.S. Intermediate-term Bonds
- U.S. Large Company Stocks
- Foreign Small Company Stock
- World Government Bonds
- U.S. Small Company Stocks
- Emerging Markets Stock
- U.S. Micro Cap Stocks
- Securitized Real Estate

FIGURE 2-3

allocation decision. The most efficient asset allocation weightings, in turn, suggest the wisdom of what Markowitz termed "scientific diversification." This is diversification based not on a higgledy-piggledy collection of many investments; but rather on combining investments to generate return at an efficient level of risk. In this example, the best portfolio contains a positive weighting of the worst investment. Once the portfolio's required return has been identified, primary effort is put into calibrating the return target with the investor's risk preferences. In this context, owning just a few stocks seems to be a foolish investment strategy that amounts to mere speculation. Modern Portfolio Theory often runs counter to traditional investment wisdom.

The Periodic Table of Investment Returns

A common method for illustrating the value of diversification is the use of a "periodic table" of investment returns. We create such a table (**FIGURE 2-3**) for the twenty-year period 1994 through 2013.

As the table illustrates, the relative performance of asset classes can shift dramatically year-to-year. Investors have a choice as to whether they will attempt to predict the winning asset classes for the forthcoming year, or maintain exposures to all asset classes so they avoid the possibility of extreme performance results. It is difficult to identify any exploitable investment pattern from Figure 2-9. Winners seem not to persist; and, conversely, a strict contrarian approach – investing in the previous year's losers – also seems not to assure long-term profitability. The lack of predictability is a source of frustration for the focused portfolio approach, but is a potential benefit for a diversified portfolio approach. A later section examines the nature of this benefit as well as limitations and pitfalls that may arise when designing a diversified portfolio. It revisits Figure 2-9 from a very different perspective.

An Investment Tag Team Match: Warren Buffett & Andrew Carnegie versus John Bogle & Harry Markowitz

Is there a way to reconcile Warren Buffet/Andrew Carnegie with John Bogle/Harry Markowitz? One often encounters a phrase like "when you buy a share of stock, you are investing in a company." However, the phrase's vocabulary may serve to confuse as much as enlighten. When an entrepreneur invests in a company, he seeks control of company assets, and, by extension, control of the company's business strategies, with an ultimate goal of commercial success. When an investor buys a share of stock in a company, he or she probably does not want operating control of the firm. Rather, the investor desires a reasonable return on the stock purchase with an ultimate goal of investment success. Carnegie wishes to control U.S. Steel, Buffett wishes to control Berkshire Hathaway, and Bogle wishes to achieve an attractive return for a large population of mutual fund shareholders. The strategies required to attain commercial success differ from those required to attain investment success. Unfortunately, to the great confusion of many investors, a common vocabulary is used for both projects.

We can take a second pass at the phrase: "when you buy a share of stock, you are investing in a company." The force and effect of the vocabulary inevitably directs attention to the fact that each share of stock represents a pro-rata right to share in the future dividends and profits of the company. Again, a good portfolio should only own the stocks of good companies – right? Who would want to own the stock of a company that might have poor future dividends and profits? The portfolio design process reduces itself to a bottom-up hunt for good stocks with asset allocation concerns slipping far into the background – "my investment policy is to make money." Investors are faced with the compelling examples of commercial success that always abound in the press, and are confused by the vocabulary in common use. But Warren Buffett doesn't run money; he runs businesses. There is no such thing as the Buffett Mutual Fund. The financial analyst looking for a good ***business*** investment concerns himself with the "fundamentals" ["the firm has good earnings quality, the firm has a strong balance sheet, the firm has attractive patent protections and cutting edge technology …"]. The analyst looking to design a good ***portfolio*** concerns himself with both fundamentals – a security seen as a bundle of forecasted monetary payoffs in each economic environment – as well as with a security's statistical aspects – a vector of returns that is a bundle of quantitative characteristics including its correlation values with other securities.

Finally, it is interesting to consider the limits of diversification. Given the downside volatility in many capital markets during the Crash of 2008-2009, it is not surprising to see a resurgence of the sort of rhetoric popular in the aftermath of the Crash of 1929. Some investors now view stocks as mere speculations that should be avoided for portfolios tasked with funding critical economic objectives. Investors are these days constantly tuned to detect asset price "bubbles" – both real and imagined. Some suggest that critical goals should be scrupulously matched and exclusively funded with low-risk fixed income investments. Under this view, equity investing is merely a residual activity that, with luck, gives investors a chance of being rich. The higher expected return of stocks is a siren's song that, sooner or later, will lead investors to crash their financial ship. Principal guarantees take the place of portfolio diversification.

The strategies required to attain commercial success differ from those required to attain investment success. Unfortunately, to the great confusion of many investors, a common vocabulary is used for both projects.

Some pundits suggest on the other hand that prudent asset management must involve dynamic market timing shifts to avoid vulnerable sectors of the domestic and world economies. Others tout this as a "traders'" or "stock pickers" market. Still others recommend a large allocation to commodities like silver and gold. The process of portfolio design through broad-scope diversification takes a back seat to a strict metric of Profit & Loss. Under any of these viewpoints, diversification seems ineffective and Modern Portfolio Theory is a fraud.

The "best" portfolio includes the "worst" investment.

CORRELATION AND ASSET ALLOCATION

The previous sections show how an efficient combination of investments with differing statistical characteristics enhances a portfolio's risk/reward tradeoffs. This method of portfolio construction stands in contrast to a technique that bundles investments sharing common characteristics – safety of principal, forecasted capital appreciation, high current dividend or interest income, and so forth – into a portfolio. In brief, the example illustrates how a combination of three securities generates a portfolio that achieves the expected return at a level of risk lower than that of any individual security. The pedagogical message of this admittedly stylized example is that the most favorable combination of securities includes an investment that, when viewed in isolation, promises comparatively low returns and high risk. The "best" portfolio includes the "worst" investment. A comparable example generally appears in most introductory investment textbooks to illustrate how combinations of assets with differing risk/return patterns offer an opportunity to create portfolios well suited to investor goals. More advanced investment texts use similar examples to introduce technical expositions on the mathematics of diversification.

A key concept for understanding the principles of efficient ("scientific") portfolio diversification is the correlation statistic. The central question we address is whether the severe 2008-2009 bear market forces investors to reassess the risk/reward benefits of portfolio diversification derived from analyses of investment returns earned in previous, more "normal" years. In other words, is diversification an effective strategy for controlling portfolio risk, or should it be relegated to the scrap heap now that the Crash of 08 has "changed everything"? Understanding the concept of correlation is a prerequisite to understanding the limits of diversification.

The Geometry of Correlation

We previously defined correlation as:

> *…a measure of the linear association between two investments. If the return of investment A tends to be above its long-term average at the same time that the return of investment B tends to be above its long-term average, then the two investments are positively correlated. If the return of one investment tends to be lower than its long-term average while that of the other investment tends to be higher, then the two investments are negatively correlated. Finally, if the returns of each investment exhibit no linear association, the returns are not correlated. Uncorrelated returns have a correlation value of 0; returns that are perfectly correlated have a correlation value of +1; and returns that are perfectly negatively correlated have a correlation value of -1. The correlation statistic can assume any value within the ±1 interval.*

Geometrically, one can think of correlation as the interaction of return vectors. Working in a simplified two-dimensional coordinate plane [a "bivariate return distribution"], each return vector is a line through the origin if we set the initial period t – 1 return to zero. In two-dimensional subspace, if two returns are perfectly positively correlated they must point in the same direction; if perfectly negatively correlated they must point in opposite directions. Here are pictures of return vectors (arrows) in two-space for various values of the correlation statistic (**SEE FIGURE 2-4**).

It is apparent that correlation depends on the angle formed by the two return vectors. More formally, for return vectors of equal volatility, correlation is associated with the cosine of the angle formed by the corresponding vectors. Our explanation stresses the fact that correlation is a measure of a linear dependence relationship only. Two results flow from this observation:

- Some linear relationships result in spurious correlations. A well-known example is the correlation between ability in mathematics and children's shoe-size. This correlation is spurious because older children are typically better in math than younger children, and older children tend to have larger feet. Buying your youngster an ill-fitting pair of large shoes will not increase his or her scores on an arithmetic test. Statistics courses often discuss difficulties encountered when estimating correlations between data series that cannot pass tests for stationary (infinite variance series). This is important in finance because random walk price evolutions are, by definition, non-stationary.
- Two data series can have a zero value for the correlation statistic and yet exhibit a strong dependence structure because of a non-linear relationship. If, for example, X is distributed symmetrically around the origin and Y equals X2, then their correlation equals 0: the X return vector = (-2,-1, 0, 1, 2) and the Y return vector = (4, 1, 0, 1, 4). The correlation between X and Y is 0, despite their non-linear dependence relationship.

Each of these observations has important consequences for portfolio design and management that we

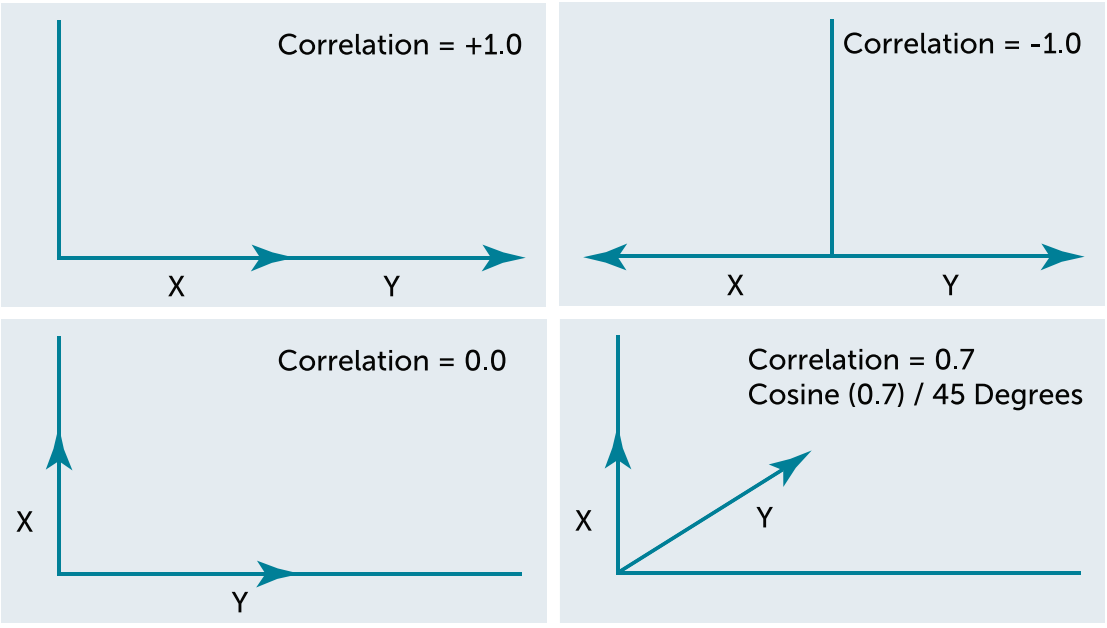

FIGURE 2-4

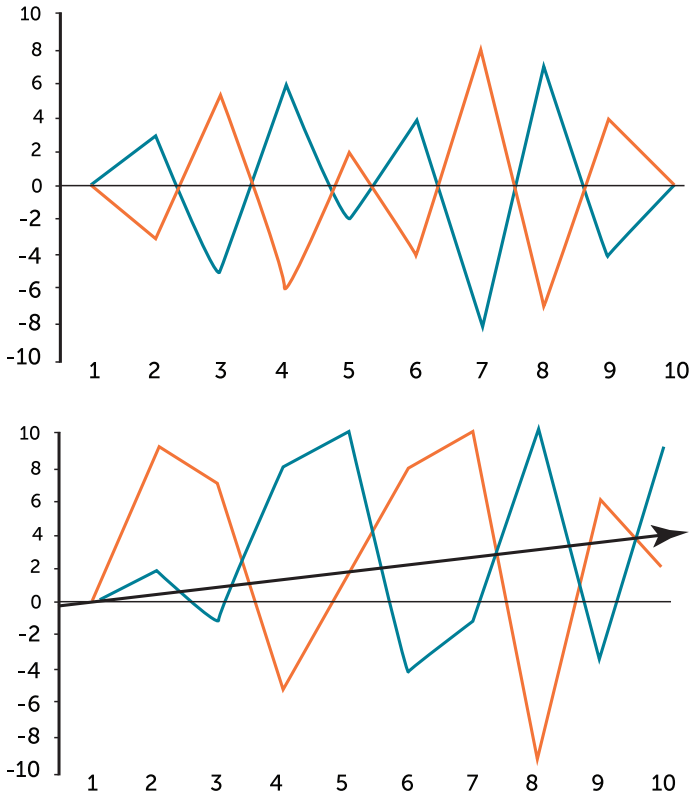

FIGURE 2-6

will discuss later.

We advance this somewhat technical explanation because many investors think that positive correlation means that two assets tend to increase in value, while negative correlation means that two assets tend to exhibit offsetting returns. This *incorrect* view can be expressed graphically in **FIGURE 2-5**.

If this were the case, combining assets with perfect negative correlation would take the portfolio nowhere fast – any gains made by investment X (blue) would be exactly offset by investment Y (brown). Combining the two investments into an equally-weighted portfolio guarantees no growth whatsoever! This incorrect view of correlation causes some commentators to observe that focused portfolios seeking high period-by-period performance are superior to portfolios formed by combining assets with low or negative correlation. This argument, although it sounds compelling, is specious.

Consider an alternative, correct, view of negative correlation as expressed in **FIGURE 2-6**.

Figure 2-6 also shows negative correlation (when asset X is above its mean return of 3%, asset Y is below its mean return of 3%, and vice versa). However, there is a positive long-term rate of growth for the portfolio as a whole, as evidenced by the upwardly sloping arrow. For example, X and Y are negatively correlated in period 't' if asset X earns 4% and asset Y earns 2%. Both assets increase in value but exhibit perfect negative correlation for the period because the returns fall on the opposite side of their respective means (averages).

Correlation and Risk Control

During the early period of Modern Portfolio Theory, from the 1960s through the 1980s, knowledge of asset correlations was considered valuable in so far as it provided a guide to designing portfolios at an appropriate level of risk. The promise of Modern Portfolio Theory [MPT] is centered in its belief that the correlation structure of securities provides the key to controlling risk without sacrificing return. Portfolios built on MPT principles differ in approach from methods that accept low returns in exchange for principal guarantees. By forming portfolios of assets exhibiting differing pair-wise correlation values, overall risk is measured and controlled from the "portfolio context" rather than by aggregating low earning, stable-value assets. Let's work through some examples to illustrate how MPT uses correlation as a "risk-control" input for portfolios.

Each of the charts in **FIGURE 2-7** depicts the consequences of forming a portfolio from two assets: asset A has an expected return of 6% with a volatility of 8% as measured by its annualized standard deviation; asset B has an expected return of 12% with a volatility of 20%. If we form a portfolio comprised of only

asset A, all of the portfolio weight will fall on the point labeled 'A.' If we begin to blend A with investment B, the economic consequences differ depending on the value of the correlation statistic. The upper left chart indicates that as we move from a 100% investment in A to a 100% investment in B, the investment results trace out a straight line because the correlation value is a perfect +1. However, if the correlation value is at the opposite extreme – i.e., negative 1 – then the upper right chart indicates that blending the two investments will result in the risk of A tending to offset the risk of B. Risk reduction continues until we arrive at a minimum risk portfolio. As the portfolio moves away from the minimum risk "blend," the portfolio tracks either A or B more closely.

The bottom left chart depicts the region of feasible investment combinations over the complete range of correlation values – i.e., ±1. The upper and lower correlation bounds carve out a risk/return region into which any two investments with known returns and standard deviations must fall. The riskiest spot in the region is located at the point where the portfolio consists of 100% B and 0% A. This point has an expected return of 12% with a standard deviation of 20%. The least risky spot in the region is located at the point where A and B combine for 0% risk – the minimum risk blend. This point has an expected return of slightly less than 8% with a standard deviation of zero. (You can tell that this is a highly stylized example because today's risk-free rate is approximately 2% – investors would love to earn a risk-free 8%). The bottom right chart indicates that a combination of asset weightings and correlation values between ±1 determines the portfolio's location within the feasible region's risk/return space. Given a positive weighting of any asset, the portfolio is likely to be improved by combining the asset with an investment in a second asset with a low correlation value. The bottom right chart illustrates the risk/return profiles when asset

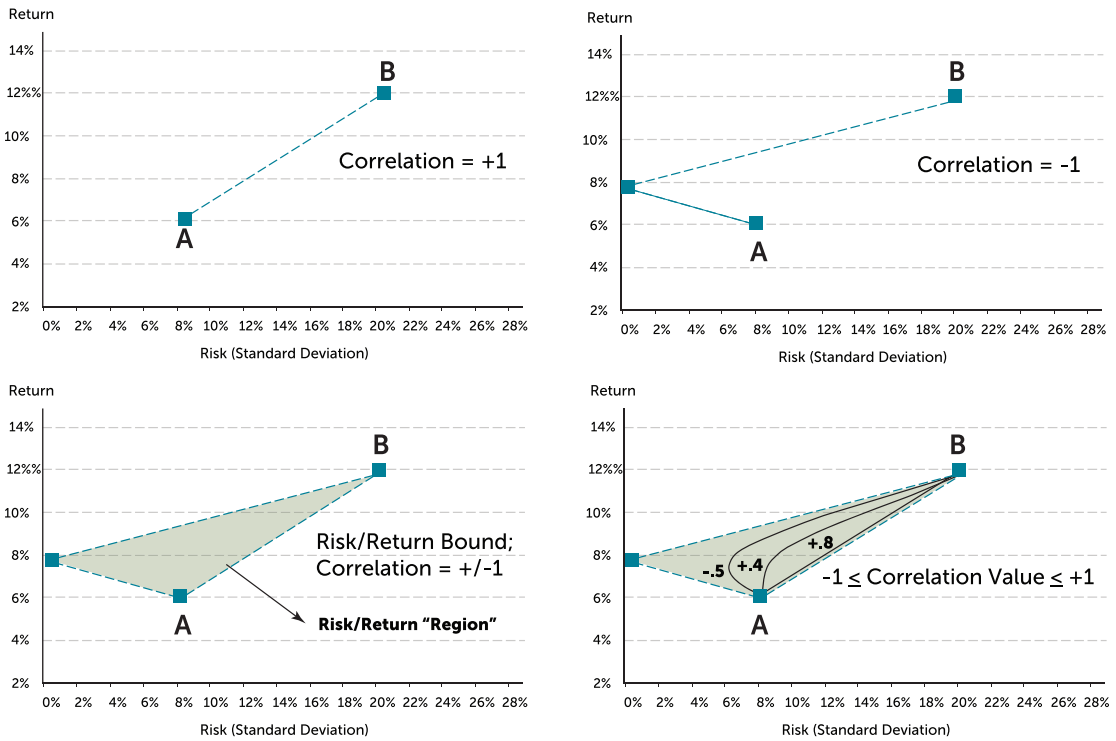

FIGURE 2-7

correlations are -0.5, +0.4, and +0.8. The higher the value, the closer the portfolio tracks to the straight line (correlation = +1.0) at the edge of the region.

Mixtures of assets with different pair-wise correlations create an aggregate portfolio with a more favorable risk/reward tradeoff. In general, a portfolio benefits more by adding assets with lower correlation values than with higher values, all else equal. Knowledge of correlation enables investments to be evaluated in a portfolio context rather than in isolation because it provides a clue to how investments interact over time. This observation gives rise to a classic problem in Modern Portfolio Theory: what is the optimal combination of assets given an investor's return preferences and risk constraints? Harry Markowitz shared the 1990 Nobel Prize in Economics, in large part, because he provided a solution to this problem.

The Periodic Table of Investment Returns Revisited

You may recall the "periodic table" of returns presented previously. We expand our view of this table by summarizing the asset class returns (i.e., the vectors of historically realized returns) into a more compact table (**FIGURE 2-8**) of correlations (average pair-wise values of the correlation statistic).[16]

1994-2013 (20 Years)	U.S. Large Company Stock	U.S. Small Company Stock	U.S. Micro Cap Stock	Securitized Real Estate	Foreign Large Company Stock	Foreign Small Company Stock	Emerging Markets Stock	U.S. 1-Year T-Bill	U.S. Intermediate Bonds	World Government Bonds
U.S. Large Company Stock	1.00	0.84	0.70	0.42	0.81	0.60	0.43	0.09	-0.06	-0.08
U.S. Small Company Stock	0.84	1.00	0.96	0.59	0.79	0.74	0.67	-0.19	-0.20	-0.25
U.S. Micro Cap Stock	0.70	0.96	1.00	0.61	0.70	0.72	0.66	-0.24	-0.14	-0.18
Securitized Real Estate	0.42	0.59	0.61	1.00	0.43	0.50	0.41	-0.06	0.02	-0.14
Foreign Large Company Stock	0.81	0.79	0.70	0.43	1.00	0.93	0.76	-0.07	-0.35	-0.09
Foreign Small Company Stock	0.60	0.74	0.72	0.50	0.93	1.00	0.84	-0.25	-0.42	-0.08
Emerging Markets Stock	0.43	0.67	0.66	0.41	0.76	0.84	1.00	-0.21	-0.32	-0.20
U.S. 1-Year T-Bill	0.09	-0.19	-0.24	-0.06	-0.07	-0.25	-0.21	1.00	0.29	0.01
U.S. Intermediate Bonds	-0.06	-0.20	-0.14	0.02	-0.35	-0.42	-0.32	0.29	1.00	0.58
World Government Bonds	-0.08	-0.25	-0.18	-0.14	-0.09	-0.08	-0.20	0.01	0.58	1.00

FIGURE 2-8

[16] Table exhibits correlation values for the twenty-year period ending 2013.

The classic definition of the portfolio design process entails the optimal combination of investments based, in part, on the correlation values like those exhibited in Figure 2-8. If certain simplifying assumptions are allowed, it can be demonstrated that there is a unique combination of assets that generates the highest expected returns for a given level of risk; and, the lowest level of expected risk for a given return. Financial economists term this unique combination "the efficient portfolio." Furthermore, investing in any portfolio other than the set of efficient portfolios along the risk/return spectrum results in an unnecessary destruction of wealth, in the sense that a non-efficient portfolio has expected returns insufficient to compensate the investor for the assumed level of risk. Correlation values seem to be the key to creating prudent portfolios.

When the investor combines holdings across different asset classes are into a portfolio he effectually creates a single complex security. The risk and return characteristics of the portfolio differ from those of its component asset classes. However, it is difficult to calculate these portfolio characteristics. Such calculations require specialized software.[17] Unless the investor performs such calculations, however, the overall character of the portfolio, and particularly the risk it poses, remains obscure. Yet these hidden data are the most important insights an investor can obtain. Without knowledge of overall portfolio risk and return, the investor is effectively blind with respect to the consequences of any particular investment decision.

Yet these hidden data are the most important insights an investor can obtain. Without knowledge of overall portfolio risk and return, the investor is effectively blind with respect to the consequences of any particular investment decision.

Recent Research: Cause for Reassessment?

During the period that roughly spans the late 1980s through the present, probably no other area of academic research in finance has proved more fruitful than the study of asset price behavior. Skilled econometricians investigated the properties of financial asset returns and, with the aid of increased computer power, developed a rich set of dynamic asset pricing theories. Central to this research is a re-examination of the nature of correlation. Recent advances in econometrics – the application of statistical techniques to finance problems – have led, in some cases, to substantial modifications of the classic principles of Modern Portfolio Theory. The scope of the literature on financial econometrics is vast, and we here provide only a brief discussion of some basic points.

The classic definition of correlation relies, in part, on the central limit theorem. According to this point of view, a long-term average expected return represents the central tendency for the growth of

[17] For independent trials, the variance of a sum (i.e., a portfolio) equals the sum of the variances (i.e., the individual components). However, because of the correlation structure of securities within the portfolio, the variance of a sum equals both the sum of the variance and the sum of all cross-product (or "covariance") terms. In a two asset portfolio, there are two individual asset variance terms plus two covariance terms; in a four asset portfolio there are four individual asset variance terms plus twelve covariance terms; in a ten asset portfolio there are ten individual asset variance terms plus ninety covariance terms; in a hundred asset portfolio there are one hundred individual asset variance terms plus nine hundred and ninety covariance terms. In the limit, as the number of assets grows large, the proportional risk of any individual asset moves asymptotically towards zero – only systematic or market risk remains. Labels like "safe assets" or "growth assets" become meaningless because investments cannot be evaluated in isolation but only from within the portfolio context.

ROLLING 36 MONTH PERIOD CORRELATIONS
S&P 500 VS. FOREIGN LARGE COMPANY STOCKS (MSCI EAFE)

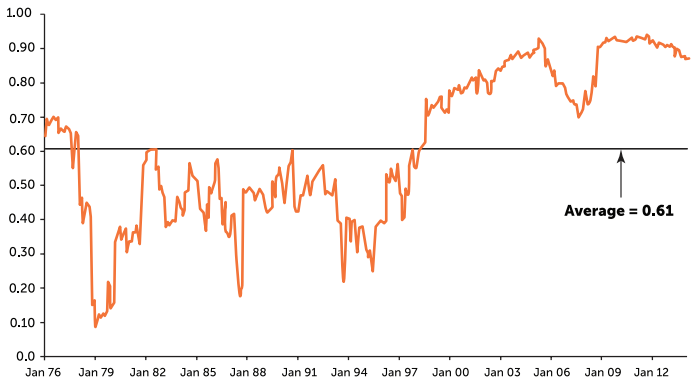

FIGURE 2-9

wealth under specific asset allocations. In any period, realized returns may be above or below this central tendency, but such deviations represent only temporary deviations from the true – but unobservable – central mean. Likewise, depending on the method of measurement, by the central limit theorem, there is a constant long-term value for volatility. Risk-averse investors have a preference for high average positive return, and an aversion for high volatility of returns – they like return and dislike risk. Although the traditional economic view allows for period-by-period variations in realized risks and returns, such variations are merely temporary perturbations from fixed long-term constant parameter values.

Ultimately, this is a static, equilibrium-oriented system rather than a dynamic economic world view. Volatility differs from period-to-period; but, its long-term value is a constant – i.e., not time varying. Correlation – as the "byproduct" of asset returns and volatility – is also deemed, by the central limit theorem, to converge to an average or theoretical steady-state value. Econometricians call this constant value "unconditional correlation." Under the central limit theorem, the larger the sample (i.e., the longer the history of returns), the greater the investor's confidence in the "true" (i.e., unconditional) value of asset correlations.

Beginning in the late 1980s more powerful computers allowed financial economists to model asset returns such that volatility became volatile (time varying volatility) and correlations became dynamic (conditional correlation versus unconditional correlation). By the mid-1990s, certain large institutional investment houses and consulting firms developed more sophisticated "risk metrics" capable of producing advanced computer-driven asset pricing models. Recent econometric research has, to some extent, turned elements of classic Modern Portfolio Theory on their head. For example, in 2005, Markowitz published an essay arguing that the market portfolio is not efficient and there is probably no linear relationship between an asset's beta[18] and its expected returns.[19]

Some current asset pricing theories see parameters such as mean and volatility not as converging towards theoretical steady-state constant values, but as dynamic values that must be adjusted both within differing regimes and across differing regimes. There may not be a true overall unconditional average such as the central limit theorem suggests; rather, volatility and correlation values may be conditional on the particular market regime – e.g., "bull" or "bear" market. Consider, for example, **FIGURE 2-9** of rolling three-year correlation between large capitalization U.S. stocks (the S&P 500) and large capitalization foreign stocks (the EAFE Index) over the period 1976 through 2013.

A correlation table fixes the value of the correlation statistic at 0.61, which is the average for the period. However, the actual three-year rolling correlation values range from a low of approximately 0.1 to

[18] Systematic risk relative to the market.

[19] Markowitz, Harry M., "Market Efficiency: A Theoretical Distinction and So What?" Financial Analysts Journal (September/October, 2005), pp.17-30.

a high of 0.92. Building a portfolio on the assumption that the average is a reliable and constant parameter may not be a particularly good idea.

Figure 2-9 suggests two important facts about correlation:

- It is an average taken over many years; and, like all averages, may not be representative of actual year-by-year values.
- It is dynamic. Rather than forcing the correlation value to "fit" the entire period by assuming that it converges to a constant value, it may be more appropriate to split the time period into two or more regimes – e.g., a bull market regime and a bear market regime. If the correlation values shift dramatically from regime to regime, then building a portfolio based on an overall average may yield suboptimal results.

The second of the two facts leads some econometricians to argue that the most useful statistic is ***conditional*** correlation rather than absolute or ***unconditional*** correlation. Estimating a value for conditional correlation involves asking the question: "If the economy is in regime X, what are the likely asset correlations in this regime?" This question is, of course, different from calculating the correlation values over all regimes within the sample period. Asset pricing models using conditional correlation values seem to produce outputs that better replicate the real world behavior of investment returns.[20]

Conditional correlation calculations highlight not only the dynamic nature of correlation, but reveal a fact that is critical for risk control purposes. In severe down markets, volatility tends to increase (a higher standard deviation signifies that investment returns are more uncertain) and, most importantly, correlations also tend to increase. For example, the S&P 500/EAFE graph (Figure 2-9) shows correlation rising to over .90 during the financial crisis of 2008. This observation has profound consequences for portfolio management. During bear markets, when downside volatility increases, a corresponding tendency for an increase in asset correlation makes it less likely that a portfolio can emerge unscathed.[21] If correlation is the key to efficient diversification, then increasing correlation values erode the benefits of diversification when it is most needed.

During bear markets, when downside volatility increases, a corresponding tendency for an increase in asset correlation makes it less likely that a portfolio can emerge unscathed.

During the last several years, a flood of research has appeared on the topic of "diversification meltdowns" during periods of severe downside returns. Here is a brief recap of two important topics:

- First, correlation is only one measure of the possible dependence structures of financial return time series. It is a good dependence measure if the return series are normal (bell-curves) but potentially misleading for non-normal time series. Unfortunately most publically traded assets (individual stocks and bonds, as well as baskets of securities such as stock and bond mutual funds) flunk statistical tests for normality. Although they may flunk for a variety of reasons, the bad news is that financial returns are often "fat-tailed." This

[20] A more formal definition of conditional correlation is: conditional covariance divided by the product of the conditional standard deviations, where all numerical inputs are a function of the available information set. Engle, Robert, Anticipating Correlations: A New Paradigm for Risk Management (Princeton University Press, 2009), p. 16.

[21] Increased volatility does not automatically result in increased positive correlation. See, for example, Rebonato, Riccardo & Denev, Alexander, "Coherent Asset Allocation and Diversification in the Presence of Stress Events," Journal of Investment Management, (2012), pp. 19-53. The authors argue that each economic crisis generates unique statistical patterns – that is to say, there is not a "typical" crisis.

means they manifest extreme results (both positive and negative) at a probability greater than that found in normal distributions. This is not good news for risk-averse investors. Extreme downside volatility increases pair-wise correlation values so that many asset combinations appear to be headed into a death spiral simultaneously. This can be very scary.[22]

- Second, financial return series exhibit a variety of extremely interesting non-linear associations. Cutting edge research is moving beyond correlation metrics into analysis of asset co-integration, portfolio copula structures, and regime-switching conditional parameter estimation. More advanced methods can capture risk characteristics of financial asset returns that correlations miss. Correlation is a valid risk-control metric only when distributions manifest a symmetric, linear dependence structure. The distribution of financial asset returns, by contrast, often manifest strikingly asymmetric tail dependence. Bell curves have most of the probability mass in the center, and the tails are relatively skinny. Extreme events are considered to be unlikely. However, a more credible method of illustrating portfolio risk is to reflect tightening correlations in extreme market conditions.

...the astute reader may recognize that the financial advice profession has, to a great extent, landed clients back into the old fear/greed decision making structure that has been discredited for decades.

New Approaches and Old Remedies

As the dust settled on the global bear market, many investors pondered whether they should re-examine their macro allocation (ratio of stocks to bonds). Modern Portfolio Theory suggests that stock risk is manageable in the portfolio context because other asset classes such as securitized real estate, emerging markets stocks, and blue-chip U.S. stocks manifest differing pair-wise correlation values. Further research, however, suggests this statement should be modified: asset classes manifest differing pair-wise correlation values ***on average***. In extreme volatility regimes, however, the correlation values often differ significantly from their historical averages, and in down-market regimes, the pair-wise correlation values may move towards +1. For investors who elected to assume certain bond risks by holding junk (high-yield) bonds or mortgage-backed debt instruments, the convergence towards unity of the correlation structure in down-market regimes was particularly devastating.[23]

During the depths of the global recession, some investment advisors advocated a stay-the-course posture because, in their view, stocks were "on sale." It was a good time to re-commit to equities because they were likely to go up in value as the business cycle moved out of the recession. Other advisors sought to re-assess client risk tolerance as a first step in selecting a new long-term strategic asset allocation. The strategy often involved shifting to short-term, government-issued fixed income instruments with guaranteed payments of interest and principal. From these facts the astute reader may recognize that the financial advice profession has, to a great extent, landed clients back into the old fear/greed decision making structure that has been discredited for decades.

[22] Recent discussions on the topic of seemingly uncorrelated assets include "the butterfly effect" – a plunge in Los Angeles real estate values impacts orders for a factory in Dongguan, China – and on the "crowded trading effect" – hedge fund margin calls on stock portfolios require widespread sales of collateral asset positions like Treasury Inflation Protected Bonds. This research indicates the limits of viewing correlation as a simple linear association that is captured by a constant parameter value.

[23] Meissner, Gunter, Correlation Risk Modeling and Management (John Wiley & Sons, 2014) provides a good survey of the global financial recession's impact on various measures of dependence among financial assets.

Decisions are driven by a Profit & Loss metric ("today's the day to make money"/"don't lose any more money") that is not helpful. For all of the advances in financial economics, it seems as if some investors are returning to the days of using investment nostrums from yesteryear to cure current portfolio ills. Is there a credible solution path? The answer to this most important question forms the subject matter of the next section.

Decisions are driven by a Profit & Loss metric ("today's the day to make money"/"don't lose any more money") that is not helpful.

The concept of utility is key to the development of sound investment strategies.

APPROACHES TO ASSET ALLOCATION

Strategic Asset Allocation in Portfolio Management: Selecting and Controlling Exposures to Systematic Risk

The function of strategic asset allocation in portfolio management is to integrate the investor's return objectives, risk tolerance, investment preferences and constraints with long-term capital market expectations in order to enhance investor utility. The concept of utility is key to the development of sound investment strategies. As noted, utility is a numerical measure of 'happiness' or 'satisfaction' with the portfolio. Unless you are a gambler, utility is usually positive in return and negative in risk. Thus, the "best" portfolio – the one with which the investor is most happy – is not always the one that can generate the most money. Few investors would readily agree to invest their entire nest egg in a portfolio of lottery tickets, biotech companies, oil wells, or other high-risk/high payoff deals. Specifically, the greater a portfolio's utility value, the more the investor prefers it to portfolios with alternative allocations. Thus, we restate our initial proposition: the primary purpose of strategic asset allocation is to increase utility by establishing appropriate exposures (weightings) to asset classes.[24]

Asset allocation is the process by which an investor:

- Selects systematic risk exposures appropriate for the purposes, distribution requirements and other economic goals of the portfolio,
- Selects assets to provide the desired risk exposure(s), and
- Weights the assets within the portfolio to conform to personal preferences and risk constraints.[25]

It is the job of an investment advisor to use specialized skills to enhance the investor's utility

[24] One commentary suggests that "each asset class should include relatively homogeneous investments, and the asset classes should be mutually exclusive. For the purposes of risk control, an included asset class should not have extremely high expected correlations with other asset classes (or combinations of other asset classes). From a similar perspective, it is also desirable that the asset classes together make up a preponderance of world investable wealth." The authors point out the use of asset classes within the strategic asset allocation context: "Distinct (and well-differentiated) groups of assets should have distinct exposures to factors and/or exposures to different factors. These observations suggest a key economic role of strategic asset allocation: A strategic asset allocation specifies the investor's desired exposures to systematic risk". Sharpe, William F., Chen, Peng, Pinto, Jerald E. & McLeavey, Dennis W., "Asset Allocation," Managing Investment Portfolios, (John Wiley & Sons, 2007), pp. 230-320.

[25] From time-to-time some commentators suggest that portfolio allocation should be 'risk factor allocation' rather than 'asset class allocation.' That is to say, the investor should identify the risk exposures which are appropriate, and derive a weighted exposure to each risk factor such that the total portfolio risk is acceptable. One difficulty to such an approach is that it may be difficult to accurately forecast the expected return from each risk factor exposure. Risk allocation, however, remains a promising field for future research.

– i.e., happiness – from a portfolio of limited financial resources.[26] Specifically, asset allocation requires a solution to a three-dimensional simultaneous equation, and it is the discovery of that solution that calls for skill on the part of the advisor. The variables to that equation are:

- The required return
- The investor's risk constraints, and
- The anticipated needs for cash.

The third element is especially important. If a portfolio's allocation is unlikely to support anticipated cash needs, it is not a feasible allocation. This means that the investor must periodically reassess the portfolio's Investment Policy.

Two basic tenets of financial theory are:

- In the long run, the returns earned on a diversified portfolio are reliably related to the portfolio's exposures to systematic risk; and,
- Only systematic risks are rewarded, because all other risks can be diversified away.

DETERMINANTS OF PORTFOLIO PERFORMANCE

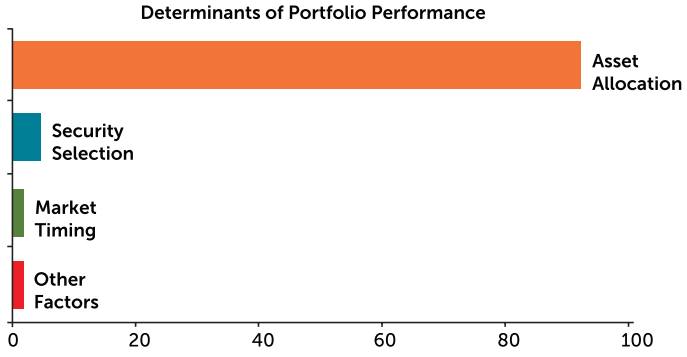

FIGURE 2-10

From the 1980's onwards, there has been a fruitful research effort to develop a more sophisticated understanding of risk and to develop more insightful ways to measure, profile, and manage it. An understanding of econometric research requires a somewhat high level of mathematical and analytical skill. However, many of the insights of recent econometric research inform the tasks of portfolio design and asset management. Therefore, it is critical for an advisor or financial planner, representing that his organization possesses investment acumen, to document that his or her recommendations are the product of a credible and defensible decision making process. This is probably something more than a good intention to find investments that might make money.

The Importance of Asset Allocation for Portfolio Performance

How important is asset allocation? This is a subject of some controversy. Conventional wisdom, based on a 1986 study, suggests that the asset allocation decision is the primary determinant of return for portfolios with long-term planning horizons.[27] That is to say, asset allocation explains much of the variation in returns over time (See **FIGURE 2-10**).

From a short-term perspective, these findings are counterintuitive, because stock selection and transaction timing have a significant impact on short-term returns. But focusing on the short-term can be detrimental for investors with longer planning horizons. The study found that market timing activities actually subtracted returns from portfolios over planning horizons longer than ten years. However, the study did not explain why individual portfolio returns differ from each other – that is to say, it does not

[26] For a detailed discussion of utility and portfolio management see: Collins, Patrick J. & Stampfli, Josh, "Managing Private Wealth: Matching Investment Policy to Client Risk Preferences," The Banking Law Journal (November/December, 2009), pp. 923-958; and Collins, Patrick J. & Stampfli, Josh, "What Trustees Should Know about Asset Management Approaches and Rebalancing Elections," Wealth Strategies Journal (November, 2007). These are available on the Schultz Collins website.

[27] Brinson, Gary P., Hood, Randolph L., and Beebower, Gilbert L., "Determinants of Portfolio Performance," The Financial Analysts Journal July/August, (1986), pp. 39-44. See also, Brinson, Gary P., Singer, Brian D., and Beebower, Gilbert L, "Determinants of Portfolio Performance II: An Update," Financial Analysts Journal, Vol. 47, #3 (1991), pp. 40-48.

examine the cross-sectional variation of returns [i.e., why fund A's returns differ from fund B's versus what explains just fund A's return variance over time].

However, another recent study suggests that, even over long planning horizons, security selection should dominate asset allocation decisions with respect to its impact on portfolio performance. The study outlines five factors that could explain investment returns:

1. Asset allocation,
2. Country allocation,
3. Global industry sector allocation,
4. Country-specific industry sector allocation, and
5. Security selection.[28]

The authors isolate each factor and simulate 10,000 portfolios (60% stock/40% fixed income asset allocation) using data from 1987 through 2001. Portfolios based on the security selection factor had the greatest range of returns; portfolios based on the asset allocation factor had the smallest dispersion of returns. Therefore, at least theoretically, the authors conclude that security selection has the greatest potential for influencing long-term investment returns.[29]

Other recent studies come to a different conclusion. A 2000 study of the effect of asset allocation on investment performance points out that the importance of asset allocation depends on the investment issue under consideration.[30] Specifically, the investor might be interested in knowing:

- What percentage of a portfolio's ups and downs (variability in return) is explained, over time, by its asset allocation choices? or,
- How much of the performance difference between two distinct portfolios can, over time, be explained by differences in their asset allocation? or,
- How much of a specific portfolio's actual returns can, over time, be explained by its asset allocation?

These are very different questions that require disparate methods of analysis. The authors decompose the monthly returns of balanced mutual funds over a ten-year period into a 'policy' return (the return attributable to the fund's asset allocation), and an 'active' return (the remaining return).[31] The study confirms that approximately 90% of the variability in the returns of the average (median) fund can be explained by its asset allocation decisions. When funds are compared to each other, however, the conclusions differ. If two funds select the same asset allocation and each invests in the same cross-section of passively managed indexes, 100% of the variability of returns across time of each fund would be attributable to asset allocation policy.[32] However, the funds under evaluation differed with respect both to asset allocations and security selection, market timing, fees and other factors. The study concludes that, on average, asset allocation decisions account for about 40% of the variation of

[28] Kritzman, Mark & Page, Sebastien, "The hierarchy of Investment Choice: A Normative Interpretation", The Journal of Portfolio Management, Spring 2003.

[29] The titles of several recent research studies suggest that asset allocation is unimportant to financial success. For example, Munnell, Alicia H., Orlova, Natalia Sergeyevna & Webb, Anthony, "How Important is Asset Allocation To Financial Security in Retirement," Center for Retirement Research at Boston College (April, 2012), concludes that their data "suggests a minor role for asset allocation in creating a secure retirement." However, this is primarily due to the fact that most retirees have such a small nest egg that a decision like working longer dominates any asset weighting decision. The best allocation can do little good if the portfolio is not worth much.

[30] Ibbotson, Roger G., & Kaplan, Paul D., "Does Asset Allocation Policy Explain 40, 90, or 100 Percent of Performance?" Financial Analysis Journal (January/February, 2000), pp. 26-33.

[31] Active return = (total return – policy return)

[32] Likewise, if two funds had the same asset allocation policy but each invested in a separate set of securities, asset allocation would explain 0% of the return differences over time.

...the attempt to beat the market is itself a significant contributor to portfolio risk.

returns across funds.

Finally, the authors test for the percentage of individual fund returns[33] that, over time, can be explained by asset allocation. This is the ratio of policy return divided by total return. A hypothetical fund with a consistent asset allocation policy implemented by a purely indexed investment strategy will, by definition, have a ratio equal to one. Funds exhibiting ratios greater than one will have ***subtracted*** value through active management decisions (actual total returns in the denominator fail to equal the policy returns in the numerator); funds exhibiting ratios less than one will have ***added*** value through market timing (decisions to change asset allocation to exploit forecasted market developments) or security selection. The distribution of ratio values is very interesting. The median result (50th percentile) was 1.00 – on average, actively managed mutual funds neither added nor subtracted value during the period under evaluation.[34] The best actively managed funds (5th percentile) exhibit ratios of 0.82; however, the worst performing funds exhibit ratios of 1.32. But the large dispersion of results is simply another expression of investment risk and uncertainty.

The authors derive two conclusions from these results:

- Because the active managers, as a group, cannot achieve a return greater than the return of the market (the average performance before costs of all investors must equal the performance of the market), asset allocation policy explains, on average, approximately 100 percent of the returns of aggregate mutual funds.
- If the investor has the ability to select superior managers before committing funds, there is a possibility of earning market-beating returns. This entails not only a close examination of risk-adjusted historical results, but also the assumption that such results will persist into the future.

The implications for investment policy are clear:

- Over longer planning periods, the asset allocation decision is an important factor in determining returns;
- The choice of active management may be prudent; however, the investor should be aware that the attempt to beat the market is itself a significant contributor to portfolio risk; and
- Long-term policy should be designed to insulate the portfolio, cushioning the impact of business and market cycles, and forestalling ill-considered decisions based on short-term factors. Abandoning policy may increase portfolio risk by subjecting assets to the vagaries of transitory economic conditions.

What's the Target?

If a portfolio takes no risk, it earns only the risk-free rate of return. Once the investor settles on the allowable amount of risk – the "sleep tight" test – a critical portfolio management task is to determine if the portfolio's asset allocation can generate the return required to attain financial success. The prudent investor periodically checks the portfolio's dollar-value

[33] As opposed to the percentage of the variability of return.

[34] Results are pre-tax. For taxable investors actively managed funds may trigger substantial income tax liabilities because of their higher level of turnover. It is interesting to note that the inability to add value is also a test of the efficient market hypothesis. In this case, markets are considered efficient if the profits derived from active management are unable to overcome extra costs and risks. Forecasts generate, on average, zero net profit. The distribution in this study is skewed towards the downside indicating that finding superior investment managers is a difficult task.

sufficiency to determine the likelihood that economic goals remain feasible. But, if the money needed for future distributions is itself a function of constantly changing variables (health costs, purchasing power of money, investment results, cost of college, life span, standard of living objectives, and so forth) how can the investor determine how much is needed, much less how to allocate it? Even if a reasonable approximation to a target amount of wealth is possible, how can the investor determine if he or she remains on track?[35]

The task suffers from the "curse of dimensionality." There are simply too many moving parts to accommodate comfortably in a single equation or a rough approximation. Randomness is everywhere; and the temptation is to retreat out of this conceptual mess towards a more-money-is-better-than-less approach in which the investor seeks financial success by trying to achieve the highest possible return. Such a retreat returns the investor to the 1930's philosophy of Keynes – buy a few good stocks – and Burr Williams – commit funds only to appropriately attractive market sectors. In a low-interest-rate climate, this often reduces to the search for a high-yield portfolio under the assumption that dividend and interest payments convey a requisite degree of safety. All eggs go into a single basket: *caveat investor*.

The Importance of Judgment or, Look Before You Leap

Three important tasks face the investor confronting the asset allocation decision:

- Determine the allowable amount of risk given initial portfolio wealth. This is the initial calibration between the asset allocation decision and the investor's risk tolerance.
- Determine, at reasonable time intervals, the allowable amount of risk given the inevitable changes in portfolio value. This is the stay-the-course or make-a-change decision that reflects the investor's change in utility per change in wealth.
- Determine if the allowable amount of risk is sufficient to generate the portfolio's required future return given its current level of dollar wealth. This is the decision that calibrates the investor's willingness and ability to assume risk with the return required for keeping the portfolio on track relative to the economic demands placed against it.

Abandoning policy may increase portfolio risk by subjecting assets to the vagaries of transitory economic conditions.

What the investor would like to do is to compare and evaluate asset allocation choices over the range of possible investment results. The goal is to determine which allocations offer a high likelihood of financial success where success is measured in terms of specific goals, rather than in terms of beating a financial benchmark. Obtaining insight into the range of feasible investment outcomes enables investors to better understand the tradeoff between required returns and downside risk. If the possible downside results show a decline in wealth at a magnitude and probability greater than the investor's allowable risk tolerance, either investment objectives or asset allocations may have to be revised.

So the investor must accomplish a number of formidable tasks:

- Ascertain the wealth required to achieve economic objectives given variability in longevity, investment returns, inflation rates, and cash flows;
- Determine the asset allocation best able to achieve targeted objectives when such

[35] Or, as Yogi Berra stated: "You've got to be very careful if you don't know where you're going, because you might not get there."

objectives are variable (i.e., stochastic) in nature;

- Monitor the portfolio over time so as to know whether the portfolio remains on track as its dollar value fluctuates through various economic environments (i.e., to tell whether the probability of a dollar shortfall relative to the target's funding requirements is increasing or decreasing);
- Assess the economic consequences of exercising asset management options to facilitate the portfolio's ability to meet reasonable investment goals and expectations; and,
- Avoid the necessity of working through formulae that require the worst of three worlds: complex mathematical derivations, unwarranted statistical assumptions for financial time series, and oversimplified investor preference functions.

Given the complexity of the analysis, it is apparent that simulation based approaches to the asset allocation decision are particularly helpful. Because they can test the evolution of a portfolio under thousands of different potential economic scenarios, they allow for numerous solution paths to be developed and quickly evaluated. A credible risk model of this sort can provide insight into a host of prudent planning options. A simulation program allows both the investor and interested parties to look before they leap.

During the latter part of the twentieth century, the study of investing turned from a largely descriptive exercise into a more positive science. The literature of guesses, hunches, and prognostications became a literature of econometrics. This is a literature of equations, hypothesis testing, mathematical models, and capital market theory. The changes in financial economics had as profound an impact on the field of finance as other scientific revolutions had on their respective fields. Advances in technology and computing capacity promise a new era of risk modeling that allows for more credible and defensible asset allocations. Chapter Nine describes how interactive, computer-assisted decision making can promote asset management elections well calibrated to an investor's objectives and risk tolerance.