CANTERBURY
INVESTMENT MANAGEMENT

The Evolution of
Adaptive Portfolio Management

Position / White Paper

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EXECUTIVE SUMMARY

The Evolution of Adaptive Portfolio Management

We believe in the value of both academic education, rethinking conventional wisdom and learning from practical experience. Our mission is to create knowledge, apply, and disseminate the practice of Adaptive Portfolio Management. Adaptive Portfolio Management is a much-needed revolutionary breakthrough in managing risks of the ever-changing market environments.

This paper will give an overview of over 20 years of the Canterbury Investment Management team's body of work. Our work has led to significant advancements in the evolution of adaptive portfolio strategy.

We will critically examine all generally accepted portfolio management theories, assumptions and practices used to formulate early portfolio management methods. We will continue by studying how these theories later influenced Wall Street's risk management beliefs and led to the birth of the investment management industry. This paper will examine the long-term effectiveness of these traditional methodologies and how they became the tenets of "prudent" investing. We will conclude by exploring the ways in which revolutionary breakthroughs in emerging technologies and innovative investment product creation have led to an evolution in risk and portfolio management called Adaptive Portfolio Management.

Why Do We Invest in Financial Markets?

Most individuals invest to secure their financial independence and to build their personal wealth. Financial independence means that one will have more freedom of choices to pursue whatever is most rewarding or important. Personal wealth is more than just money; it is everything you value including your relationships, health and your unique vision of your future life.

Most Long-Term Investors Have the Same Goal

We invest with the intent of making money, not losing our investment. Most traditional investment management practitioners would say that prudent investing is about managing risk and producing consistent returns. There are many theories on how to manage the risk of an investment portfolio. To successfully put these risk and portfolio management strategies to the test, we must first consider what we are trying to accomplish.

The primary goal of most long-term investors is to become, and remain, financially independent. The investment objective is to generate the highest possible compounded returns over a lifetime.

Producing compounded returns refers to the geometrical growth of the portfolio's dollar value. For example, a base of 100, compounding at a 100% rate, would double to 200 and then double to 400, 800, etc. The concept of compounding returns sounds simple, but it has been almost impossible to achieve in the financial markets because of the impact of periods with high volatility and large declines.

The Risk of Portfolio Volatility and Failed Risk Management

Accepting normal price fluctuations is part of the cost of owning liquid securities. Unacceptable losses occur when needed adjustments are not made to limit a portfolio's fluctuations to normal levels.

Every decline in a portfolio's value will require a higher percentage advance to break even. For example, a -10% decline on $100 would leave $90. A 10% increase on $90 would only get back to $99. The larger the decline, the larger the percentage advance required to get back to breakeven. A -50% decline will require a 100% advance to recoup losses, and an extreme -75% loss would take a 400% gain. Losses of 75% or more were seen in tech stocks following the dotcom bubble and subsequent crash. The same happened to many large financial companies during the financial crisis in 2008. This is a very important concept to understand because it proves that volatility will kill the benefit of compounded returns.

Risk management is the critical component to producing compounded returns. Poor risk management can lead to increased portfolio volatility, which in turn leads to substantial declines in value. Subsequently, without the ability to limit downward fluctuations to normal and acceptable levels, any temporary gains will evaporate, and long-term compounding will not occur.

What Causes the Market Environments to Change?

The markets are driven by the irrefutable law of supply and demand, which is, in turn, driven by the beliefs and resulting actions of buyers and sellers. Investors tend to vacillate somewhere between two extremes, the rational "wisdom of crowds" and the irrational "madness of crowds." The buying and selling of rational market participants help maintain an orderly market and "normal" fluctuations.

Volatile markets and large swings in price result from the activities of emotional and sometimes irrational investors as they react to the unexpected. When investors begin to develop a "herd mentality," by moving in the same direction at the same time, the result will be a substantial loss in a portfolio's benefits of diversification.

Advantages And Disadvantages: Liquid Securities vs. Non-Liquid Business Ownership

Yale's Robert Shiller is credited for collecting the price data on the Standard and Poor's 500's predecessor indexes. His data on U.S. common stocks extends all the way back to 1871.

Did you know that the combined group of companies in Shiller's index has reported positive corporate earnings for over 150 years straight? On the other hand, the value of each company's traded shares will fluctuate in price based on the supply and demand in the market.

A stock index is typically much more volatile than the underlying companies' earnings. The reality is that there are few similarities between direct ownership of a company and the value of its stock. Direct ownership means that the investor will directly participate in the company's profits or

losses. The company's publicly traded stock is priced based on the perceived value as determined by the supply and demand for the traded shares. The company's profits or losses can vary greatly from the returns on its shares that are traded on an organized market. In fact, the shares' value, plus the dividend, could go up much more than the company's profits. The shares can also drop in value even if the company's earnings are positive.

Stated another way, an investor can lose money by owning an index fund that is invested in the same companies that, as a group, have reported profits every year, without fail.

A privately owned company is typically held for the long-term. The decisions are made by the owners. On the other hand, financial securities are liquid for a reason. The volatility of their fluctuations will increase and decrease. Their correlations with other securities in a portfolio will change over time. Therefore, liquid securities should be managed to maintain the optimum benefits of diversification.

The traditional method postulated by the academic creators of portfolio theory was to establish a fixed asset allocation and diversify among index funds that represent different asset classes. They promoted a passive approach to investing: buy, hold and periodically rebalance.

The passive investing approach has been used for so long that it has become unquestioned conventional wisdom. In fact, the practice defies the logic of how markets work. I will explain why.

What Investors Want and What They Get Are Not the Same

Investors will typically hire a portfolio manager, or an investment consultant, to manage their portfolio. The investment management practitioners' primary purpose is to meet the agreed upon defined investment goals and objectives.

The most important purpose of portfolio management is to effectively manage risk. Risk is defined as volatility. A portfolio's volatility can be reduced through efficient diversification. To be more specific, a portfolio with "efficient diversification" means that it owns a group of securities that have low correlation with one another.

All portfolios that hold fixed allocations will experience periods of increasing volatility and losses that are larger than what would exceed most investors' expectations.

The substantial losses from a bear market will occur following a final peak in the portfolio's value. It is also important to note that a portfolio's peak value includes all previous contributions from savings as well as all past appreciation. One bear market can wipe out many years of growth.

Most investors have experienced a time when their stable portfolio suddenly became volatile and had a significant drop in value.

An investor would ask: "How could my portfolio drop by so much when we agreed that my tolerance for risk was only 'moderately conservative'?" The simple answer is that your portfolio just experienced a failure in risk management.

A basic tenet of the most used traditional portfolio management methods states that a portfolio's asset allocation and diversification requirements should be set at fixed percentages. The percentages should be based primarily on the investor's risk tolerance and investment timetable.

A moderately conservative investor would likely be assigned about a 60% stock and 40% bond portfolio. Fixed asset allocations and tight ranges for diversification are typically illustrated in a pie chart. Once the pie is cut into pieces, the pieces don't change.

The markets are dynamic and will experience many different market environments over the life of a portfolio. The combination of securities that will perform best in a low volatile bull market will look very different from the combination that would best manage the risk of a volatile bear market.

By definition, a portfolio that maintains a fixed asset allocation and diversification will not be able to adapt to the changing market environments. As a result, the increasing volatility will cause the portfolio's correlations to increase and the ability to reduce volatility to decrease. Therefore, a portfolio's fluctuations will become a reflection of the ever-changing underlying markets.

When a volatile bear market encounters a fixed portfolio, the result will be a failure in risk management. That is why the simultaneous decline in stocks and bonds in 2022 caused conservative and moderately conservative portfolios to suddenly become risky.

Bottom line, the long-held practice that assigns fixed allocations based on risk tolerance will not work when needed most: during volatile bear markets.

That is a major flaw!

Breakthrough Technologies Require New Rules and Processes

Traditional Wall Street portfolio and risk management is based on theories and practices dating back to the 1950s through 1980s. A lot has changed since the development of the portfolio theories that were used as a basis for most of today's portfolio management strategies.

Today, we have better and faster technologies than we could have imagined. The unprecedented wave of innovation has led to the creation of complex software algorithms, A.I., security analysis platforms, and specialized exchange traded funds (ETFs) that were created as risk management tools.

Investment technologies and innovative investment tools have continued to advance, but most risk and portfolio management methods have remained remarkably the same. The evolution to new strategies begins as investors and investment professionals alike finally accept the reality that their existing process is flawed. Next comes the recognition that much of what we thought was true has either become obsolete, changed dramatically, or in the case of traditional portfolio theory, never worked very well during volatile bear markets anyway.

Today we have all the technologies and innovative tools needed to be effective at managing portfolios through any market environment: bull markets, bear markets, or anything in between.

In fact, risk and portfolio managers have had access to powerful technologies and many innovative securities for about fifteen to twenty years. With that said, there is no statistically relevant evidence that shows that the most used portfolio management strategies have been able to harness these new capabilities to improve results.

The question remains, can the addition of these new technologies and innovative alternative securities actually improve results, or have more choices just led to more complexity and more uncertainty than before?

The failure of the long-held fixed allocation portfolio management methods comes as no surprise. Markets are dynamic and ever-changing; fixed asset allocation and stagnant diversification are not. The development and introduction of these new advanced tools and technologies have made many existing portfolio theories, and the portfolio management methods that were inspired by them, obsolete.

Which Is Broken, Portfolio Management Methods, The Markets or Both?

In the attached academic White Paper, we will discuss why the financial markets are not broken or rigged. Instead, traditional risk and portfolio management methodologies are based on flawed assumptions about how the markets work. Any process that is built on flawed assumptions is, and has always been, broken.

Can A Broken Model Be Fixed by Scientific Methods And Creativity?

The availability of new technologies and unique investment tools can create game-changing opportunities. With that said, advanced tools do not create revolutionary breakthroughs. Revolutionary breakthroughs occur when equally advanced strategies are created, tested, and provide empirical evidence that the combination of the two can solve existing weaknesses and produce better results. The evolution in risk and portfolio management occurs when new rules are applied that are capable of managing a whole new paradigm of possibilities that didn't exist when the old methods were established.

The development of an "objective" strategy, built on scientific principles, will follow the creation of new technologies. Breakthrough strategies can take a great deal of time to develop, program, and stress test to provide statistically significant value.

We know that all traded financial securities will fluctuate and will go in and out of favor over time. One would think that an adaptive portfolio strategy that could adjust its holdings to move in concert with the changing markets would make logical sense. An adaptive methodology would operate under a totally different set of rules that would fly in the face of long held conventional wisdom.

The development of an adaptive portfolio management system would require creative and critical thinking as well as objectivity and scientific standards. In his book, *Evidenced-Based Technical Analysis*, David Aronson defined a methodology as *objective* "only if it can be implemented as a computer program that produces unambiguous market positions."

A comprehensive adaptive portfolio management system would be required to run many different calculations on a wide universe of securities. Every action taken must follow a defined set of rules that are repeatable, testable, and can produce evidence-based results. One must accept the unexpected, avoid confirmation bias, and have willingness to question and reconsider existing beliefs.

Innovation Through Creative Thinking: What Do a Thermostat and Effective Risk Management Have in Common?

The weather and the markets have several things in common. Both are dynamic and can experience extremes. As such, when dealing with either, we need a process to level the extremes in order to create a safe and stable environment.

When faced with fluctuations in outdoor temperatures, we use a thermostat to maintain a consistent indoor temperature. The key to the effectiveness of the thermostat is the thermometer. The thermometer measures the current indoor temperature, and the thermostat adjusts the air conditioner and furnace accordingly. It responds to the thermometer by either turning up the air conditioner when it becomes too hot or the furnace when it gets too cold.

Similarly, markets are neither consistent nor stable. Market environments range from efficient and stable to emotional and irrational. Cycles with high and increasing volatility have more risk than periods of low and decreasing volatility.

Effective risk and portfolio management thus requires its own thermostat process to manage the correct combination of securities to maintain stability throughout changing markets.

Similar to how we use a thermometer to inform us when the temperature changes, when we observe an increase in our portfolio's volatility, we then know the market environment is in the process of changing. The diversified combination of securities that was working to preserve stability in the past is no longer working or is less efficient in the new market environment.

Introduction: Canterbury's Comprehensive Adaptive Portfolio Management Strategy

A home thermostat is an example of an adaptive process. Just as the thermostat aims to maintain stability indoors, regardless of external conditions, an adaptive portfolio utilizes a methodology to maintain portfolio stability and avoid "substantial declines" through the ever-changing market environments.

Canterbury's adaptive portfolio management model employs a dynamic process for adjusting portfolio holdings to match the unique characteristics of each market environment. Canterbury's adaptive process was designed to be an all-inclusive comprehensive portfolio strategy. The system was designed to manage all aspects of asset allocation, diversification and security selection as one coordinated systematized process.

Overview Of Canterbury's Adaptive Portfolio Management Process

Step 1: Identify the Current Market Environment

The adaptive portfolio management process begins by identifying the current environment known as a "Market State." Each Market State represents a different market environment and has its own unique traits and tendencies. The adaptive system optimizes a custom combination of securities that best fit the unique characteristics of the current Market State.

Step 2: Classify the Universe of Securities into Diverse Investment Classes

Once a Market State is determined, an adaptive process then optimizes a custom combination of securities that best fit the unique characteristics of the current Market State.

Most equity asset classes perform best when the S&P 500 (the market portfolio) is in a low volatility Market State. However, there are also alternative investment classes and securities that benefit from high volatility or a bearish stock market. The adaptive management model typically invests in individual stocks and Exchange Traded Funds (ETFs). The model categorizes each ETF into one of two Major Classes:

- Global Stock Market Universe
- Bonds and Alternatives to the Global Stock Market

Each security's group assignment is based on several factors, such as the asset class represented, the correlation to the U.S. stock market, and the correlation to its group and subgroups. Each security is also assigned an objective "Security State," which operates similar to a Market State, but is uniquely specific to that individual security. Each security within its group is ranked on a risk-adjusted basis, which is a combination of that security's relative strength and volatility level.

Step 3: Construct an Efficient Portfolio to Match the Current Market Environment

Security selection is only one component of an adaptive portfolio. The management of an efficient portfolio requires its own process to maintain an optimal combination of diversified securities. Contrary to traditional portfolio management practices, the optimal combination of diversified securities is a moving target. The portfolio that is most efficient in a bullish market environment will look almost opposite of a portfolio that is most efficient in a bearish market environment. In either case, however, the portfolio fluctuations should feel similar. To accomplish this, an adaptive portfolio diversifies its holdings to meet a set of constraints such low and consistent portfolio volatility and maintaining a proper benefit of diversification for the given market environment. Each of these constraints should be quantifiable.

Conclusion

New opportunities are often accompanied by new risks. Successful investment managers will recognize the need to develop a proven risk management process that takes those risks into account. This is a task that the most used portfolio management processes have been unable to accomplish due to the stagnant nature of their strategies.

The following white paper provides irrefutable evidence that traditional risk and portfolio management methods have consistently failed during volatile bear markets. The results show that substantial losses have occurred regardless of the availability of these new advancements.

In addition, most traditional portfolio management methods are based on false assumptions and subjective decision making. Subjective decision making is not repeatable and does not meet scientific standards. The common practice of initiating buy and sell activities, without clearly defined rules, will not produce statistically valid results. A scientific method, on the other hand, is characterized by uncompromising and rigorous rules-based stress testing to produce relevant results.

The Canterbury adaptive portfolio management model was developed and extensively tested to manage the risks of the new investing paradigm and can thus benefit from previous limitations.
In the past, bullish market environments were required to produce profitable portfolios. Compounded returns, over the long-term, only existed in savings accounts and fake math projections from spreadsheets. Today, it is possible to benefit from the market's changing volatility, instead of being punished by it.

Disclosure: All definitive statements and subjective opinions contained in this academic study represent the observations and conclusions of the authors, Tom Hardin and Brandon Bischof. The sole purpose of the production of this report is to make a contribution to the body of knowledge in the field of investment portfolio management. This report is to be used for educational purposes only and is not to be used or considered as solicitation for any investment management services offered by Tom Hardin, Brandon Bischof, Canterbury Investment Management, or any Registered Investment Advisor receiving sub advisory services from Tom Hardin and Brandon Bischof. Additional disclosures and disclaimers are contained throughout this report.

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Dispelling Conventional Wisdom

The Eve of a Revolution

I can honestly say that I have never been more excited and optimistic about the future of investment management than I am today. We are in the midst of an unprecedented wave of innovation in cutting edge technologies and specialized investment tools. This new age of financial enlightenment is responsible for a proliferation of new and unique investment vehicles that would have been unimaginable a few years ago.

Much of the credit goes to Wall Street, the front runner in innovation and product development. It has given the investing public access to all manner of technologies and, in so doing, provided investors with almost every tool they need to benefit in virtually any market environment – bearish or bullish. These latest breakthrough technologies have the potential to dramatically improve the consistency of returns and to secure the investor's financial future.

That being said, the challenge that stems from breakthrough technologies is that of developing equally revolutionary strategies to manage the unique risks of a new paradigm. Investors will not be able to realize the full benefits of the most recent advancements until equally innovative strategies are developed to take advantage of them.

Consider the advancements made in communications technology. Developments in communications technology have provided the public immediate access to global information. Usually, access to more information and resources leads to greater collective knowledge and increased efficiency in market pricing. Conversely, it can also create paralysis and confusion. Information overload and almost unlimited choices make it difficult to make smart decisions, particularly in conjunction with outdated strategies based on subjectivity.

Another example of the importance of developing timely new strategies to benefit from innovation in technologies can be found in military history. An analysis of military tactics show that many leaders have lost wars because they could not develop new strategies fast enough to counter advancements in weapon technologies. This is not to say that the old strategies were not well conceived. Most were innovative in their time and based on years of research and analysis. Nevertheless, technological innovation eventually made many of them obsolete.

Likewise, the march of innovation has exposed the weaknesses of many traditional, and unquestioned, investment management theories. The truth is that most investors are not doing any better than they were before, and many are doing even worse.

Revolutions Begin When the Status Quo is No Longer Acceptable

Traditional Wall Street risk management relies on a narrow set of assumptions of how markets behave. Today's markets are impacted by more variables than ever before. Assumptions made in the past did not consider the many unique risks and rewards inherent in specialized securities, exotic derivatives, and interconnected global markets.

Granted, almost all cutting-edge breakthroughs find their roots in traditional methods. The next generation of strategies evolves as the old one fails to cope with the new realities. In the domain of investment management, we have reached that point where advancements in specialized securities and investment technologies have far surpassed the capabilities of traditional strategies and existing portfolio management theories.

Today, the financial services industry has remained stuck in the past and their methods have no meaningful advancements since they were introduced during the late 1970s and 1980s. The science of portfolio management is on the cusp of entering a period of momentous revolutionary change.

How are New Cutting-Edge Strategies Created?

Revolutionary ideas and strategies result from being open to new ways of thinking and innovative ways of using new emerging technologies. As Mark Twain once said, *"It ain't so much what we don't know that gets us into trouble. It's what we know that just ain't so."* As this quote suggests, all existing theories and beliefs now need to be scrutinized in the context of the new paradigms that have emerged.

Any viable investment strategy must be based on science and avoid subjectivity. A portfolio management model must provide specific actions and make measurable claims before it can be determined whether the model has predictive value. The programmed indicators of the model are then tested extensively on data from a variety of market environments, ranging from normal to volatile and sometimes irrational markets.

Tradition

There was a time when existing investment theories and models were new and controversial. The original innovators prided themselves on challenging conventional wisdom and creating new theories. These theories soon evolved into new technologies and eventually new strategies and models. Over time though, these innovative, controversial, and modern ideas became accepted as the norm and, eventually, unquestioned tradition.

Traditional beliefs are slow to change. Revolutionary ideas and strategies are often counterintuitive, flying in the face of conventional wisdom. However, as investment methods move forward, investors will find that many of the concepts they take for granted have changed

dramatically or become obsolete – or were never true to begin with. As technology evolves, so too must the strategies that go with it.

The Progression of Portfolio Theory

To understand how to develop successful new theories and strategies, it is instructive to familiarize oneself with earlier theories and their development. Portfolio theory deals first and foremost with the issue of risk management, tackling the question of how best to construct a diversified portfolio that would remain stable when markets are volatile. Most of the framework for portfolio management theory was developed at the University of Chicago during the 1950s-1970s.

In 1952, Harry Markowitz, a graduate student at the University of Chicago, published a paper titled *Portfolio Selection*. The argument of that paper became the basis for what would later become known as Modern Portfolio Theory (MPT). Modern Portfolio Theory revolves around the central thesis that diversification among securities of low correlation (securities that move differently from each other) can reduce volatility and thus improve returns. Markowitz had discovered a relationship between risk and return and began to analyze how individual securities could be combined in a way to improve a portfolio's risk /reward profile. He stated that a rational investor would always choose the portfolio with the highest return and lowest risk. Such a portfolio would be deemed the most "efficient portfolio." As James Picerno quoted Markowitz in his book, *Dynamic Asset Allocation,* "the value of securities analysis lies in focusing on the whole [portfolio] rather than the parts."

Building on Markowitz's work, Nobel Laureate James Tobin (1958) asserted that a "Super Efficient portfolio" would be appropriate for every investor. His thesis was that every investor should hold both the Super Efficient portfolio and a risk-free asset. Introducing the idea of asset allocation, he claimed that an investor could tailor his portfolio to match his specific financial needs and risk tolerance by varying the proportions of risky securities and risk-free cash.

In 1964, Nobel Laureate William Sharpe took Tobin's and Markowitz's work a step further by outlining the fundamentals of what would later become the Capital Asset Pricing Model (CAPM). One of his key arguments was that the "market portfolio," such as the S&P 500, is in fact Tobin's Super Efficient portfolio. Sharpe's paper advised owning "the market" because it would achieve the portfolio with the highest expected return at a given level of expected risk. Sharpe assumed that the market pricing mechanism was perfectly efficient, in that all known information was reflected in the current market prices. He also assumed market returns were "normally distributed" and symmetrical, meaning that returns were equally likely to fall above or below the mean return. Assuming that Sharpe's thesis was valid, the Gaussian bell curve of normal distribution would be an appropriate tool for estimating probabilities relating to risks and returns in financial markets.

Sharpe was not alone in postulating the efficiency of markets. In fact, French scientist Louis Bachelier had put forth the idea long before Sharpe. In his 1900 dissertation, he wrote that securities prices followed a "random walk." In other words, price changes are independent and are

dispersed in a "normal distribution" or a bell curve. University of Chicago economist Eugene Fama, creator of the Efficient Market Hypothesis, probably explained it best when he wrote, *"In an efficient market, the actions of the many competing participants should cause the actual price of a security to 'wander' randomly about its intrinsic value."* Today we refer to Fama's "wandering" as market noise or normal fluctuations.

Prior to Modern Portfolio Theory, security selection was based on various forms of research used to predict which stocks would be the best performers in the future. With the advent of the MPT, Markowitz paved the way for an entirely different approach to security selection. The belief, shared by Markowitz, Tobin, Sharpe, Fama and others, that the returns on stocks and markets were efficient, random, and equally distributed meant that all known information was already reflected in stock prices. Additional research for the purpose of "beating the market" would add little, if any, value. The goal of Modern Portfolio Theory therefore should be to create efficiently diversified portfolios with low risk and high returns. The key to achieving this was in diversifying securities based on their contribution to reducing portfolio volatility.

Creating an efficient portfolio may be difficult, but it is not any more difficult than choosing securities that would outperform the market. Benjamin Graham, the father of value investing, was the first to admit that the circumstances that allowed his methods to flourish in the 1930s and the 1940s "no longer applied," and in 1956, he closed his investment management firm.

Graham noted in a 1962 speech given to the New York Society of Financial Analysts, *"Neither the Financial Analysts as a whole nor the investment funds as a whole can expect to 'beat the market' because in a significant sense they (or you [the analysts]) are the market."* He went on to add *"that the average analyst was best off simply accepting market prices as given, and spending his time and mental energy constructing portfolios that effectively balanced risk and return."*

Summary of Modern Portfolio Theory Assumptions

This background allows us to see the thought processes behind the key assumptions of today's portfolio management methods. These key assumptions include the following:

- Risk and volatility are defined and treated as the same thing.
- Securities prices are determined by the actions of all market participants and are based on their combined knowledge and changing beliefs regarding the future.
- The Efficient Market Hypothesis posits that securities prices are "strongly efficient" and "randomly distributed."
- The belief that markets and securities prices are random and equally distributed led to the acceptance of the bell curve of normal distribution as the preferred method for determining the probabilities of future risks, correlations, and returns.
- The acceptance of the Efficient Market Hypothesis led to the popularity of passive investment management, indexing, and fixed or static asset allocation and diversification.
- Diversification among securities with low correlation will reduce risk/volatility and increase risk-adjusted returns.

- By nature, investors are risk adverse; therefore, a rational investor will always want the highest return at the lowest risk. Such a portfolio is referred to as the most "efficient portfolio."

Markowitz's theory that managing volatility is the key to producing higher long-term returns was spot-on. History has shown that his basic theory on the benefits of diversification and portfolio efficiency is probably even more significant than he realized when his landmark paper was first published. To this day, Wall Street continues to rely on the principles of Modern Portfolio Theory to manage risk and construct portfolios. In fact, almost all of today's risk management models rely on metrics using bell curve probabilities.

However, despite the great influence of MPT, time has exposed fatal flaws in several of its assumptions. Experience has shown that creating and maintaining an efficient portfolio, over the long run, has proven to be more difficult than Markowitz, or anyone, could have imagined.

Almost All Long-Term Investors Have the Same Goal: Compounded Returns

Before we take a critical look at the flaws in MPT's assumptions and today's portfolio management strategies, let us first address what it is we are trying to accomplish. This in itself is simple. The ultimate goal of any long-term investor is to generate the highest possible compounded returns over a lifetime. Compounding refers to the accumulative effect of growing profits on previously earned profits. Producing compounded returns thus refers to the geometrical growth of the portfolio's dollar value over time.

Compounding interest is simple in a savings account but has been nearly impossible to achieve in volatile financial markets. This is because periods of high portfolio volatility often culminate in substantial declines in value, which in turn limit a portfolio's potential to compound. A portfolio must remain stable to achieve long-term appreciation and declines therefore must be limited to normal fluctuations. Consequently, portfolio management is a risk management issue.

In discussing the imperativeness of avoiding substantial declines, it is important to note that when measuring compounded returns, "percentage or simple returns" differ significantly from "dollar returns," as illustrated in **Figure 1.**

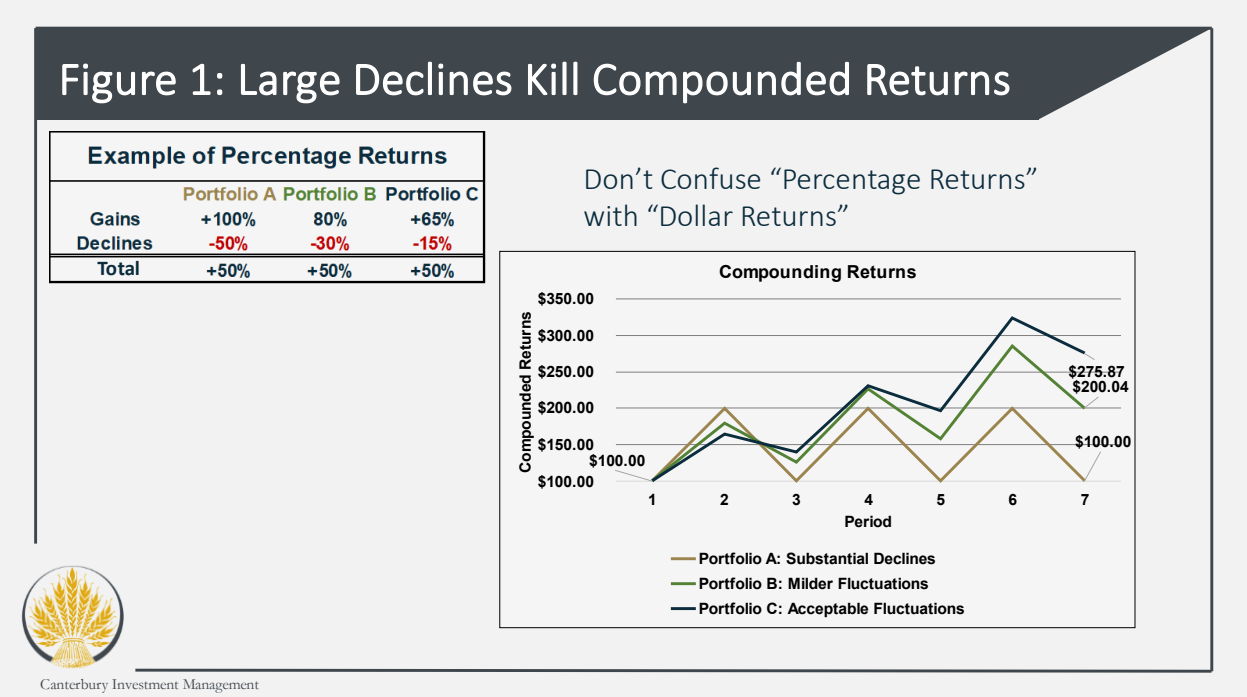


Figure 1: *This graph illustrates the fallacy of focusing on "percentage" gains and losses. If we look at the box on the left-hand side of the figure, we see that each portfolio had the same net arithmetic percentage gain of +50%.* ***Portfolio A*** *experienced a +100% gain, followed by a -50% loss, repeated.* ***Portfolio B*** *experienced a +80% advance, followed by a -30% decline, repeated.* ***Portfolio C*** *experienced a +65% advance, followed by a -15% decline, repeated. During the advancing periods,* ***Portfolio A*** *had the highest simple returns, followed by* ***Portfolio B*** *and then* ***Portfolio C****. However, during the declining periods,* ***Portfolio C*** *was able to limit its downward fluctuations to acceptable levels while* ***Portfolio A*** *could not. As a result,* ***Portfolio C*** *meets the primary goal of long-term investors by benefiting from compounded growth.* ***Portfolio A*** *saw its temporary gains evaporate because the large substantial declines destroyed the ability to achieve long-term compounding.*

This chart exposes the fallacy of the myth that introducing more risk to a portfolio improves compounded returns.

In the real world of investing, a -15% decline would push the outer limits of a "normal fluctuation." Long-term investors will experience many -8% to -12% corrections, which can and will happen at any time with little or no warning. However, they will have no meaningful impact, other than psychological stress, on a portfolio's ability to generate long-term compounded returns.

In contrast, a "substantial decline" can and will have a negative impact on the ability to compound returns. A substantial decline is defined as a 20% or greater decline from peak value. A passive or unmanaged portfolio, comprised of almost any combination of stocks and bonds, is vulnerable to a 20% or greater decline during a difficult market environment.

As investors, the major issue we face is the constant change of the optimal blend of low-correlated securities when the market shifts from one environment to another. Maintaining low and consistent portfolio volatility requires an active process to systematically adjust portfolio holdings to securities with bull market characteristics, suitable for the current environment. The key to achieving compounded returns is effective risk management, regardless of the market environment. Developing such a process is a difficult undertaking and will be discussed later in this paper.

Understanding the Markets: Why do Markets Become Volatile?

The markets are driven by the irrefutable law of supply and demand, which is in turn driven by the actions of buyers and sellers. Investors tend to vacillate somewhere between two extremes, the rational "wisdom of crowds" and the irrational "madness of crowds." The buying and selling of rational market participants help maintain an orderly market and "normal" fluctuations. Large market movements, on the other hand, result from the activities of emotional and sometimes irrational investors as they react to the unexpected.

As a whole, large groups of rational individuals can display remarkable results. In his book *The Wisdom of Crowds*, James Surowiecki tells the story of Francis Galton, a polymath and cousin of Charles Darwin, at an agricultural fair in England in 1906. Galton observed a contest in which bets were made on the weight of an ox. Later he analyzed the conjectures of some 800 people and found that their average guess (1,197 lbs.) was almost the exact weight of the ox (1,198 lbs.).

Surowiecki points out that *"under the right circumstances, groups are remarkably intelligent and are often smarter than the smartest person in them. Groups do not need to be dominated by exceptionally intelligent people in order to be smart. Even if most of the people within a group are not especially well-informed or rational, it can still reach a collectively wise decision."*

As wise as the crowd may sometimes be, so too can it become just as irrational. The difficulty in predicting future risk and returns stems from the fact that market participants themselves are complex and unpredictable. Due to the infinite combinations of group knowledge, wisdom, and current emotional states, market participants can choose to take any number of actions or no action at all. The truth about the nature of markets, which is merely a reflection of the behavior of those who participate in them, is that they can be both rational and irrational, efficient and inefficient, sequential and random, predictable and unpredictable.

During irrational market periods, volatility can have a devastating impact on long-term compounded returns, which one only needs to look at the S&P 500 index to see. Ironically, this index is the very market portfolio that William Sharpe advised owning. The S&P 500 may be "owned" in the form of an Exchange Traded Fund (symbols SPY or IVV).

In **Figure 2**, we can see that following a +100% advance, the S&P 500 index traded at **1,527** in March of 2000. Thirteen years later, in 2013, it was trading at approximately the same level.

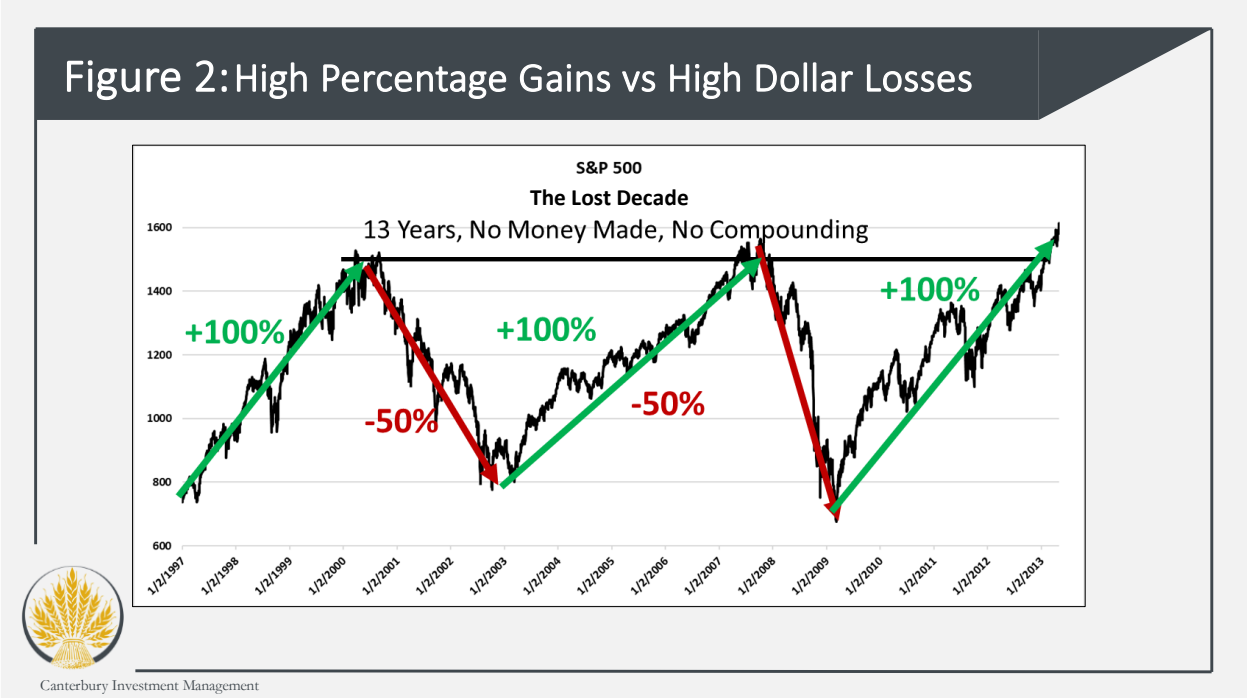


Figure 2*: The S&P 500 may or may not represent an efficient stock market, but it is not an "efficient portfolio." During this 13-year period, the stock market has had periods of high returns but also had some large declines. We see that the S&P 500 experienced* ***3 periods of +100% advances*** *and* ***2 periods of -50% declines****. Excluding the initial +100% advance, the net "percentage difference" between the total advances and declines (simple return) is* ***+100%*** *(100% - 50% + 100% - 50%) but the net "dollar difference" (compounded return) was 13 years of no gain. (This graph does not include income from dividends.) The large declines wiped out the gains and ruined the benefit of compounding.*

What is interesting is that within that thirteen-year period, the combined income statements of those S&P 500 companies actually showed profits for every year. In other words, the companies themselves had positive earnings but most investors suffered through high market volatility and in fact made little or no money.

In **Figure 3,** if we look at the last 150 years, spanning the years from 1874 to 2023, the combined income statements of those S&P 500 or index equivalent companies (prior to the S&P's inception) showed profits every year, according to the index's company earnings yield. The index itself, however, suffered through high market volatility. During volatile bear markets, like the ones experienced in from 2000-2002 and 2007 to March 2009, the market index saw substantial declines, even though its underlying companies remained profitable.

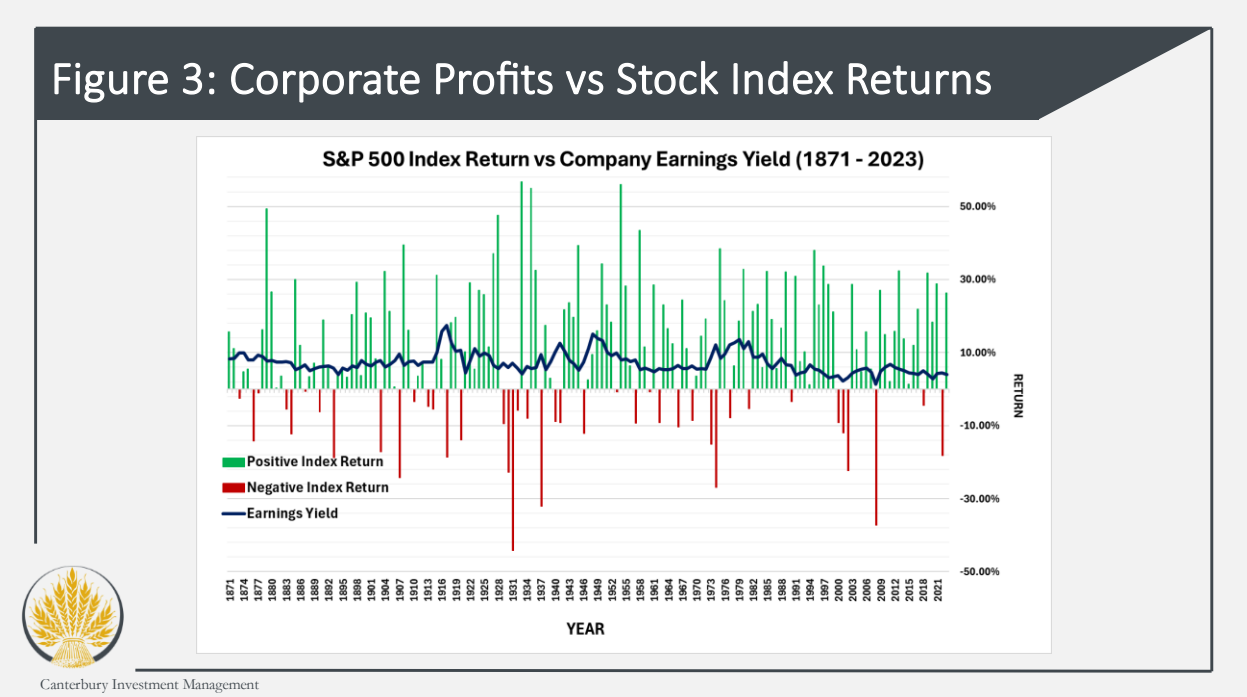


***Figure 3**: The S&P 500 has produced sporadic, inconsistent annual returns each year dating back to 1871. Meanwhile, the underlying companies, as a collective, have produced profits every single year over the same timeframe. Corporate profits have been consistent and stable, while the stock market index has had wide fluctuations, both up and down.*

Observation: The S&P 500 index has had periods of large gains. It also has had periods of high volatility, including two periods of declines in the -50% range since the turn of the century. During those periods, the index did not benefit from compounded returns.

Conclusion: Market indexes are vulnerable to substantial declines. Index funds, such as the S&P 500, do not meet the requirements to be a truly efficient portfolio for investment purposes. Therefore, with all due respect to Sharpe, the S&P 500 is not the "Super Efficient portfolio" that he and Tobin were hoping to find.

The S&P 500 index fails to live up to be the "Super Efficient portfolio" that Sharpe and Tobin were expecting because of the issue of correlation. Most investors would agree that the primary purpose of diversification is to reduce risk by limiting portfolio volatility. Bear in mind, though, that the changing market environments will impact how securities fluctuate in relation to each other, resulting in either a negative or positive impact on the benefit of diversification.

The transition from a rational Bull to an emotional Bear market, as shown in **Figure 4**, demonstrates how a mix of securities that was effective at maintaining low correlation and a stable portfolio during a rational environment will fail to manage the unique risk connected to a more emotional Bearish market environment.

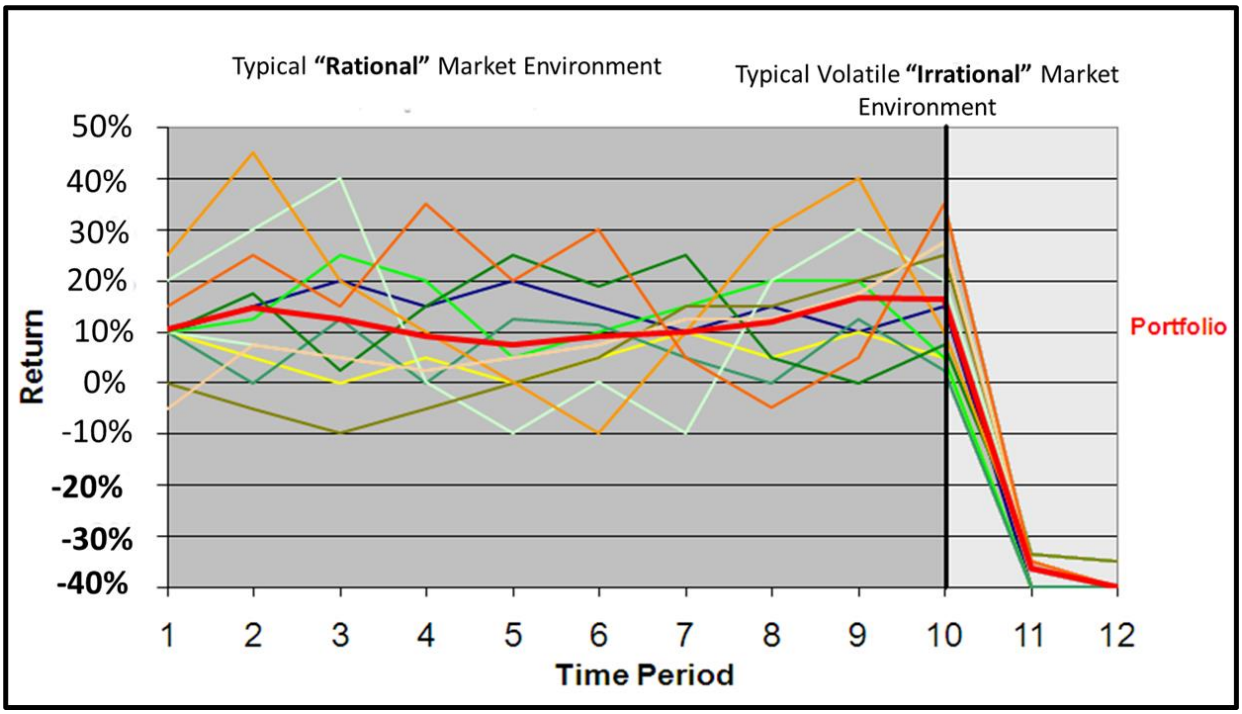


***Figure 4**: Traditional diversification fails to maintain acceptable fluctuations when markets are volatile and securities become correlated. The left side of this example shows a typical portfolio with a high degree of randomness among securities. Each security has similar volatility and, as a result, each should justify a premium return for accepting the uncertainty associated with limited volatility. As can be seen, some securities performed better than expected and some did not. The smoothed red line represents the combined portfolio and resulting benefit of proper diversification. The right side of the chart illustrates what happens when an unexpected, high impact event occurs that causes most securities to become correlated and decline together.*

Failure to maintain low correlation then causes an increase in volatility and leads to a substantial decline in portfolio value.

Taking a Critical Look at Wall Street's Most Commonly Held Myths

Knowing what it is that we need to do to succeed (avoid substantial declines and maintain true diversification), let us now take a look at some of Wall Street's most prevalent myths and briefly discuss in what ways they counteract our objectives.

Wall Street Myth #1: Assuming More Risk is Likely to Produce Higher Returns

A common belief perpetuated by the old theories is that, given enough time, assuming more risk is likely to produce higher returns.

"The overall level of risk you choose is based primarily on your tolerance to assume risk in exchange for potential rewards."
-Bank of America

Contrary to popular beliefs, **taking additional risk is not the driver of higher returns in financial markets**. The driver of financial investment returns is the geometric compounding of a portfolio value over time. As illustrated earlier in **Figures 1** and **2**, in the case of financial markets and portfolio management, risk and reward are not treated equally. A 50% decline requires a 100% advance just to break even and it does not matter which happens first. Given enough time, taking more risk (meaning volatility) will eventually result in substantial declines, ruining the likelihood of achieving compounded returns.

We know this to be true because a risky portfolio, by definition, has higher volatility, meaning higher correlation. High correlation means that the portfolio is concentrated in securities with similar characteristics. A concentrated (risky) portfolio is more likely to have periods with higher, short-term profits. However, the lack of diversification will also cause the risky portfolio to experience periods with "substantial declines."

To put it another way, taking more risk over the long run is similar to making big bets when playing Russian roulette with a six shooter. The probability of winning the first time would be 5 to 1 or 83%. But barring an incredible run of good luck, long term, you are dead. Taking more risk, beyond normal fluctuations, is not something a "rational investor" should, or would, choose to do.

Wall Street Myth #2: Fixed Percentage Asset Allocation Will Produce Consistent Results

Wall Street believes that asset allocation, that is the percentage of the portfolio assigned to each asset class, should be assigned based on the investor's "risk tolerance." In other words, an asset allocation should be a fixed percentage apportionment based on a subjective list of investment objectives.

Such methods are ineffective because the static nature of fixed percentage asset allocation methods is incompatible with the dynamic nature of the markets. Markets have many unexpected twists and turns. A portfolio with a fixed asset allocation cannot adjust effectively to this variable nature. This is particularly true when a fixed asset allocation for the portfolio is combined with the passive management of individual holdings. In this case, a so-called conservatively allocated portfolio can become highly volatile and risky when markets are emotional. On the other hand, a more aggressively allocated portfolio may behave sluggishly, to the point of being boring, when markets are slow. The variable and ever-changing nature of the markets is not suited to fixed asset allocation, casual monitoring, or periodic rebalancing based on the calendar.

When asset allocation is locked into a fixed percentage, the portfolio will be a reflection of the markets and have uncontrolled risk.

Wall Street Myth #3: The Most Efficient Portfolio Does Not Change Over Time

The original theories regarding diversification and efficient portfolio construction assumed markets were highly efficient. Therefore, other than for periodic rebalancing, the same static portfolio was expected to be "bought, held, and rebalanced" forever. Today, most investors who choose a passive style of investment are said to be "indexing." Another popular passive management strategy is to buy and hold, or "dollar cost average," several diversified style-specific funds, as illustrated in the infamous pie chart.

However, as James Picerno, in his book *Dynamic Asset Allocation*, stated, "the older, traditional interpretation of Modern Portfolio Theory where everyone holds the same market portfolio – isn't necessarily wrong, but it's overly simplistic."

To this day, Wall Street consults programs and portfolio managers continue to construct portfolios using the same traditional bell curve assumptions and methods (scatter-graphs, the efficient frontier, standard deviation, Alpha, Beta, Sharpe Ratio, etc.). Portfolios are constructed by hiring the combination of "style specific" investment managers that would have been the best in the past. Investment consultants make asset allocation decisions by reviewing historical data, past performance, and past correlations. As a result, the newly constructed, and later rebalanced or reconstructed, portfolios will look very similar to what would have been the best asset allocation and combination of funds or managers in the past.

Constructing portfolios using this approach is a mistake because the combination of securities that produced the most efficient portfolio during a stable or rational market is very different from the diversified portfolio that would perform best in a volatile Bearish market. Markets tend to be cyclical, and each cycle has its own unique characteristics. For instance, some market environments contain more risk than others.

Taking advantage of these different market environments are difficult though when restricted by Investment Policy Statements (IPS) and written investment objectives. They tend to limit a portfolio management strategy's or advisor's ability to react to changing market cycles. Admittedly, most consultants do not have access to proven strategies that are likely to make timely adjustments anyway. In any case, portfolio holdings and allocations should continually be optimized based on the changing and unique characteristics of the current market environment as opposed to fixed and overly restricted parameters outlined in a written document.

Wall Street Myth #4: A Risk Tolerance Questionnaire Provides Meaningful Insights

The typical "investor profile" process usually requires around 10 minutes to complete a questionnaire that typically consists of 10-15, mostly subjective, questions. The following are a few sample questions:

- Do you consider the objective of the foundation, institution, or individual investor to be: Conservative, Moderate, or Aggressive?
- Is the foundation's, institution's, or investor's tolerance for risk high, medium, or low?

- How much would you be willing to lose over the course of a year?
- Define the amount of volatility you would accept in return for potentially higher returns: very little, some, moderate, or a considerable amount of volatility?
- What is the expected life of your foundation or institution - how many years do you plan to remain invested to ride out the cycles?
- Choose which is most important: future growth, income, or both?
- What are your expected distributions for the next year and the next 5 years?

At first glance, it may seem logical to ask these questions and assign point values based on the answers given. Add up the points and use the total to assign a "subjective" investment profile label, like "moderately conservative" or "aggressively moderate." There also appears to be some logic in using an "emotional risk tolerance" as a guide in assigning "pie chart" asset allocation and diversification parameters. However, this "logic" can be dangerous to your wealth.

The "Risk Tolerance Profile" ineffectively prepares investors to understand the future pitfalls they may experience during their investing lifetime, and the traditional fixed percentage allocations, recommended within the guidelines of the "investment profile" or Investment Policy Statement, have not been successful at containing risk within the expected range. The following is a case in point:

Financial Crisis – Market Peak: 10/09/2007 through Bottom: 3/09/09
Conservative Allocation (example) 50% S&P 500 and 50% 7 to 10 Year Treasury Note Index: **-18.53%**
Moderate Allocation (example) 70% S&P 500 and 30% 1 to 3 Year Treasury Note Index:
-28.99%
Source: Performance from Orion Advisors

Would the typical description of "conservative" or "moderate" adequately describe the risk of loss experienced during the financial crisis?

Now, let's look at a more recent period where a Moderately Conservative (Balanced) mutual fund, or 60% stock, 40% bond allocation also failed to contain risk within an expected range:

2022 Bear Market – Market Peak: 12/29/21 through Bottom: 10/12/22
S&P 500 (Index) 100% S&P 500:
-25.37%
Vanguard Balanced Fund (Mutual Fund: VBINX) 60% US total stock market and 40% Aggregate Bond Index:
-22.42%
Source: Optuma Technical Analysis Software

Everyone has different personal objectives, timetables, and risk tolerance. Meaningful insights cannot be gained from completing a questionnaire, and successful investment strategies are not

built on subjectivity, gut feelings, or profile labels. Your investment portfolio does not care about your beliefs about risk or your thoughts about the market; it is indifferent to your feelings regarding its current behavior or future performance. Meaningful insights come only from focusing time and energy on the mission of your foundation or institution or on a personal wealth management or financial planning process built around a scientific and analytical process. Successful investing comes from well thought-out strategies and models using rules-based approaches and extensive testing.

Wall Street Myth #5: Traditional Risk Management Models Work in Volatile Markets

The increased complexity that accompanied the proliferation of Wall Street's new investment tools and technologies has also created more market noise and short-term volatility than ever before. As a result, there are more trading days that exceed the predicted range of probabilities than in the past, and Wall Street's bell curved based risk management models are simply incapable of dealing with the periods of wild swings that continue to impact portfolios in unexpected ways.

One example is JP Morgan's flawed Value at Risk Model (VAR) in 2012, which cost the firm over eight billion dollars in a very short period of time. The bell curve probabilities used in the VAR model had dramatically underestimated the risk in a complex group of securities called Credit Default Swaps (CDS).

The fact that VAR models simply do not work when needed most is not news, though. During the summer of 1998, Long Term Capital Management (LTCM), a hedge fund, experienced a similar incident. LTCM's staff boasted of 2 Nobel laureates and 27 PhD's. Together, they created a new method to value derivatives using bell curve probabilities. Suffice it to say that their prediction of an almost impossible Russian bond default and their predicted VAR did not quite work out the way they had planned. The Federal Reserve and several money-center banks were forced to intervene, and LTCM clients lost billions of dollars and did not survive the year.

The following is a quote from my book *Investor Revolution*, published in 2007 – prior to the financial collapse:

"Traditional Wall Street firms don't have a process that is sufficiently dynamic to deal with our ever-changing environment. Consequently, traditional Value at Risk (VAR) models are rendered worthless…Wall Street firms continue to put themselves in positions to lose tens of billions of their and their clients' money."
-Tom Hardin, *Investor Revolution* (2007)

Doing the same thing over and over again, expecting a different result, typically does not work out very well.

Can Old Strategies Based on Old Theories Work in the Twenty-First Century?

We do not deny that Modern Portfolio Theory and the related theories that followed were revolutionary for their time. Prior to MPT, investors focused on the merits of individual securities, not the portfolio as a whole. Modern Portfolio Theory and the bell curve of normal distribution can be credited as the basis for Wall Street's approaches to portfolio construction and risk management to this day. The question, though, is whether old theories and models can continue to work in today's interconnected global markets of revolutionary new technologies and unique innovative investment vehicles?

Knowing what it is we are trying to achieve (compounded returns) and how to achieve it (avoid substantial declines), we can see that Wall Street has not been successful in meeting investors' goals. Wall Street has not effectively adapted its strategies to benefit from the changing paradigms their innovative products have created. Barring a new bull market, there is no reason to believe they will be able to adapt to new strategies in order to improve investment returns anytime soon.

The Bell Curve is Wall Street's Gold Standard for Predicting Future Risks and Returns

As stated earlier, one of the basic tenets of Modern Portfolio Theory is the belief that markets and securities prices are random and equally distributed. That assumption has led to the acceptance of the bell curve of normal distribution as the preferred method for determining the probabilities of future risks, correlations, and returns. Since many of Wall Street's myths regarding investment management ultimately come back to the bell curve, it might be wise to now take a closer look at it to determine why traditional strategies are unsuccessful during volatile periods.

The bell curve operates under what is called the Law of Large Numbers. According to the Law of Large Numbers, low probability outliers will average out over time and have little or no impact on the eventual outcome. Take retired professional basketball player Yao Ming for example. He is 7 feet 6 inches tall. Based on the bell curve's standard deviation of the average heights of men in the world, Yao's height is almost statistically impossible. Does that mean the bell curve is a poor predictor of heights? Because of the Law of Large Numbers, Yao's height is averaged in with the heights of the 3.4 billion men in the world, and as a result, his height has no impact on the average height of men in the world.

Alternatively, the Power Law Distribution operates under a different set of rules than the bell curve. Nassim Taleb, author of *The Black Swan* and *Fooled by Randomness*, illustrates the characteristics of the Power Law Distribution in his story about a young turkey being introduced to his new home and new caretaker, the farmer. In **Figure 5** below, the chart on the right-hand side shows the progression of the turkey's life. The vertical axis measures the turkey's quality of life and the horizontal axis counts the days of the turkey's life.

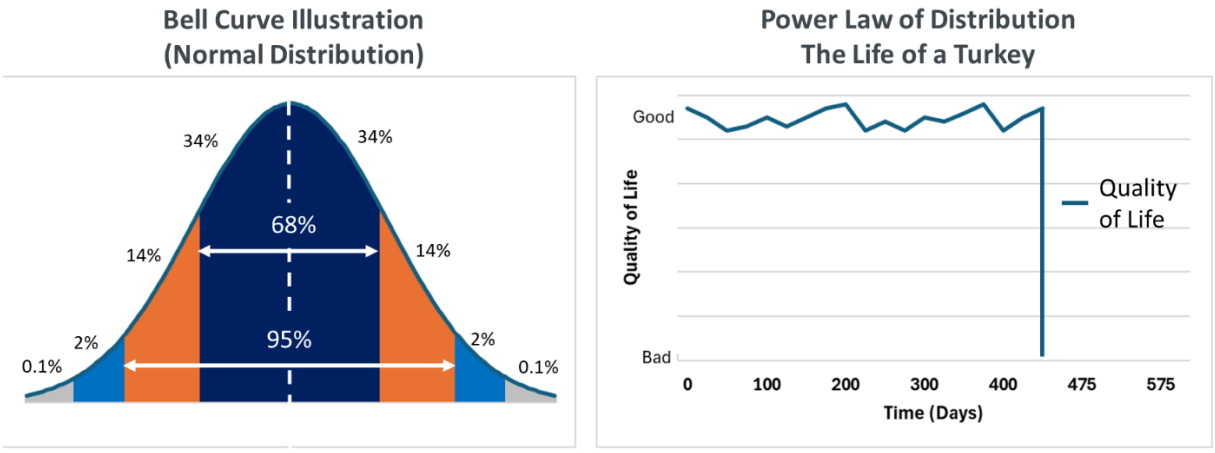


Figure 5: The Bell Curve vs. The Power Law *Almost all of Wall Street's risk management models continue to use the bell curve shown on the* ***left****. The Power Law Distribution (on the* ***right****) is better at showing the challenges facing investors when low probability/high impact events disrupt the markets. In portfolio management, the problem we face is that one good event does not "average out" an equally bad event. When flipping a coin, one head will offset one tail. In portfolio management, a +50% advance combined with and a -50% decline, will net out as a loss.*

As we can see from the chart, the turkey has experienced a good life. He has over 450 daily observations that he is safe and well-fed. From these observations, he has every reason to believe that he and the farmer have the same interests. One day in late November, the farmer walks up to the turkey with an ax in hand and asks the turkey to lay his head on the stump of an old fallen tree. Based on his analysis of past data and on the fact that he has never seen an ax, the turkey determines that the probabilities of him being at risk are virtually nonexistent. Seconds later, the turkey registers his first bad day out of 450. Did the Law of Large Numbers average out the one outlier as it did for Yao Ming? The answer is an emphatic "**no**."

The Power Law vs. the Law of Large Numbers

The early portfolio theories were based on the assumptions that markets were random and efficient and thus utilized the bell curve. The bell curve of normal distribution works best when the samplings are high and the variance among outcomes is low and randomly distributed. In reality however, financial markets are not random, and they experience low probability, high impact events that are not averaged out in the law of large numbers. The bell curve is therefore better suited for predicting the probability of a coin landing on heads five times in a row than predicting the wide-ranging twists and turns of the markets.

On the other hand, the Power Law, which describes the exponential relationship between two variables, is more suited to describing the behavior of the market because it allows more room for outliers (low probability events) than the bell curve. Like the turkey, investment portfolios are much more affected by the ramifications of the outliers in the Power Law than in the Bell Curve's Law of Large Numbers. A lifetime of savings and gains can be wiped out during just one period

containing a large decline. The Law of Large Numbers works only when the outliers lie within a relatively narrow range. A 30%, 50% or greater decline can exceed the portfolio's ability to "average out" the impact.

Figure 6 leaves no doubt that financial markets are dominated by high impact/low probability events. These unlikely periods of high volatility occur with much more regularity than bell curve risk models would predict. What these risk management models fail to recognize, according to economics John Maynard Keynes, is that "markets can stay irrational longer than you can stay solvent."

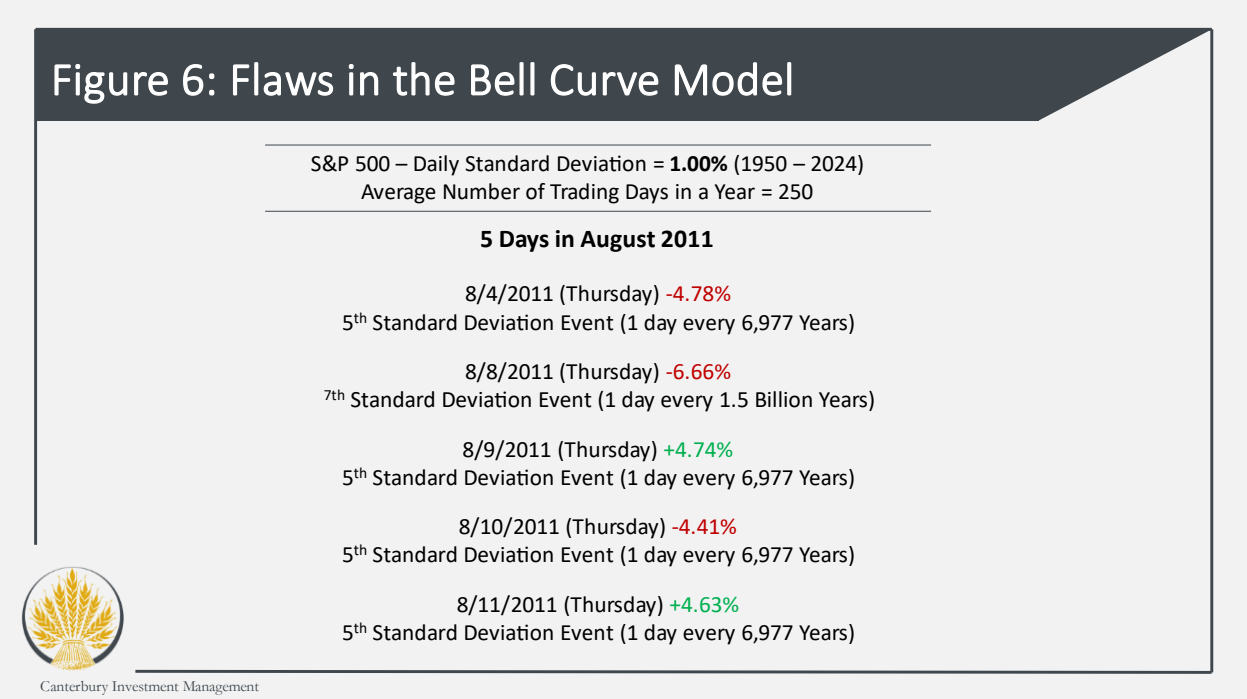


Figure 6: Flaws in the Bell Curve Model *The bell curve suggests that the probability of having a one day decline similar to any of the 5, of 6, trading days in August 2011 is virtually impossible. However, the reality of having five such events occur in six trading days proves that markets are not random. There is no statistical validity to using bell curve metrics to measure or predict the risk of low probability/high impact events in the financial markets.*

This data proves the fallacy of "randomly distributed" market movements and the ability of traditional models to accurately predict the severity of future risk. Goldman Sachs's hedge fund experienced substantial losses during the first dislocations in credit markets in 2007. Chief financial officer David Viniar remarked, "We were seeing things that were 25 standard deviations moves, several days in a row," implying that such an event could not have been predicted statistically. Justin Fox wrote in his book *The Myth of the Rational Market*, "The improbable-but-not-impossible was not something that bell curve statistics could address." Traditional risk management models simply do not work when they are needed most.

Introducing Adaptive Portfolio Management

An Adaptive Process, like a Thermostat, Helps Provide Stability in an Unstable Environment
Having addressed the flaws in traditional management strategies, the next logical question is how should investors protect their portfolios from the market's ever-changing moods? The answer lies in a comparison to the weather.

The weather and the markets are similar, in that they both experience volatile and unpredictable changes. The wide-ranging temperatures in the Midwest are comparable to the wide-ranging prices in the markets. Both call out for a process to level the extremes and to provide a safe and stable environment.

When we face changing weather patterns, we use a thermostat to maintain a consistent indoor temperature in the face of fluctuating outdoor temperature. The thermostat is an adaptive process that monitors external conditions and makes adjustments to keep the inside of your home comfortable. The thermostat uses a thermometer to measure the current indoor temperature. Based on the thermometer's readings, the thermostat then employs the air conditioner and furnace to maintain your home's comfort level. By using a scientific process to adjust these devices, we can be assured that the indoor temperature will remain at the desired level.

We cannot control the weather itself, but we can manage the indoor temperature. Investors, similarly, cannot govern the market's wild gyrations, but do have the tools to manage portfolio volatility. In the weather analogy, the thermostat's function is to allocate the suitable amount of hot or cool air to make the indoor environment comfortable. Similarly, an adaptive portfolio would function to adapt to ever-changing market conditions.

What is Adaptive Portfolio Management?
What if your portfolio worked like a home thermostat? That would require your portfolio to have an adaptive process. Adaptive portfolio management is a rules-based, testable process designed to stabilize portfolio volatility by adjusting to changing market environments. Such a process actively manages asset allocation and diversification in order to benefit from each market environment's unique characteristics. Through continual and active readjustment, an adaptive portfolio seeks to maintain acceptable fluctuations and avoid "substantial declines." The inspiration Canterbury's adaptive portfolio management process arose from the need to manage portfolio volatility and to generate compounded returns throughout **all** market conditions.

This methodology evolved through a combination of out-of-the-box thinking, a willingness to embrace advancements in investment technologies, and the availability of specialized securities like Exchange Traded Funds (ETFs). The adaptive portfolio management process represents years of trial and error, testing and extensive software development, and is comprised of integrated

algorithms. Let's walk through Canterbury's adaptive portfolio management process, how it works, and the statistically relevant results it can produce.

Singapore Enjoys Very Consistent Weather; Indianapolis Does Not

Let us take a look at traditional investment management through the lens of our weather metaphor. Singapore boasts a very warm, tropical climate that is very consistent. If we look at **Figure 7** below, we see that Singapore enjoys an average temperature of 82.2°F, only occasionally dropping as low as 79°F or rising as high as 92°F. Most of the time, temperatures remain within this tight range.

In contrast, temperatures in Indianapolis vary widely, ranging from 7°F to 95°F and rarely experiences the mean of 50.7°F. However, the inhabitants of Indianapolis can also experience the same predictability of a consistent range of temperatures as in Singapore if its people remained indoors and used a thermostat to manage the furnace and air conditioner to produce stability.

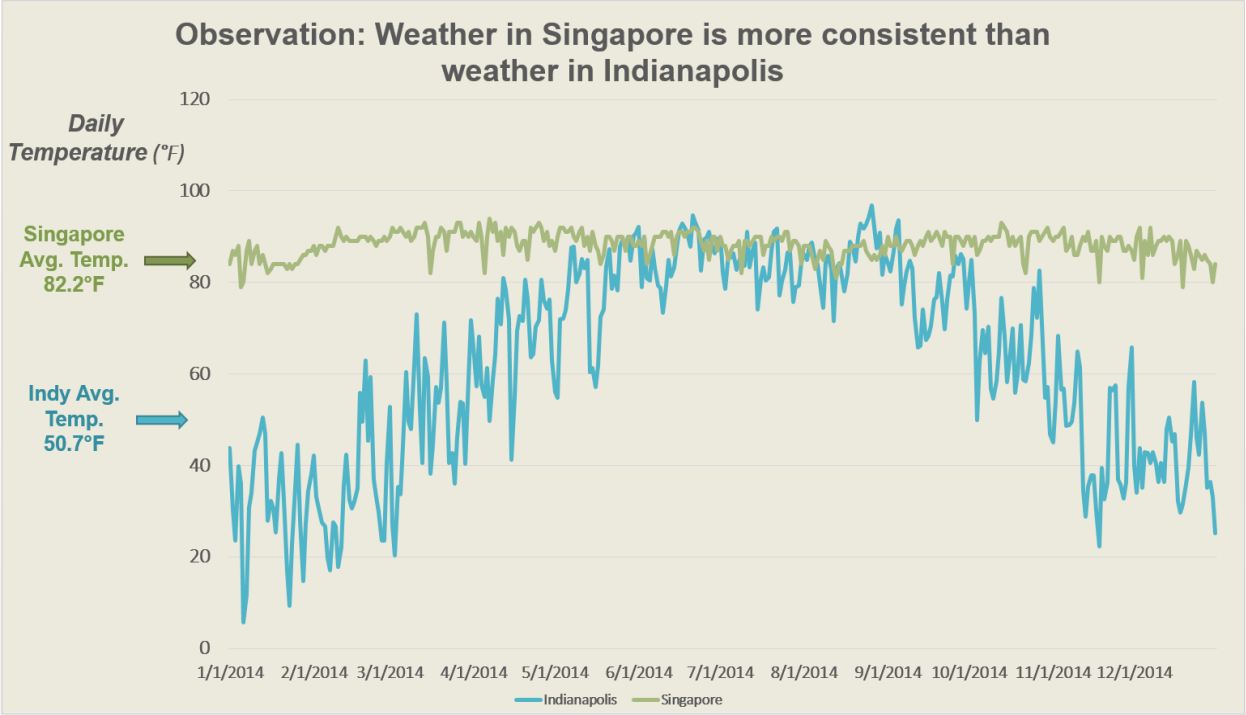


Figure 7: *The climate in Singapore is more stable than Indy's.*

The traditional method of assigning a fixed asset allocation would be similar to "fixing" the furnace to produce +20°F heat all the time, assuming a 50°F mean, in order to maintain a consistent 70°F in a place like Indiana, regardless of whether the outdoor temperature read 7°F or 95°F. Assigning a fixed asset allocation will likewise result in uncontrolled risk and leave the portfolio vulnerable to changes in market volatility, which could in turn lead to substantial declines.

Changes in Volatility can be a Leading Indicator of Future Market Environments
Fortunately for those in Indianapolis, temperatures do not go from 7°F to 95°F overnight.

The thermometer is a crucial component of the thermostat because it measures changes in temperature as weather patterns change. That information is relayed to the thermostat, which can then adjust accordingly. Our studies show that changes in market volatility can likewise be an effective leading indicator of future market behavior and direction. For example, low or decreasing volatility is typically associated with bull markets, while high and increasing volatility is characteristic of bear markets and bubbles. We use the Canterbury Volatility Index (CVI) as the market's "volatility" thermometer. The CVI reads similar to temperature. Generally speaking, volatility below CVI 75 for the S&P 500 is considered low, while volatility rising above CVI 75 is a characteristic of a more emotional and irrational market. The CVI flags an increase in volatility, which can give an early indication of a shift in market environment.

Figure 8 shows the Canterbury Volatility Index (CVI) overlayed on the S&P 500 index. Notice that as the market peaked September 2007, volatility had already begun to increase, indicating that risks in the market were on the rise.

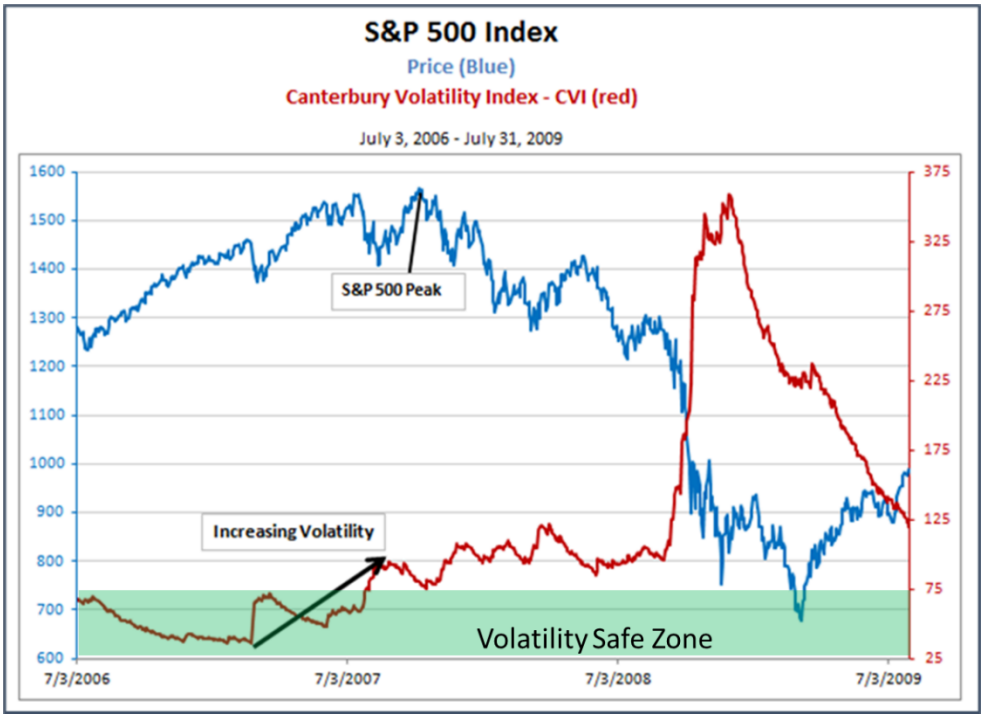


Figure 8: *An increase in volatility preceded the Bear market and crash during '08 and '09. The S&P 500 and CVI tend to move opposite of each other. This chart clearly shows several months of increasing volatility (red CVI) prior to the October 2007 market peak (blue S&P 500 Index). The green zone represents a safe (low volatile) area for volatility. Volatility becomes high/increasing prior to the market's peak.*

If we zoom out and view the S&P 500 index over a longer duration, coupled with the Canterbury Volatility Index (CVI), you will notice that volatility has an inverse relationship to the market. Rising/high volatility is generally associated with a declining market or a parabolic advance/bubble, while decreasing/low volatility can be associated with a rising market. This is depicted in **Figure 9**.

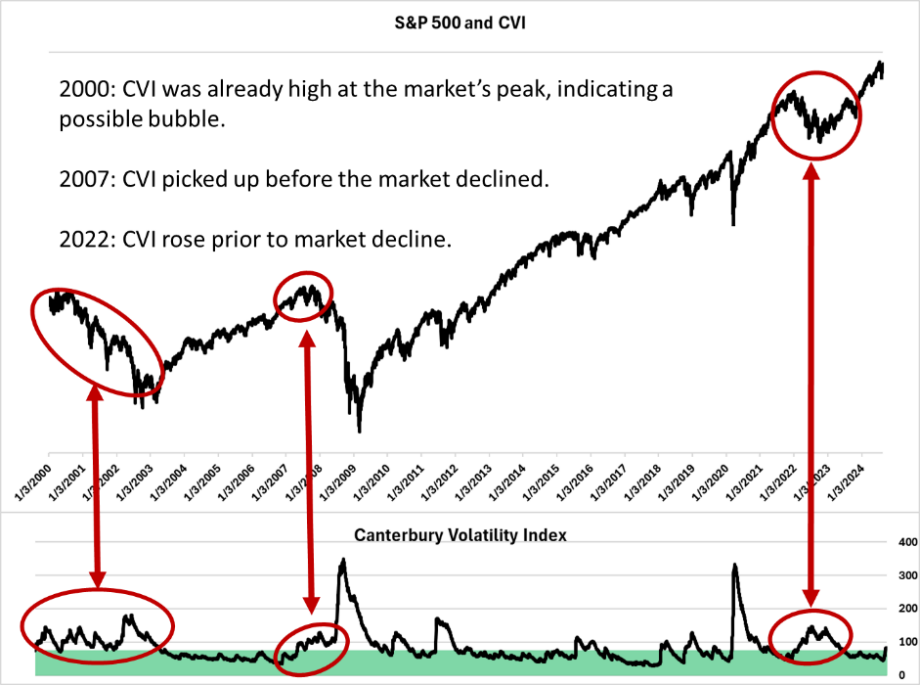


Figure 9: The S&P 500 and the CVI *have a negative relationship. Rising/high volatility is a bear market characteristic, while declining/low volatility is a bull market characteristic. The green zone on the CVI chart indicates where volatility is low and market fluctuations are rational. Note that all bear markets, such as the ones experienced in 2000, 2008, and 2022 were all volatile, and became volatile prior to a substantial decline.*

Identifying Market Environments and Canterbury's Market States

Going back to the weather analogy, we can use a weather map (as in **Figure 10**) to see when storms are approaching. Areas of red indicate dangerous zones for storms and yellow warns us of the possibility of inclement weather. If the markets are comparable to the weather, why not have a similar map for financial market conditions? Identifying the external macro environment is the first step in generating appropriate portfolio adaptations.

Figure 11 shows how the market environments have changed over the past 24 years. Market environments and Canterbury's "Market States" will be discussed below in detail. One critical component of a market environment is changes in volatility (discussed above). The red areas on the chart signify periods high volatility and reflect negative market characteristics. The yellow areas represent periods of transition either into or from a bearish market environment. Green areas show periods of low volatility when markets are bullish. The areas of green on the chart signify

periods of stability, while the red areas represent volatile periods or "storms." Note that red and yellow "stormy" periods have a high correlation with a declining stock market, while green areas have a high correlation with an increasing stock market. The lower fourth of the chart shows the Canterbury Volatility Index. The highlighted green area outlines the desired range of volatility (below 75) that would correspond to the calm periods on the upper chart, during which the S&P 500 increases. As we can see, large declines correspond with spikes in volatility. We can therefore conclude that if we want to remain in the calm periods where increases occur, we need to limit our portfolio volatility to the desired range. Otherwise, we will find ourselves in "stormy" weather and vulnerable to large declines.

***Figure 10**: The stock market's environment is variable, similar to the outdoor weather. In this weather map to the left, the red and yellow areas indicate approaching storms. Cities over which these two storms are forming must beware of potential dangers, much like investors who find themselves with high portfolio volatility. This is common among market states in the yellow and red areas in the chart below.*

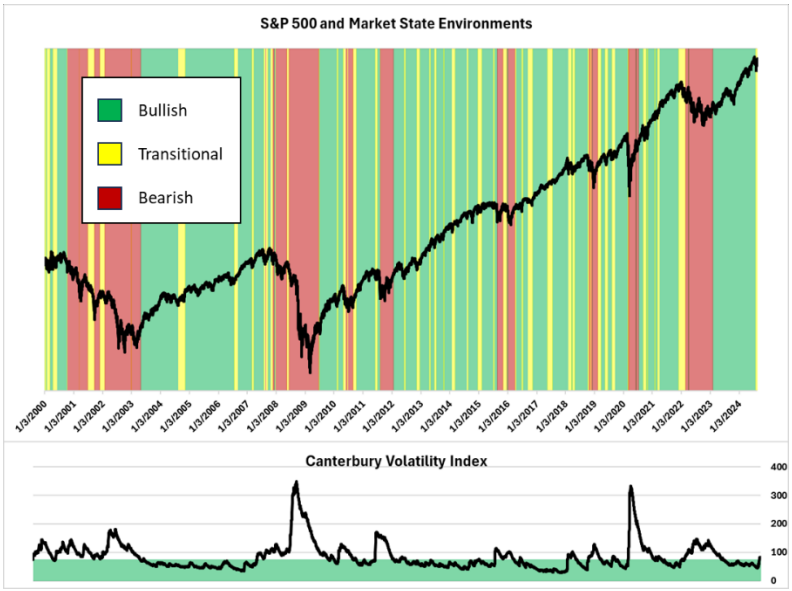


***Figure 11: The S&P 500 and Market State Environments:** Markets have environments that work similar to weather. The Market State Environment chart shows an objective method to quantify bull and bear markets. Green areas indicate low volatility and a bull market; red areas a high, irrational volatility and a bear market, and yellow areas are transitional (rising or falling volatility). The lower fourth of the chart shows the Canterbury Volatility Index. For the S&P 500, a CVI of 75 or less is generally considered efficient. Notice how volatility negatively correlates with the market's directional trend.*

The technical characteristics of each environment are shown in **Figure 12**.

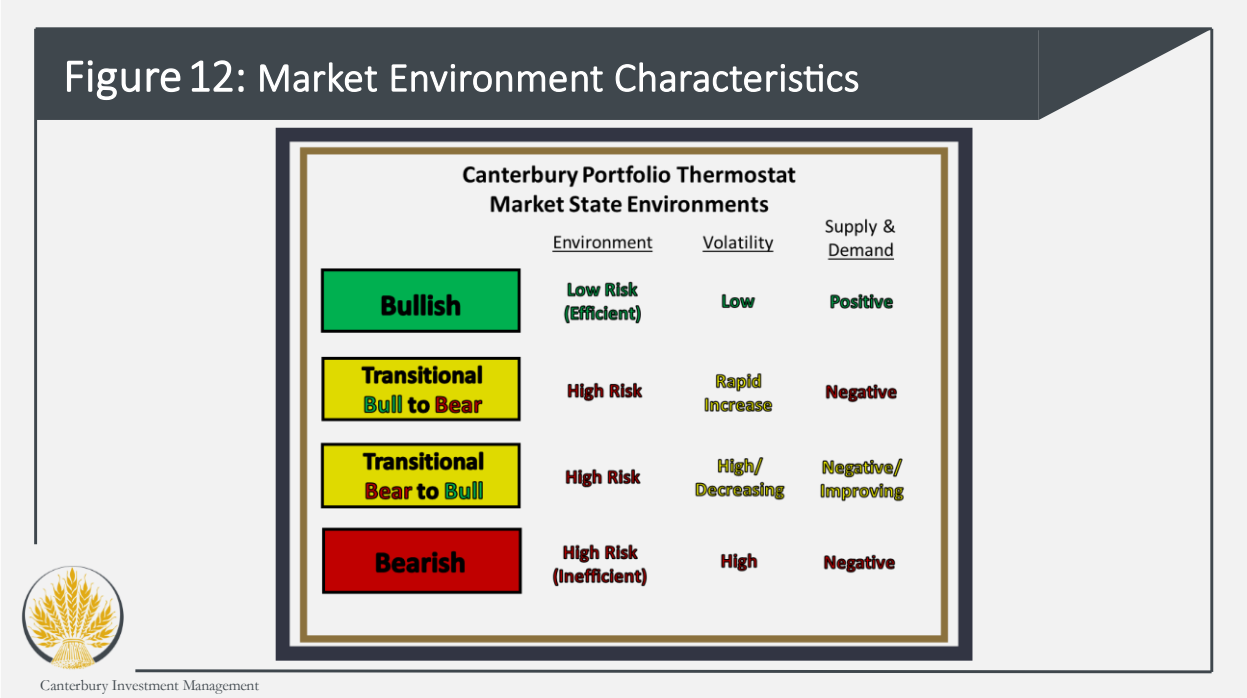


***Figure 12: Market State Environments** have different characteristics.*

How are Market States Constructed?

In order to identify the primary market environment, Canterbury uses an objective, technical process to compute a "Market State." Identifying the primary market environment is comparable to separating the black from the white, but many shades of grey lie within each category. Canterbury's adaptive process therefore subdivides each primary market environment (bull, bear, transitional) into multiple objective Market States, each according to the unique traits and tendencies they exhibit.

Market environments can be broken down into 12 different Market States, with each Market State having its own unique technical characteristics. Market States are categorized by analyzing three primary inputs:

- Long-term indicators are used to identify the primary trend of the market or security. These indicators include a combination of price action and different termed moving averages.
- The Canterbury Volatility Index (CVI), which evaluates the degree of rationality of the current market environment.
- Short-term supply and demand indicators, which include common technical indicators and determine the strength of the current environment.

Using the combination of long-term, volatility, and short-term supply and demand indicators, Canterbury has identified 12 individual Market States, shown in **Figure 11**, which include:

- 5 Bullish (rational) Market States
- 4 Bearish (irrational) Market States
- 3 Transitional Market States (which tend to precede a change from Bullish to Bearish, indicating caution)

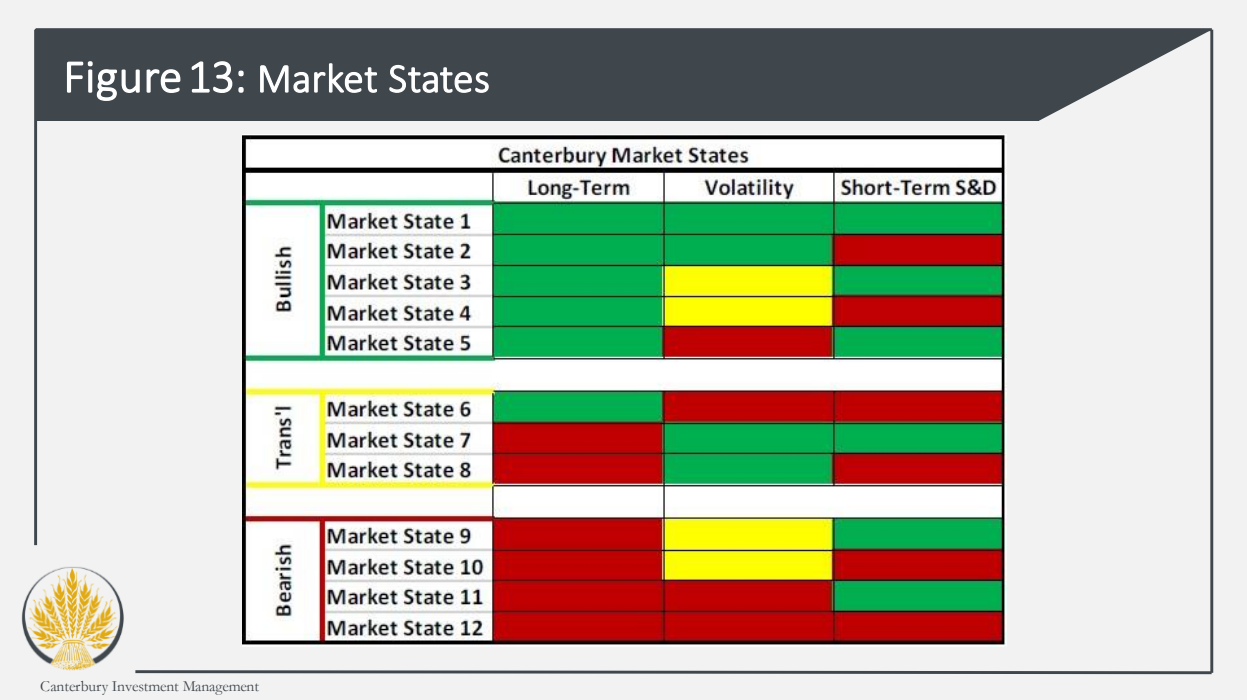


***Figure 13**: **Canterbury Market States** are a combination of long-term, volatility, and short-term supply and demand indicators. There are 5 bullish Market States, 3 transitional Market States, and 4 bearish Market States. Green indicators represent a positive reading; yellow volatility readings represent the rise or fall of volatility; red is a negative reading.*

Figure 14 breaks down each market environment and Market State characteristic. Market States provide the status of the market today and the associated risks, but do not predict the longevity of how long that a specific environment will stay intact.

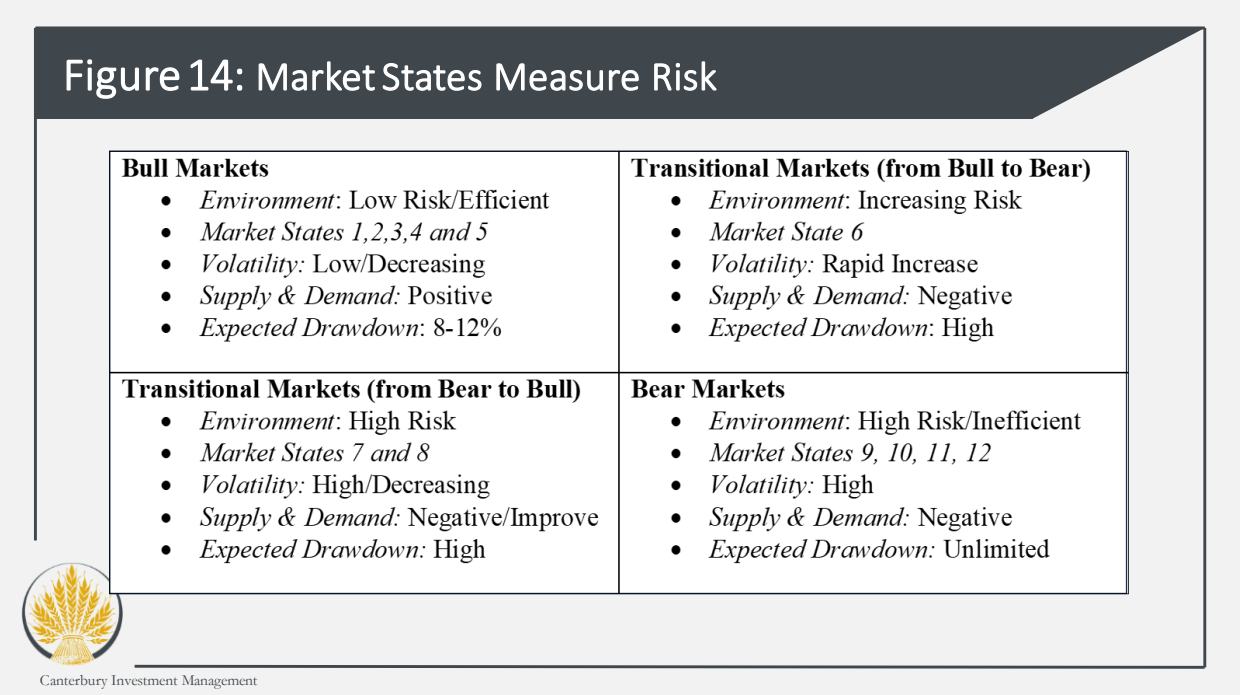


Figure 14: Market States Measure Risk. *Our studies show that bullish Market States outperform bearish Market States.*

Evidence Supporting the Validity of Market States and Market State Environments

As stated in the executive summary of this White Paper, David Aronson defined a methodology as objective "if and only if it can be implemented as a computer program that produces unambiguous market positions." One must accept unexpected results, avoid confirmation bias and have a willingness to question and reconsider existing beliefs.

The question we aim to answer in this section is "do Market States accurately tell us about the current risks in the market?" Can they be a viable means to separate the risky, irrational market from the stable, rational ones?

Annualized Risk and Return

Let's look at some statistics that analyze Market States for the frequency they occur and the results that they produce, both from a risk as well as reward perspective. Canterbury has daily data, on the S&P 500, which dates back to 1950. Using this data, we have identified the daily Market State and Canterbury Volatility Index reading for every day (this is over 18,700 days). This volume of daily data provides more statistically conclusive information as compared to the annual data that is traditionally used in investment practices.

Table 1 shows some interesting statistics for each Market State Environment. Note that Market States 6-8 (transitional) have been combined with Market States 9-12 due to their high-risk nature.

Market State Environment Statistics		
Statistic	**Bull Market States**	**Bear/Transitional Environments**
Percentage of Trading Days	63.93%	36.07%
Annualized Compounded Return	10.70%	3.18%
Annualized Standard Deviation	11.78%	21.03%

Table 1: Market State characteristics show that bull Market States are much more frequent than Bearish and Transitional Market States combined. Bullish Market States also have less risk, indicated by the annualized standard deviation, and higher annualized returns. Annualized compounded return was computed by taking the compounded rate of average daily returns while in each Market State environment, then annualized using an average of 252 trading days per year.

As shown in the above figure, bullish Market State environments are characterized by low volatility and stability. The annualized standard deviation of combined bear and transitional Market States was nearly double the standard deviation during bull Market States. Bull Market State environments had higher returns verses risk taken when comparing the average annual compounded return versus annualized standard deviation.

Market States and the Bell Curve

Earlier in this paper, the bell curve was introduced as Wall Street's gold standard for predicting risk and returns. The section concluded that "the bell curve of normal distribution works best when the samplings are high and the variance among outcomes is low and randomly distributed. In reality, however, financial markets are not random, and they experience low probability, high impact events that are not averaged out in the law of large numbers. The bell curve is therefore better suited for predicting the probability of a coin landing on heads five times in a row than predicting the wide-ranging twists and turns of the markets."

Do Canterbury's Market States improve the effectiveness of the bell curve for markets? Before we can answer that question, how well do markets fit the bell curve in the first place? Canterbury tested daily S&P 500 data from the beginning 1950 through August 15th, 2024 (18,776 trading days). The daily standard deviation was calculated to be 0.99%. Assuming an average daily return that is very close to 0 (actual is 0.04%), this would mean that a normal distribution of random daily returns would occur as follows (*Table 2*):

Standard Deviation	Daily Range	Expected Occurrence Outside Range
Within 1 σ	+0.99% to -0.99%	Daily
>1 σ	> (+/-)0.99%	Twice Weekly
>2 σ	> (+/-)1.98%	Monthly
>3 σ	> (+/-)2.97%	Every 1.5 Years
>4 σ	> (+/-)3.96%	Every 62 Years

>5 σ	> (+/-)4.95%	Every 6,900 Years

Table 2: Expected Daily Occurrence of various ranges of Market Returns

As you will see below, the actual results revealed little to no statistical evidence that markets follow a normal distribution. As the number of standard deviations increases, the bell curve's probabilities of expected results become further removed from the reality of what markets produce.

The following is a summary of the increasing gap between the bell curve's expected results and the reality of actual occurrences in the market (*Table 3*):

Standard Deviation	Daily Range	Expected Occurrence Outside Range	Actual Occurrence
Within 1 σ	+0.99% to -0.99%	Daily	Daily
>1 σ	> (+/-)0.99%	Twice Weekly	Weekly
>2 σ	> (+/-)1.98%	Monthly	Monthly
>3 σ	> (+/-)2.97%	**Every 1.5 Years**	**Every 3 Months**
>4 σ	> (+/-)3.96%	**Every 62 Years**	**Every 8.6 Months**
>5 σ	> (+/-)4.95%	**Every 6,900 Years**	**Every 1.5 Years**

Table 3: Expected versus Actual frequency of daily market returns

Table 3 Summary: Events beyond a 3rd standard deviation occur much more frequently than a normal distribution bell curve would predict. For example, a day beyond a third standard deviation (a day beyond +/- 2.97%) should only happen every 1.5 years according to bell curve math but occurs once every three months on average, often in clusters. Markets have too many outliers to fit the normal bell curve.

If we apply the use of Canterbury's study of Market States to the bell curve, there is conclusive evidence that market outliers are not random and are more likely to occur when certain market characteristics are in place. In other words, large and erratic trading days occur much more frequently during Canterbury's four bear Market States. Large daily swings in the market are less likely to happen during one of Canterbury's 5 bull Market States.

Table 4 shows the distribution of daily returns in bull Market States (11,875 trading days), assuming the market's overall daily standard deviation of 0.99%. This is compared to the actual market occurrences.

Standard Deviation	Daily Range	Actual Market Occurrences	Bull Market State Occurrences
Within 1 σ	+0.99% to -0.99%	Daily	Daily
>1 σ	> (+/-)0.99%	Weekly	Weekly
>2 σ	> (+/-)1.98%	Every 1.5 Months	Every 2.5 Months
>3 σ	> (+/-)2.97%	**Every 3 Months**	**Every 1.5 Years**
>4 σ	> (+/-)3.96%	**Every 8.6 Months**	**Every 6.89 years**

>5 σ	> (+/-)4.95%	**Every 1.5 Years**	**Every 12.06 years**

Table 4: Distribution of daily returns during a bull Market State

Summary of Table 4: According to the data, when we look at the distribution of daily returns for the S&P 500 market index, we conclude that most erratic trading days, or the largest outlier days do not occur during one of Canterbury's five bull Market States. On average, a trading day beyond a 3rd standard deviation has occurred once every three months. However, if you just consider the trading days that occur in one of the bull Market States (about 64% of all trading days), you expect to experience a trading day beyond +/-2.97% every 1.5 years, which is much closer to what would be expected by a normal distribution bell curve.

Trading days in a bear market tell a much different story. *Table 5*, below, compares the trading days in a bull Market State (64% of trading days) to the trading days that occur in a bear Market State (14% of trading days).

Standard Deviation	Daily Range	Bull Market State Occurrences	Bear Market State Occurrences
Within 1 σ	+0.96% to -0.96%	Daily	Every 2 Days
>1 σ	> (+/-)0.96%	Weekly	Weekly
>2 σ	> (+/-)1.92%	Every 2.5 Months	Bi-Weekly
>3 σ	> (+/-)2.89%	**Every 1.5 Years**	**Monthly**
>4 σ	> (+/-)3.85%	**Every 6.89 years**	**Every 1.9 Months**
>5 σ	> (+/-)4.81%	**Every 12.06 years**	**Every 4 Months**

Table 5: Distribution of daily returns during a bear Market State compared to a Bull Market State

Table 5 Summary: Bear Market States do not occur very often, accounting for less than 14% of all trading day since 1950. Although infrequent, bear markets are irrational and can be devastating. During a bear Market State, erratic trading days occur often. While in a bull Market State, you may expect to see a trading day beyond +/-2% every few months, but during a bear Market State, those trading days happen frequently. As we move further out on the bell curve, the frequency of erratic trading days goes up significantly during a bear Market State.

Since 1950, the S&P 500 has only experienced 111 trading days beyond +/-3.85% (or beyond a 4th standard deviation). Seven of those days beyond a 4th standard deviation occurred during a Bull Market State, while 85 of them occurred during a bear Market State. Keep in mind that the S&P 500 has been in a bull Market State 4.65x as many days as it has been a bear Market State.

The Largest Up and Down Days

There is an old saying in markets that "if you miss the ten largest up days in the market, you're done." After analyzing the ten largest up days in the market and ten largest down days in the market, 18 out of 20 of those trading days occurred during one of the four bear Market States. The remaining 2 days occurred during a transitional Market State. These trading days are shown in *Table 6.* If you had an index portfolio that only experienced the ten largest up days in the market as well as the 8 largest down days that occurred in a bear Market State, that portfolio would be

nowhere near breakeven. Bottom line, all bear markets are volatile and missing the ten largest up days in the market only matters if you subject your portfolio to the ten largest down days.

Largest Up/Down Days for the S&P 500							
Rank	Largest Up Day	Up Day Date	Market State		Largest Down Day	Down Day Date	Market State
1	11.58%	10/13/2008	12 (Bear)		-20.47%	10/19/1987	12 (Bear)
2	10.79%	10/28/2008	12 (Bear)		-11.98%	3/16/2020	12 (Bear)
3	9.38%	3/24/2020	12 (Bear)		-9.51%	3/12/2020	12 (Bear)
4	9.29%	3/13/2020	12 (Bear)		-9.03%	10/15/2008	12 (Bear)
5	9.10%	10/21/1987	12 (Bear)		-8.93%	12/1/2008	12 (Bear)
6	7.08%	3/23/2009	11 (Bear)		-8.81%	9/29/2008	12 (Bear)
7	7.03%	4/6/2020	12 (Bear)		-8.28%	10/26/1987	12 (Bear)
8	6.92%	11/13/2008	12 (Bear)		-7.62%	10/9/2008	12 (Bear)
9	6.47%	11/24/2008	12 (Bear)		-7.60%	3/9/2020	6 (Trans'l)
10	6.37%	3/10/2009	10 (Bear)		-6.87%	10/27/1997	6 (Trans'l)

Table 6: The Largest Up and Down Days for the S&P 500 since 1950

Summary of Market States

Canterbury Market States provide conclusive, statistical, and unbiased evidence that they are an effective means to separate low volatility bull markets from high volatility bear markets. Market States identify risks. Risk is defined as volatility and drawdowns, or declines. The most substantial volatility and drawdowns occur during Canterbury's bear Market States. Any effective portfolio management method needs a process to be able to navigate bear markets and limit portfolio risks during those high-risk environments.

Financial Securities are Affected by The Market State

Identifying the current market environment is only one step in Canterbury's adaptive process. The next step in the adaptive process is to distinguish which securities are benefitting from the current market environment. With the advent of new technologies that range from fintech software to exchange-traded-funds (ETFs), we now have all the tools needed to benefit from any market environment- bull or bear.

Most equity investment classes and securities perform best when the S&P 500 (or market index) is in a "rational" market environment, or bull Market State. However, there are also investment classes and securities (alternatives to the stock market) that benefit from an "irrational" market environment or bearish Market State. Examples of alternatives that could benefit from a bearish stock market could be treasury bonds, various commodities such as gold or coffee, currencies like the Japanese yen or Swiss franc, real estate, or inverse ETFs. Inverse ETFs move in the opposite direction of their underlying index or asset. An example of the implementation of this type of security will be explored later in this paper.

Canterbury's adaptive process uses a universe of more than 200 ETFs and 200 individual stock securities. Typically, an adaptive portfolio will hold between 10-20 positions that are a mix of

individual stock securities and ETFs. Each security is assigned to a group based on several factors, such as the investment class represented and its correlation to the U.S. stock market. Securities are further categorized into subgroups based on how they correlate to each other.

Depending on the market environment, different securities will fluctuate with varying degrees of rationality and efficiency. Just as we assigned a Market State to the S&P 500, a similar technical and objective process can be used to assign a "Security State" to an individual stock security or an ETF that represents any asset class or sector. **Figure 15** shows the Information Technology Sector ETF (XLK), an EAFE index ETF (EFA), an inverse Treasury Note ETF (TBX), and Exxon Mobile Corp stock. The colored backgrounds on each chart specify the Security State environment that each security was trading in from the beginning of 2022 through June 30th, 2023.

Figure 15: Security States *This chart shows XLK (upper left), EFA (upper right), TBX (lower left), and XOM (lower right). Green areas represent when the security was in a lower risk bull Security State; yellow is a transitional Security State; and red is a high bearish Security State. Each chart is over the same timeframe (1/2/2022 – 6/30/2023). Notice that each security is experiencing a different Security State throughout the timeframe.*

In **Figure 15**, notice that each security is trading at varying levels of efficiency during the chosen time period. The time period shown was mostly during 2022. That year was characterized by not only a bear market for many equities, but also for bonds. Notice that inverse Treasury Notes were bullish for most of the chosen timeframe. The inverse Treasury Note fund was moving in the opposite direction of the bond market. An individual stock security, like Exxon (XOM) was also

showing a positive trend relative to most of the US stock market. A US sector, like Information Technology (XLK) was in a bearish environment until the first quarter of 2023.

Canterbury's Adaptive Portfolio Management Security Selection Research Process

Once securities have been assigned their own individual Security State, Canterbury's adaptive process will implement a rating and ranking for each liquid security, whether it is a stock, sector, country, commodity, currency, bond, or inverse fund. The security's rating is a function of its own Security State, volatility, and relative strength. The security's ranking is based on Canterbury's Volatility-Weighted-Relative-Strength metric (VWRS). This White Paper will not go into the details of how VWRS is computed, but it is relative strength coupled with the security's Canterbury Volatility Index (CVI) reading. In simple terms, it is risk-adjusted relative strength. Such an indicator allows something volatile, like Nvidia stock, to be compared to something that is traditionally more stable in price fluctuations, like a bond. Through risk-adjusting for volatility, VWRS puts securities on a level playing field.

The figure below, **Figure 16,** shows an example of a small, select group of securities rated and ranked using Canterbury's technical research process. The date shown is January 10th, 2022. The example has a universe of 30 ETFs that represent sectors, geographic regions, bonds, gold, and inverse funds.

Figure 16: ETF Rating and Ranking Report

Date: January 10th, 2022

Rank	Ticker	Name	Volatility	SecState	Buy/Hold/Sell
1	XLP	Staples	60	1	
2	XLE	Energy	139	5	
3	XLU	Utilities	69	2	
4	XLF	Financials	100	5	
5	XLB	Basic Materials	79	6	
6	TBX	Inverse 7-10yr note	30	7	
7	XLV	Health Care	64	2	
8	XLRE	Real Estate	89	6	
9	XLK	Information Technology	109	6	
10	XLY	Discretionary	109	6	
11	TBF	Inverse 20yr bonds	76	9	
12	EUM	Inverse Emerging Markets	76	2	
13	XLI	Industrials	83	5	
14	MDY	Mid Caps	92	6	
15	RWM	Inverse Small Cap	111	11	

Rank	Ticker	Name	Volatility	SecState	Buy/Hold/Sell
16	EFA	EAFE	67	7	
17	DGZ	Inverse Gold	64	7	
18	GLD	Gold	58	2	
19	PSQ	Inverse Nasdaq	101	11	
20	IWM	Small Caps	112	12	
21	MYY	Inverse Midcap	88	11	
22	XLC	Communications	82	12	
23	TLT	20yr tres	78	6	
24	EFZ	Inverse EAFE	61	8	
25	REK	Inverse Real Estate	84	11	
26	EEM	Emerging Markets	78	10	
27	DOG	Inverse Dow	66	7	
28	SH	Inverse SPX	72	7	
29	IEF	7-10yr notes	30	8	
30	SEF	Inverse Financials	86	12	

Canterbury Investment Management

Figure 16: ETF Rating and Ranking Report *Column 1 shows the security's rank (VWRS), column 2 is the ticker, column 3 is the name, volume 4 is the security's CVI, column 5 is its Security State, and column 6 is the security's rating (based on security state, volatility, and relative strength).*

In **Figure 16**, you will notice that the report for January 10th, 2022, had Consumer Staples rated and ranked as the #1 ETF in the select universe. US sectors such as Information Technology and Communications were giving "sell" signals, as shown by the red signal in the buy/hold/sell column. Meanwhile, inverse funds, such inverse treasury notes and inverse Dow Jones Index, were giving "buy" signals.

Portfolio Construction for Adaptive Portfolio Management

The goal of Adaptive Portfolio Management is to stabilize portfolio volatility by adapting to changing market conditions- bull or bear. An important part of the security selection process is to make timely and systematic rotations in portfolio holdings as market conditions change. Bull and bear stock markets are not just different, they are opposite. It does not make logical sense to hold the same securities through both market environments. A bullish stock market reflects the fact that there is more demand than supply for stocks, resulting in an increase in prices. A bear market in the global stock market means that there are more people pulling their money out of stocks than putting money in and are moving it elsewhere, specifically in investments that may benefit from a bear stock market.

The selection of securities that is least volatile during a bull market does not remain the least volatile during a bear market. Moving from one environment to another requires a process that continually rotates the allocations to maintain a stable and efficient portfolio. A stable and efficient portfolio must be quantifiable. How do you know if your portfolio is stable and efficient during a low volatility bull market, versus stable and efficient in a high volatility bear market?

Volatility

The first and foremost way to know just how efficient a portfolio is during a given market environment is by measuring the portfolio's level of volatility. Just as the volatility of a market or individual liquid security can be quantified (using CVI), so can the volatility of a portfolio of securities. If a portfolio holds a combination of securities that are low in volatility and low in correlation, then that portfolio logically will also have low volatility. On the other hand, if a portfolio has securities that are highly volatile and correlated to one another, then the portfolio will be less efficient and more volatile. Determining the volatility level of a portfolio is crucial and is an ongoing process since volatility levels change over time as securities within the portfolio become more or less correlated.

Low Portfolio Volatility in a Bull Market State

Maintaining low and efficient portfolio volatility in a bullish Market State is much easier than doing so in a bearish Market State. Based on the research documented in this paper, during a normal and efficient bull Market State, a portfolio should own securities that are exhibiting positive characteristics and benefiting from the bull market environment. These securities will typically be equity-related such as stocks, sectors, industries, or global regions. In some cases, this may also

include some exposure to bonds or commodities. **Figure 17**, below, is an example of an efficient portfolio during a bull Market State. Using the research example provided previously in **Figure 16,** we tracked the daily changes of security rankings and ratings.

To keep things simple and testable, let's assume we have a portfolio that is composed of six holdings. For the figure below, which shows a portfolio on July 30th, 2021 (during a bull Market State), the six highest rated/ranked securities would have been the ETFs for the Health Care sector, Real Estate sector, Communications Sector, Information Technology Sector, Consumer Staples Sector, and Basic Materials Sector. **Figure 17** shows the volatility of each one of these positions. The portfolio shown is equally weighted for simplicity (17% per holding) and the line chart shows the previous six months of fluctuation. The bolded black line is the portfolio, or combination of the six securities for the previous six months leading up to July 30th. As of July 30th, 2021, the portfolio in **Figure 17** would have had a volatility level of CVI 50, which is efficient.

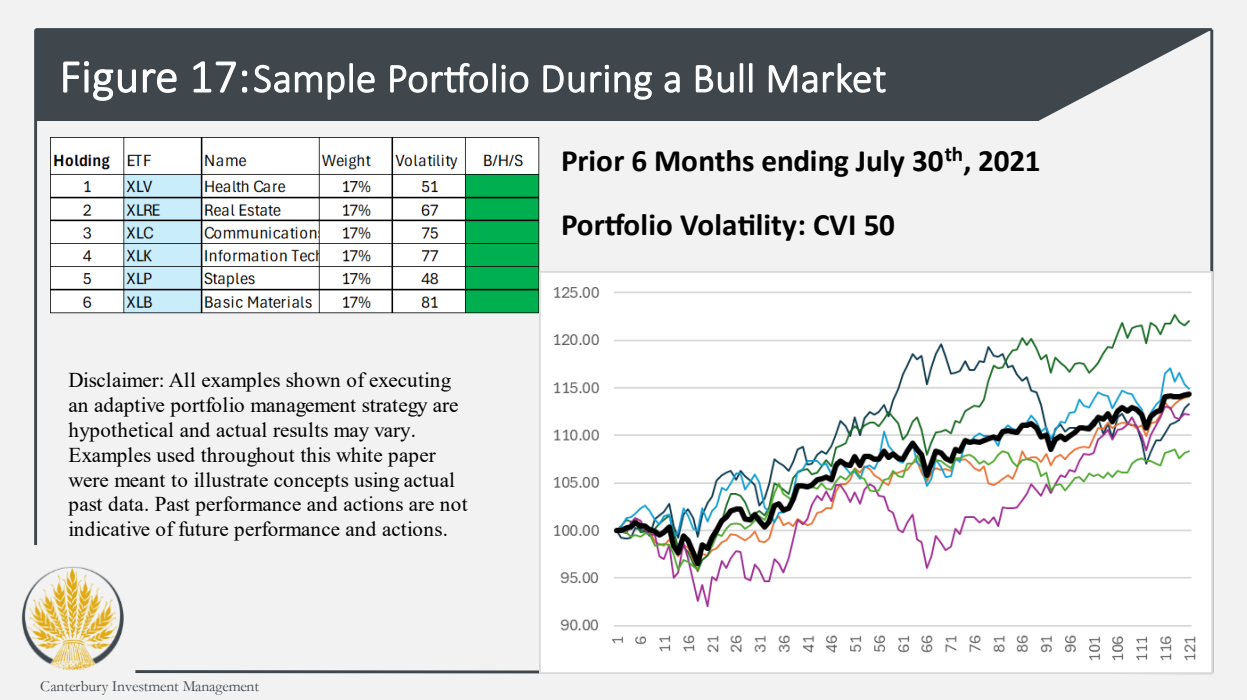


Figure 17: Sample Portfolio During a Bull Market

The Efficient Portfolio Can Become Inefficient

Now, take that same portfolio of securities and fast forward eleven months to June 30, 2022. The portfolio had been efficient during a low volatility bull market environment, but quickly became very volatile during a bearish market environment. See **Figure 18** below. Five out of six positions are giving sell signals, and the portfolio's level of volatility is now CVI 126 (more than doubled), which is very inefficient and irrational.

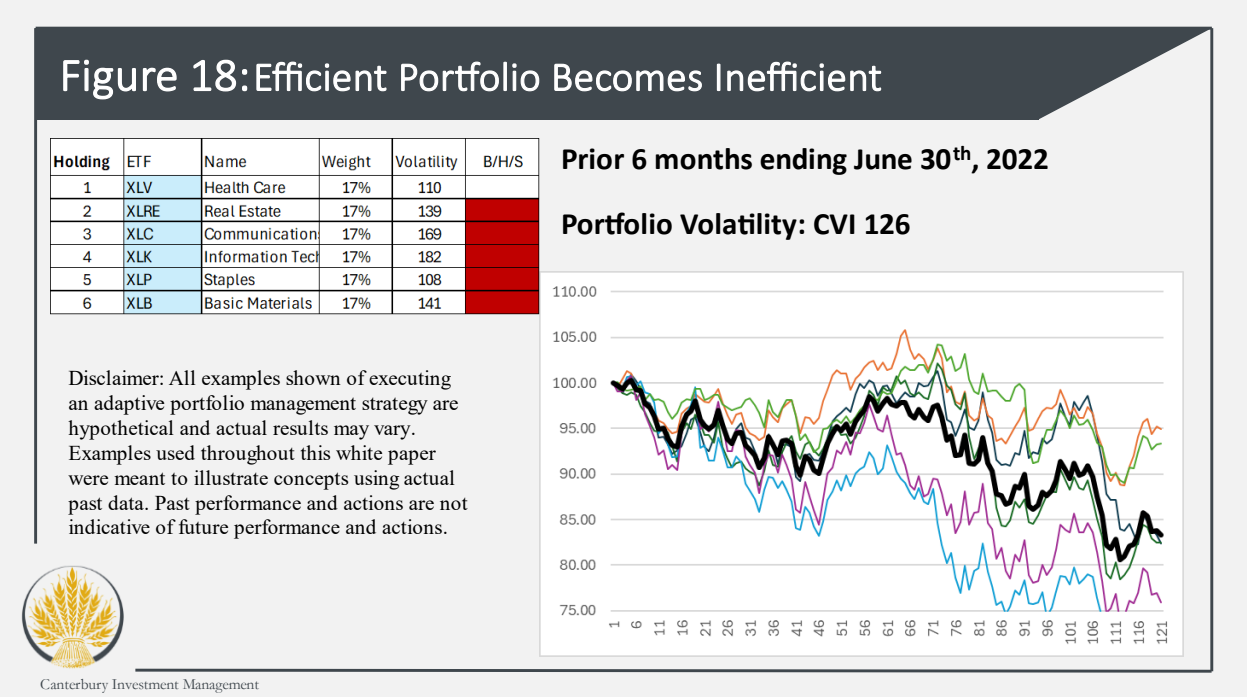


Figure 18: Efficient Portfolio Becomes Inefficient

So, how does Canterbury's adaptive portfolio address the issue of changing portfolio efficiency and volatility? The main reasons that this static portfolio went from being efficient to inefficient in less than a year is because the volatility of the individual positions increased (as shown in the figure) and each component of the portfolio became increasingly correlated to one another, as shown in the line chart in **Figure 18**. Each of the securities were moving in the same direction (down) at the same time.

The Benefit of Diversification

Diversification is used to reduce portfolio risks. Traditionally, diversification has been little more than buying different asset classes. We know from experience that there will be periods when varying asset classes will have low correlation to each other, but also periods where those same asset classes exhibit high correlation to one another. When volatility increases, and securities become more correlated, a portfolio loses its "benefit of diversification." In order to maintain consistent portfolio volatility, a portfolio needs to increase or reduce the correlation of its components depending on the current market environment.

The calculation of a portfolio's "benefit of diversification" is simple. It is a metric that compares the portfolio's volatility to the volatility of its individual components in order to determine how much risk is reduced through diversification. Here is a quick example.

Let's say that a portfolio is equally composed of three components: an S&P 500 ETF (SPY), a gold ETF (GLD), and a bond ETF (TLT). In this example, let's assume that each of the three ETFs

has an individual volatility level of CVI 100. Naturally, if you calculated the average position volatility of the portfolio, it would be CVI 100. As we can assume, however, the S&P 500, gold, and bonds are likely not perfectly correlated (or moving together in lockstep). If we were to track the volatility level based on the portfolio's fluctuations, the portfolio might have a volatility of CVI 60. In that case, the portfolio's "benefit of diversification" would be 40% (as calculated by the formula shown in **Figure 19**). The risk of the portfolio is reduced by 40% through the combination of the security's that it holds.

$$\text{Benefit of Diversification} = \left(1 - \frac{\text{Weighted Average Holding CVI}}{\text{Actual Portfolio CVI}}\right)$$

Figure 19: Benefit of Diversification Calculation

As an exaggerated example, if a portfolio held two perfectly correlated assets, such as two different S&P 500 funds, then that portfolio would have a benefit of diversification of 0%. There would be no reduction of risk from the combination of those two securities. If a portfolio held two perfectly negative correlated assets, such as an S&P 500 fund and inverse S&P 500 fund, then that portfolio would have a benefit of diversification of 100%. The resulting portfolio would move in a flat line.

For the example we showed in **Figure 17** and **Figure 18**, let's look at how that portfolio's benefit of diversification changed in eleven months, as the market went from bullish to bearish (**Figure 20)**.

July 30th, 2021 ⟶ **June 30th, 2022**

Average Volatility	67	**Average Volatility**	142
Portfolio Volatility	**50**	**Portfolio Volatility**	**126**
Benefit of Diversification	**24.81%**	**Benefit of Diversification**	**10.95%**

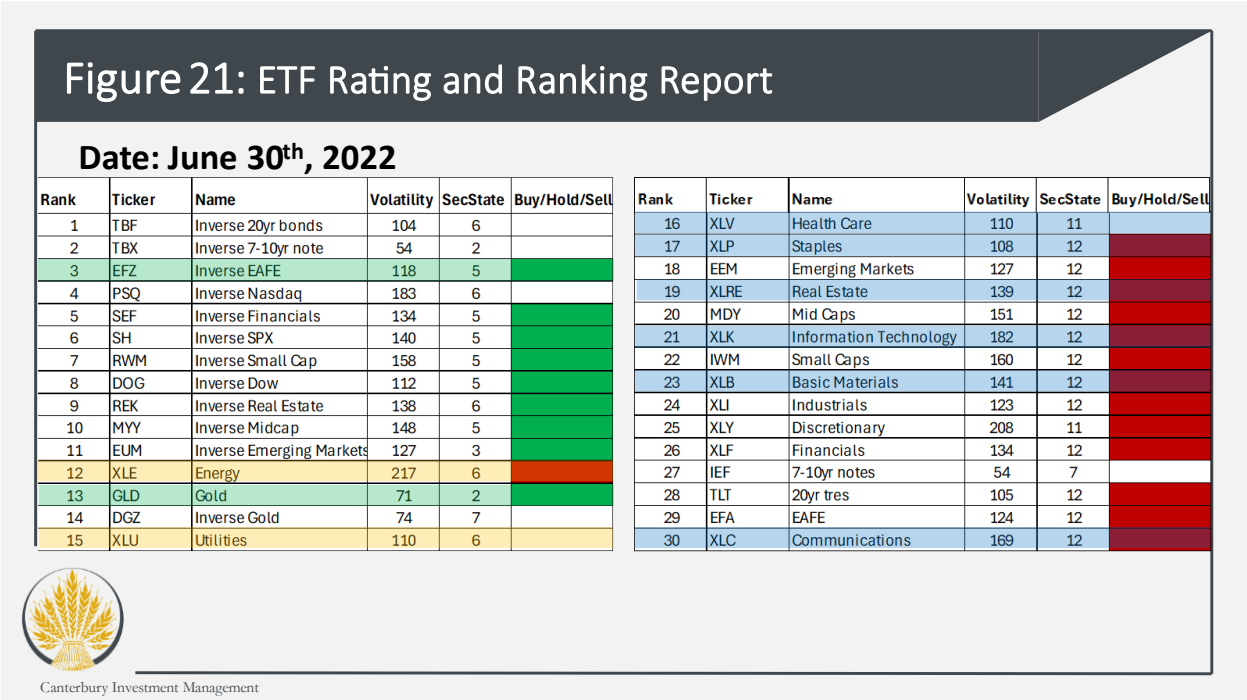
Figure 20: Changes in the Benefit of Diversification

As individual positions became increasingly volatile, they also became increasingly correlated. As a result, the portfolio's benefit of diversification fell from 25% to 11%, and the portfolio's volatility rose from CVI 50 to CVI 126.

Reducing Risk in a Bear Market

Reducing risk in a bear market requires an adaptive process to maintain a portfolio's level of volatility. In order to achieve low volatility in a bear market, a portfolio's benefit of diversification needs to be higher. This will ultimately be achieved later in **Figure 23,** but we are going to show the process to get there. In reality, an adaptive portfolio would be rotating and adjusting its holdings

as the market environment shifts, but for the sake of time, let's assume that the portfolio stayed the same from July 30th, 2021, to June 30th, 2022. At this point, we want to reduce our portfolio's volatility from CVI 126 back to below CVI 70, which is where portfolio volatility should be for it to be efficient. Let's go through a few steps.



Rank	Ticker	Name	Volatility	SecState	Buy/Hold/Sell
1	TBF	Inverse 20yr bonds	104	6	
2	TBX	Inverse 7-10yr note	54	2	
3	EFZ	Inverse EAFE	118	5	
4	PSQ	Inverse Nasdaq	183	6	
5	SEF	Inverse Financials	134	5	
6	SH	Inverse SPX	140	5	
7	RWM	Inverse Small Cap	158	5	
8	DOG	Inverse Dow	112	5	
9	REK	Inverse Real Estate	138	6	
10	MYY	Inverse Midcap	148	5	
11	EUM	Inverse Emerging Markets	127	3	
12	XLE	Energy	217	6	
13	GLD	Gold	71	2	
14	DGZ	Inverse Gold	74	7	
15	XLU	Utilities	110	6	

Rank	Ticker	Name	Volatility	SecState	Buy/Hold/Sell
16	XLV	Health Care	110	11	
17	XLP	Staples	108	12	
18	EEM	Emerging Markets	127	12	
19	XLRE	Real Estate	139	12	
20	MDY	Mid Caps	151	12	
21	XLK	Information Technology	182	12	
22	IWM	Small Caps	160	12	
23	XLB	Basic Materials	141	12	
24	XLI	Industrials	123	12	
25	XLY	Discretionary	208	11	
26	XLF	Financials	134	12	
27	IEF	7-10yr notes	54	7	
28	TLT	20yr tres	105	12	
29	EFA	EAFE	124	12	
30	XLC	Communications	169	12	

Figure 21: ETF sample report 6/30/2022

Figure 21 shows the ETF report on 6/30/2022. The blue highlighted positions are the securities that have been held in the portfolio. Looking at the ratings and rankings, the first thing we notice is that the top 11 ranked ETFs are all inverse funds. Inverse funds benefit from a volatile bear market since they rise on high volatility while their underlying index declines on high volatility. With an adaptive portfolio, you would never go more inverse than you have in long positions. An adaptive portfolio will always be close to fully invested and net-long.

When the initial portfolio was constructed in July 2021, the portfolio owned the top 6 ranked and rated US sectors. Fast forward to June 2022, and those sectors are now almost all giving sell signals and ranked near the bottom of the rankings. In a bear market, in order to be net-long, a portfolio will own some positions giving sell signals, but it will own the highest rated of those positions. The orange/yellow highlighted securities in **Figure 21** are the highest rated US sectors that are currently not held in the portfolio.

For the US sectors, Heath Care and Consumer Staples still rank near the top of the equity rankings, so those sectors will continue to be held. On the other hand, Basic Materials and Communications now rank near the bottom of the sample universe. Those two sectors will be sold and replaced by

the top two ranked US sector ETFs, which are Energy (XLE) and Utilities (XLU), as shown in *Table 7*.

Sells	Buys
Communications (XLC)	Energy (XLE)
Basic Materials (XLB)	Utilities (XLU)

Table 7: Sector Buys and Sells

This transaction would bring the portfolio's volatility down to CVI 114 and increase the portfolio's benefit of diversification to 21% (**Figure 22**). This level of diversification is nearly back to where it was during a bull market, however the portfolio's volatility is still too high and needs to be reduced further. Note that average position volatility increased, yet portfolio volatility declined due to lower correlation amongst the portfolio holdings.

Old → **New**

Average Volatility	142
Portfolio Volatility	**126**
Benefit of Diversification	**10.95%**

Average Volatility	144
Portfolio Volatility	**114**
Benefit of Diversification	**21.02%**

Figure 22: Result of selling XLC and XLB and purchasing XLE and XLU

To further reduce the volatility of the portfolio, let's look at some alternatives. The two positions we will be taking are highlighted in green in **Figure 21**. Following the initial trades in *Table 7*, Information Technology is now the lowest ranked position in the portfolio, and it is also the most volatile. We also notice that the highest ranked inverse security is inverse EAFE (Europe, Australia, and Far East). We will sell XLK and buy EFZ. Additionally, Real Estate will be sold, and Gold (GLD) will be purchased. Gold is the only non-inverse position that is currently giving a "buy" signal. This is summarized in *Table 8*.

Sells	Buys
Real Estate (XLRE)	Gold (GLD)
Information Technology (XLK)	Inverse EAFE (EFZ)

Table 8: Alternative Buys and Sector Sells

Here are the resulting changes in portfolio volatility and benefit of diversification, shown in **Figure 23**.

Original → **New**

Average Volatility	142
Portfolio Volatility	126
Benefit of Diversification	10.95%

Average Volatility	122
Portfolio Volatility	62
Benefit of Diversification	49.32%

Figure 23: Result of selling XLK and XLRE and purchasing GLD and EFZ

You can see that making these few changes in portfolio composition dramatically reduced the risk of the portfolio. While the volatility of the portfolio's individual components remained high, the portfolio's volatility was reduced to CVI 62 through having a benefit of diversification of 49%. The portfolio is still net-long exposed, with 83% of its allocation being to equities/gold and 17% of its allocation being in an inverse fund. The portfolio's net-long position would be 66% (computed by subtracting 17% inverse from 83% long).

Figure 24 shows the holding correlations of both portfolios for the previous 6 months leading up to June 30th, 2022. Notice that the new portfolio's positions do not have nearly the same correlation as the original portfolio's position. The new portfolio holds an inverse position, which goes up substantially, as well as some positions that decline in value. The resulting new portfolio has much more mitigated fluctuations, even though the individual holdings are volatile.

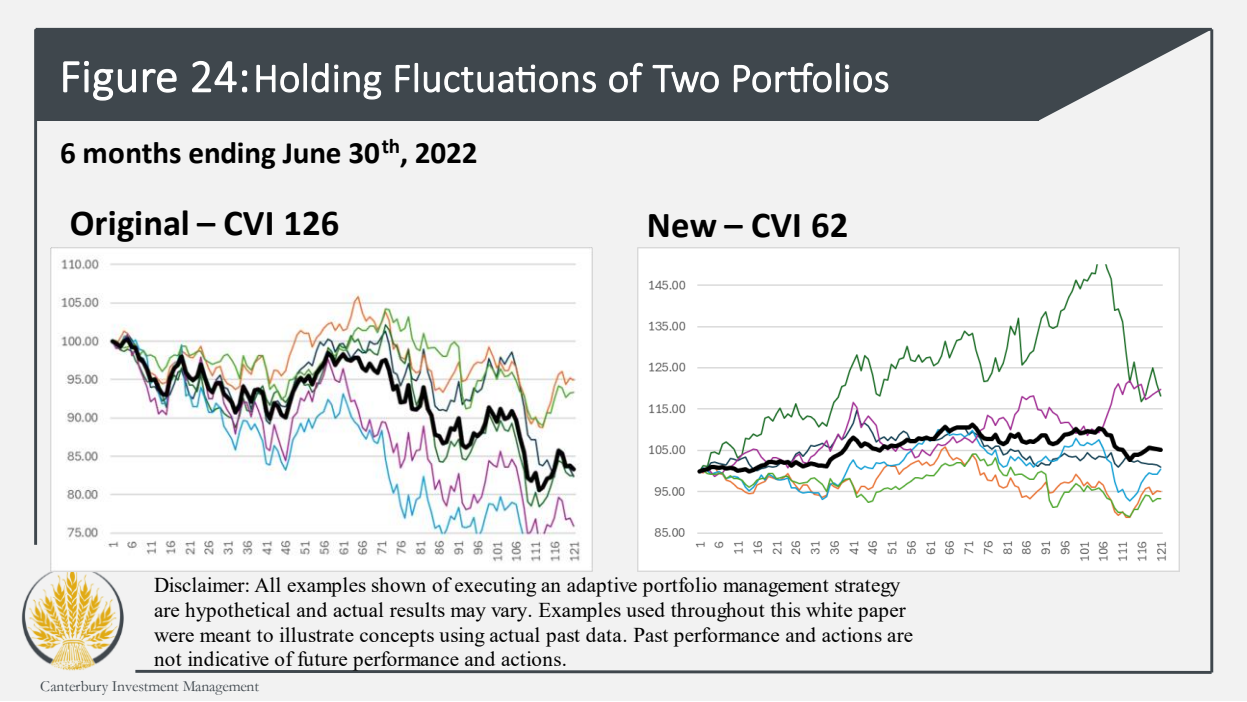


Figure 24: Holding Correlations of Two Portfolios

As noted, in reality, the transition from one portfolio to another would not occur after a substantial decline has already been completed and high volatility has already been experienced. These

changes would have been completed over time as the buy and sell signals were given. It should also be noted that past performance is not indicative of future returns. Future returns cannot be predicted, but current risks can be assessed. As those risks shift and change, Canterbury's adaptive portfolio will adapt its holdings to accommodate and maintain consistent/stable volatility.

Summary of the Adaptive Portfolio Management

The process of adaptive portfolio management has many moving parts. Canterbury's adaptive portfolio is designed to move in concert with changing market environments, while maintaining low and stable volatility. Adaptive Portfolio Management is designed to handle all aspects of a portfolio, from security selection to asset allocation, diversification, and ongoing maintenance. Adaptive Portfolio Management is based on objective, technical, and testable systems. There are many different combinations of securities that can create an efficient portfolio for today's market environment. The goals and process of adaptive portfolio management are summarized below.

Primary Goals and Objectives:

1. The "portfolio" should remain be in a bullish Market State (MS 1 through 5) regardless of the macro market environment.
2. The portfolio's volatility, as measured by the CVI, should not exceed CVI 75 when the S&P 500 is in a bull Market State, to limit substantial declines. As risks in the markets increase, the portfolio should adapt its holdings and allocations to reflect the new market environment.
3. The portfolio's goal is to limit large declines. An adaptive portfolio aims to mitigate risks, particularly when markets become volatile.
4. An adaptive should benefit from long-term compounded returns by limiting declines to normal fluctuations.

Adaptive Portfolio Management Process:

1. Identify the current market environment using Canterbury's Market States. Market States indicate levels of risks in the market and are measured 1-12. Bull Market States (1-5) have low risk, while bear Market States (9-12) have high risks. Transitional Market States (6-8) indicate risk levels are changing.
2. Create a universe of potential security holdings that benefit from the current environment. Using technical indicators, an adaptive process analyzes a universe of individual stock securities and ETFs. The adaptive process applies a rating and ranking to each one of the potential holdings and constructs a portfolio between 10-20 positions, on average.
3. Maintain low and consistent volatility by measuring the portfolio's benefit of diversification. As security correlations change, the portfolio can become more or less efficient. By monitoring the benefit of diversification and portfolio volatility, the portfolio can adjust its holdings and allocations for the current market environment-bull or bear.

About the Author- Tom Hardin

Tom Hardin, CMT, CFP
Managing Director
Chief Investment Officer

Tom brings over 40 years of extensive experience in the investment industry. Renowned as a thought leader, innovator, and educator, Tom has made significant contributions to the evolution of adaptive risk and portfolio management strategies.

Tom earned his bachelor's degree in business from Skidmore College in Saratoga Springs, New York. He launched his career as a Registered Representative at a regional New York Stock Exchange member firm and soon earned his Certified Financial Planner (CFP) designation. His journey continued at EF Hutton, where he excelled as a Regional Director in the Personal Wealth Management Division, overseeing the financial and investment planning for 32 branch offices and worked with some of the firm's highest-profile clients.

Transitioning to his passion for investment management, Tom joined Hutton's Consulting Group and achieved the firm's prestigious designation of Senior Investment Management Consultant. He furthered his expertise and earned his certification in Investment Portfolio Management from the renowned University of Chicago Graduate School of Business.

In 1987, Tom joined EF Hutton's discretionary portfolio management division, Hutton Portfolio Management, as a portfolio manager. He advanced through several corporate mergers to become a Senior Vice President and Senior Portfolio Management Director at the Portfolio Management Group, which eventually merged into Morgan Stanley.

In 2003, Tom co-founded Canterbury Investment Management, a Registered Investment Advisory firm. He founded Canterbury to be a leader in the innovation of risk and portfolio management methods.

Over the years, Tom has trained over 700 fiduciary advisors from around the country and has been a long-time advocate for investor education. He has served as a guest lecturer at various colleges and universities across Indiana such as IU's Kelley School, Purdue's Krannert School, and Butler University. Tom has frequently spoken at financial service and investment industry symposiums on the evolution of Adaptive Portfolio Management. His publications include numerous white papers and journal articles, as well as two books. His second book, *Investor Revolution*, explores how advancements in information technology and innovative investment product creation have transformed portfolio and risk management methods forever.

Tom recently co-authored a groundbreaking academic white paper with Brandon Bischof, detailing the evolution of science-based adaptive portfolio management. He considers his contributions to this field to be the pinnacle of his career, reflecting decades of dedication to advancing the effectiveness of risk and portfolio management strategies.

About the Author-Brandon Bischof

Brandon Bischof, CMT
Managing Director
Portfolio Strategy

Brandon is a highly respected thought leader in the investment management industry. He graduated *magna cum laude* from Xavier University where he majored in Finance. Brandon is a Chartered Market Technician (CMT). The CMT designation typically takes about three years to complete and is the gold standard for technical market analysis.

Brandon brings a high level of expertise and knowledge to support his contributions to the evolution of adaptive portfolio management. He prides himself as being a dedicated student of the markets. The combination of his experience in finance and technical analysis gives him a unique perspective on what is required to manage the markets' seemingly unpredictable nature.

His experience and continual pursuit of knowledge gives him a unique advantage as an innovator. Brandon embraces the introduction of emerging technologies and the creation of new and innovative investments as potential tools for innovation. He is also steadfast in his refusal to allow management practices based on long held conventional wisdom, to continue without being questioned.

As the head of Canterbury's research team, Brandon oversees the development of proprietary technical indicators for stocks, bonds, and ETFs. He has designed Canterbury's portfolio dashboard, which enables precise tracking of portfolio metrics designed to maintain stability through ever changing market conditions.

Brandon is also a skilled trainer, writer, and video commentator. He is known for his ability to distill complex concepts into understandable and accessible insights. Brandon has made important contributions to the advancements and continual evolution of Canterbury's Adaptive Portfolio Management processes. He is responsible for monitoring and developing procedures to maintain "objective" scientific standards that provide evidence of value-added results.

As a regular contributor to prominent news outlets like NASDAQ, Yahoo Finance, ETF Trends, and Fox Business, Brandon provides insightful commentary on the markets and securities to help individuals and advisors navigate the complexities of investment management and achieve long-term financial success. He also enjoys his role as a disrupter when he presents his latest study that continues to expose flaws in the traditional portfolio management methods.

At Canterbury, Brandon plays a pivotal role in enhancing investor education. His leadership in advancing investment management practices helps both individuals and financial advisors stay ahead in a rapidly evolving market. He is passionate about articulating the value of innovation and regularly engages with financial advisors nationwide to share best practices in portfolio management.

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Disclaimer

Past performance is no guarantee of future results. There can be no assurance that future performance of any model portfolios will be comparable to past performance. There are risks associated with any investment strategy, including the possible loss of principal. There is no guarantee that any investment strategy will achieve its objectives.

Every effort was used to provide accurate data and mathematical calculations to provide what we believe to be, accurate results. Canterbury Investment Management, LLC and its principal owners, make no guarantee of completeness or accuracy of data or calculations as well as conclusions of any statistical data or information contained in the charts illustrated in this presentation.

All definitive statements and subjective opinions contained in this academic study represent the observations and conclusions of the authors, Tom Hardin and Brandon Bischof. The sole purpose of the production of this report is to make a contribution to the body of knowledge in the field of investment portfolio management. This report is to be used for educational purposes only and is not to be used or considered as solicitation for any investment management services offered by Tom Hardin, Brandon Bischof, Canterbury Investment Management, or any Registered Investment Advisor receiving sub advisory services from Tom Hardin or Brandon Bischof.

This White Paper contains the use of some back tested technical indicators and the statistical relevance they provide. Every effort was used to provide accurate data and mathematical calculations to what we believe to be accurate results. Canterbury's Market State indicators are composed of various moving averages, common technical indicators, and the Canterbury Volatility Index as well as indicators on the Canterbury Volatility Index. All test relating to Market States was conducted using daily data of the S&P 500 index (^GSPC), downloaded from Yahoo Finance. Bell curve calculations were produced by Canterbury Investment Management. We believe, but do not guarantee, this data and calculations to be accurate.

All examples shown of executing an adaptive portfolio management strategy are hypothetical and actual results may vary. Examples used throughout this white paper were meant to illustrate concepts using actual past data. Past performance and actions are not indicative of future performance and actions. S&P 500 data was downloaded from Yahoo Finance (^GSPC) and was taken from 1950 – August 15th, 2024. Daily data shown on individual ETFs and stocks within this report were also pulled from Yahoo Finance. ETF Rating and Rankings Report was produced by Canterbury Investment Management using data from Yahoo Finance and using Canterbury's proprietary combination of technical indicators, and to the best of our knowledge, is accurate. Hypothetical trades/actions taken to adapt a portfolio to a new market environment were rules-based, but subjective. Reasons behind the actions taken were justified in the report. All calculations relating to portfolio volatility and the benefit of diversification were objective and calculated using mathematical formulas, pulled from the various dates specified in the report. The Canterbury Volatility Index calculation is proprietary, and the benefit of diversification calculation was provided in Figure 19 of this White Paper.