Portfolio Preservation During Severe Market Corrections: A Market Timing Enhancement to Modern Portfolio Theory

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Abstract

Global and domestic debt concerns are making economic markets extremely volatile and investors are scared. After being beaten up by the bursting of the dot-com bubble in 2000 and the sub-prime mortgage crisis in 2007, investors are justifiably reticent about placing funds into companies that may not be around in a couple of years let alone during their lifetimes, and many are fearful of losing their portfolios entirely.

Investors and fund managers are facing complex and confusing economic information and are at a loss as to which investment classes they should be buying or selling. They are especially gun-shy following the severe corrections in 2000 and 2007 when many professionally managed and personally managed portfolios lost 50% or more of their value.

They ask the question of which asset classes make sense in today's markets—a question that can be partially answered by the mathematical approach of Modern Portfolio Theory (MPT). But the larger question of when to buy into or sell out of them is an answer that Modern Portfolio Theory by design cannot adequately address. During severe market corrections, MPT is very slow to respond to a rapidly changing market environment--a situation that can lead to serious portfolio loss.

Many wealth managers still design portfolios built upon the concepts of MPT. Although MPT has revolutionized portfolio management, it is not without its limitations. One of the precepts

of MPT is that portfolios must always have funds distributed among the asset classes per the recommended allocation. In good times or in bad, one is almost never out of the market of high performing but risky assets. It is this concept that can lead to major portfolio loss during steep market corrections—losses that can take many years, even decades, to recover.

The application of a judiciously applied optimized market-timing approach to MPT not only solves the problem of which asset classes to hold and in what proportion, it also directs the fund manager as to exactly when to exit an asset class entirely and when to jump back in. In this manner, historical back-testing over all time periods since 1928 show that this new timing-modified MPT approach (designated MMPT) not only improves upon the expected return over the classic MPT approach, but also---and perhaps more significantly—greatly minimizes portfolio risk arising from sharp draw-downs especially during times of severe market stress.

The mechanism for the model is to apply a timing oscillator separately to each asset class. Typically, the oscillator is only applied to equity asset classes such as stocks as opposed to those that have fixed returns such as bonds. Every month (or every time period) when new total return data for each asset class is received, the oscillator for each asset class is optimized and computed. If it's value is positive, the funds computed by MPT are allocated to it. If the value of the oscillator turns negative, the funds that MPT would normally allocate to that asset class are placed in the safety of a risk-free vehicle such as Short-Term Treasury Bills or Money Market Funds.

To exemplify the superiority of the MMPT approach, we consider several time-frames culled from both recent and past history. Historical data used to define both model portfolios are

identical and are both comprised of the same asset classes used in most traditional models (e.g., US & international equities, corporate and government bonds, international bonds, REITs).

In the first scenario, market return (as measured by the benchmark S&P 500) was essentially flat during the ten year period between 1965 and 1975. The second two scenarios are more recent and were much more damaging to investment portfolios: the dot-com bust (2000-2002) and the sub-prime mortgage crisis (2007-2009). Lastly, we show the performance statistics over a very long-term time horizon. Using the same asset class data for both models, we are able to compute and compare annualized performance statistics for a required 10% compounded annual total return:

Model/Index	Flat market: 1965-1975	Dot-com Bust: 2000-2002	Sub-prime crisis: 2007-2009	Historical performance 1928-2013
MMPT	Return: 13.1% Risk: 13.4%	Return: 7.7% Risk: 4.9%	Return: (2.4%) Risk: 4.7%	Return: 12.5% Risk: 15.9%
MPT	Return: 2.7% Risk: 19.3%	Return: (15.1%) Risk: 12.9%	Return: (35.9%) Risk: 16.6%	Return: 10.5% Risk: 16.6%
S&P 500	Return: 1.2% Risk: 14.9%	Return: (20.9%) Risk: 15.3%	Return: (33.3%) Risk: 14.9%	Return: 9.6% Risk: 21.4%

It is evident that the timing-modified (MMPT) model provides superior returns at reduced risk (as measured by the standard deviation) to both the classic MPT model as well as the benchmark index not only over a short time period but also over a very long investment horizon.

Moreover, MMPT offers the investment manager greater flexibility in terms of portfolio

construction and investment philosophy. Features of the MMPT approach include the following:

1. A portfolio only needs to be re-balanced at most once per month to achieve the superior return/risk results published here. This efficiency of time frees up the investment manager to do other things.
2. Any asset class (other than the traditional ones listed) can be easily added or removed thus providing a mechanism for complete portfolio customization.
3. While this paper only addresses portfolios that are comprised of either being long an asset class or in cash (depending on the value of the oscillator for that asset class), the market-timing approach of the model allows the manager to short an asset class, if so desired. This option is not available in the classic MPT model.
4. The model is purely quantitative thus removing human bias and eliminates guessing as to when to enter and exit an asset class. It also provides a high degree of transparency.
5. It is self-hedging meaning that costly, external hedging mechanisms are not required to reduce risk.

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1. Introduction: Model Overview

This paper describes a modification to classic Modern Portfolio Theory (MPT) that introduces a market timing element to the traditional asset allocation buy, hold, and reallocate methodology. The inability of MPT to react quickly to declining markets is a recognized problem that calls for a solution based on a market timing enhancement. The intrinsic nature of classic MPT subjects the investor to losses during periods of market decline as well as increased portfolio risk. The addition of a market timing system to the asset allocation process provides a timely exit to declining investment components thus preserving portfolio value. The result is both improved portfolio returns as well as lower portfolio risk.

Market timing is determined through the implementation of a technical oscillator with averaging periods that are optimized separately for each asset class. Instead of maintaining the classic recommended allocations, asset classes can be exited completely when the oscillator for those classes turns negative with the funds being redirected to a safe asset class such as U.S. Treasury Bills. An asset class is reinstated when the value of the oscillator for that class changes back from negative to positive.

The patent pending methods that drive this technique are embodied in a software product called the *Portfolio Preserver*® (portfoliopreserver.com.) The process begins with a time history of monthly total return data for each candidate asset class under consideration. For the nine traditional asset classes mentioned here, monthly total return data dating back to 1928 is used. The aforementioned procedure of exiting an asset class and placing the funds into a risk-free asset class such as Treasury bills is referred to as the Long/T-Bills strategy. What this means is

that when the timing oscillator is positive, the strategy employs the classic MPT approach of being invested or "Long" that asset class according to the recommended allocation. Conversely, when the oscillator turns negative the allocation is instead placed in the safety of T-Bills (or another risk-free instrument such as an insured money market).

In addition to this simple timely exiting of asset class allocations other strategies are also available:

- Long/Long is the classic MPT approach (meaning that timing is not used).
- Long/T-Bills is the strategy described above, i.e., when the timing oscillator is positive for an asset class, funds are allocated to it; when the oscillator turns negative, those funds are removed from it and placed into T-bills or a safe cash-equivalent.
- Long/Short is the classic MPT allocation when the oscillator is positive and short that asset class when it is negative.
- Long on Margin/T-Bills is the same strategy as Long/T-Bills but with the use of margin.
- Long on Margin/Short on Margin is the same as Long/Short but with the used of margin on both sides.
- T-Bills/Short is a bearish strategy opposite Long/T-bills.
- T-Bills/Short on Margin is an ultra bearish strategy opposite Long on Margin/T-Bills.

Summary of the investment approach

Input parameter definition **(**Steps 1-3)

Step 1: Decide which of the above strategies to apply separately for each asset class.

Step 2: Select a market-timing oscillator. Although many oscillators are available (See the

Appendix), we have found that the Commodity Channel Index (CCI) works very well with a diversity of asset classes.

Step 3: Define other model parameters such as margin considerations, transaction and borrowing costs, etc.

Calculation of asset class allocations (Steps 4-8)

Step 4: Optimize the oscillator averaging period for each investment component or asset class. Once this is determined, the oscillator time history for each asset class can be computed.

Step 5: Optimize the long and short margin percentages for each asset class for any strategy that requires these values.

Step 6: Calculate the market-timing modified time histories of total return for each asset class. These are the historical performance results of using the left half of the strategy when the contemporaneous value of the oscillator is positive and the right half when it is negative.

Step 7: Process the modified time histories through the algorithms of classic MPT to produce the unstrategized allocations.

Step 8: Use the current sign of the oscillator to determine which side of the strategy to use. If the oscillator is positive, apply the left half of the strategy (long or in cash) and if it's negative, apply the right half (short or in cash).

The above is repeated each month or as often as portfolio rebalancing is performed.

Now that the approach is outlined, let's take a step back and examine why such an approach is needed in especially in today's market environment.

2. Market Timing Addresses Flaws in Modern Portfolio Theory

Asset allocation according to Modern Portfolio Theory: The pros & cons

Many wealth managers design portfolios built upon the concepts of Modern Portfolio Theory. Although MPT has revolutionized portfolio management, it is not without limitations. One of the precepts of MPT is that portfolios must always have funds distributed among the asset classes per the allocation recommendations. In good times or in bad, one is almost never out of the market of high performing but risky assets. It is this concept that can lead to large portfolio losses during market corrections—losses that can take many years, even decades, to recover.

How this MPT limitation can be minimized

Realizing the risk of loss during downturns, portfolio managers have sought to downplay the MPT approach by offering their own managed services. It seems that each manager has his or her own approach towards risk management and, typically, the approach is labeled as "proprietary" making it opaque to investors as to how or why their funds are being distributed. Such subjectivity on the part of the fund manager can be eliminated by following a completely quantitative approach. We feel that an MPT modified approach employing a robust market-timing scheme such as the one set forth in this paper fulfills the need for risk-reduction and portfolio preservation as well as providing for transparency.

Modified Modern Portfolio Theory (MMPT)

This section will describe the mathematics of what will herein be termed Modified Modern Portfolio Theory (MMPT). It is Modern Portfolio Theory (MPT) with an enhancement of market timing to address the criticism of MPT that it does not favor upside risk over downside risk.

That is, it considers equally bad excess positive returns over excess losses. In MPT, the investor is subjected to potential prolonged losses in declining asset classes until the long term data is finally able to "catch up" and reduce exposure. It can take a long time before the classic mathematics of MPT can respond and finally capitulate and provide an exit point from a losing investment. With MMPT, this is not the case. Declining asset classes are spotted quickly thus preserving portfolio value during market corrections.

The Portfolio Problem

Let's begin with a review of the portfolio problem which is a minimization procedure to find that portfolio allocation with the lowest risk given the constraint of simultaneously producing a specified minimum overall long term average return. Risk is defined as the variation in overall portfolio return from that defined minimum. That is, we want to achieve our required goal but also stay as close to it as possible with minimum fluctuations.

Given a fixed sum of money, let **F** represent the total investment funds to be allocated among **n** different investment alternatives with known time histories of total returns. (Note: All of these time histories must start on the same date.) Let **L** be the desired minimum return to be achieved by the portfolio. Let $\mathbf{x_i}$ be the amount of funds allocated to investment **i** and let $\mathbf{x_{ik}}$ denote the return per dollar from investment i during the kth time period in the past. Let **p** be the total number of historical time periods of data. If the future behaves like the average of the past (one of the tenets of MPT) then the expected return per dollar, $\mathbf{E_i}$, from each investment class i is:

$$E_i = \frac{1}{p} \sum_{k=1}^{p} x_{ik}$$

and the expected return from all investments combined is:

$$E = E_1 x_1 + E_2 x_2 + ... + E_n x_n$$

Choose the quantity **z** as a measure of the total variability of future payments (e.g., risk):

$$z = \frac{1}{p} \sum_{k=1}^{p} (x_{1k} x_1 + x_{2k} x_2 + ... + x_{nk} x_n - E)^2$$

which reduces to:

$$z = \sum_{i=1}^{n} \sum_{j=1}^{n} \sigma_{ij}^2 x_i x_j$$

where σ_{ij}^2 are the covariances given by:

$$\sigma_{ij}^2 = \frac{1}{p} \sum_{k=1}^{p} (x_{ik} - E_i)(x_{jk} - E_j)$$

The function to be minimized is therefore:

$$z = \sum_{i=1}^{n} \sum_{j=1}^{n} \sigma_{ij}^2 x_i x_j$$

subject to the constraints:

$$x_1 + x_2 + ... + x_n = F$$

$$E_1 x_1 + E_2 x_2 + ... + E_n x_n \geq L$$

with all variables non-negative.

This is solved through the use of quadratic programming. Applying Kuhn-Tucker conditions to the program and using the method of Frank and Wolfe provides an optimum result.[3]

Oscillators

Let's now examine the application of an oscillator to the time history data for each investment class. The value of the oscillator determines if an investment is to be held according to the

allocation calculated by MPT or is instead entirely shifted to a designated safe asset class (T-bills).

Popular oscillators used to indicate overbought/oversold conditions are the Commodity Channel Index (CCI), the Moving Average Convergence/Divergence (MACD), and the Rate of Change (ROC). Of these three, extensive back-testing over all market conditions has shown that the CCI is the most accurate in terms of timing and yields the best results in terms of obtaining the desired portfolio return at the minimum amount of risk. The reader unfamiliar with these oscillators are referred to the Appendix where they are discussed in detail.

Time History Alteration

One of the key elements of MMPT is the substitution of the returns obtained by an investment or asset class for those returns achieved by the safe asset class when the oscillator has signaled a shift away from that asset class. In this way the time history for an investment as presented for evaluation is a combination of the unmodified asset class returns and those returns for the safe asset class. When the oscillator is negative those values in the time history of returns for that asset class are instead the time history values for the safe asset class. When the oscillator is positive the values are the values achieved by the asset class.

3. Comparison of portfolio returns between the MMPT model and the classic MPT model

Background

The following sections will compare the performance of a portfolio constructed with the MMPT model described above with the performance of the classic MPT model designed to achieve the same return over three periods of market correction: the extended flat market

between 1965 to 1975, the bursting of the dot-com bubble from 2000-2002, the sub-prime mortgage crisis of 2007-2009.

Before delving into these case studies, a word on how the model portfolios are constructed is in order.

Portfolio construction

Both the classic MPT and MMPT portfolios are composed of the same nine asset classes (listed below) most widely used in traditionally allocated portfolios.

The nine traditional asset classes used in this analysis

1. Large-cap U.S. Stocks (S&P 500)
2. Small-cap U.S. Stocks
3. Long-Term investment-grade Corporate Bonds
4. Long-Term Treasury Bonds
5. Intermediate-Term Treasury Bonds
6. 30-day U.S. Treasury Bills (or a safe cash-equivalent)
7. Real Estate Investment Trusts (REITs)
8. International Stocks
9. International Bonds

A required compounded annual total return of 10% is selected being that it is neither too conservative nor too speculative. Both portfolios are rebalanced following updated allocation recommendations provided each month using the same database of historical monthly returns for each asset class.

Current portfolio allocations are derived using monthly total return data for each asset class dating back to January of 1928.

Case Study #1: 1965 – 1975: Extended flat market

There are periods in history when entering the market hasn't been providential. The period from 1965 to 1975 was one of those times when a classically constructed MPT portfolio initiated in 1965 would essentially be in the same place ten years later.

Figure 1. Comparison of MMPT/MPT/SPX returns from 1928 – present (semi-log scale) (MMPT - green; MPT - magenta; S&P 500 - blue)

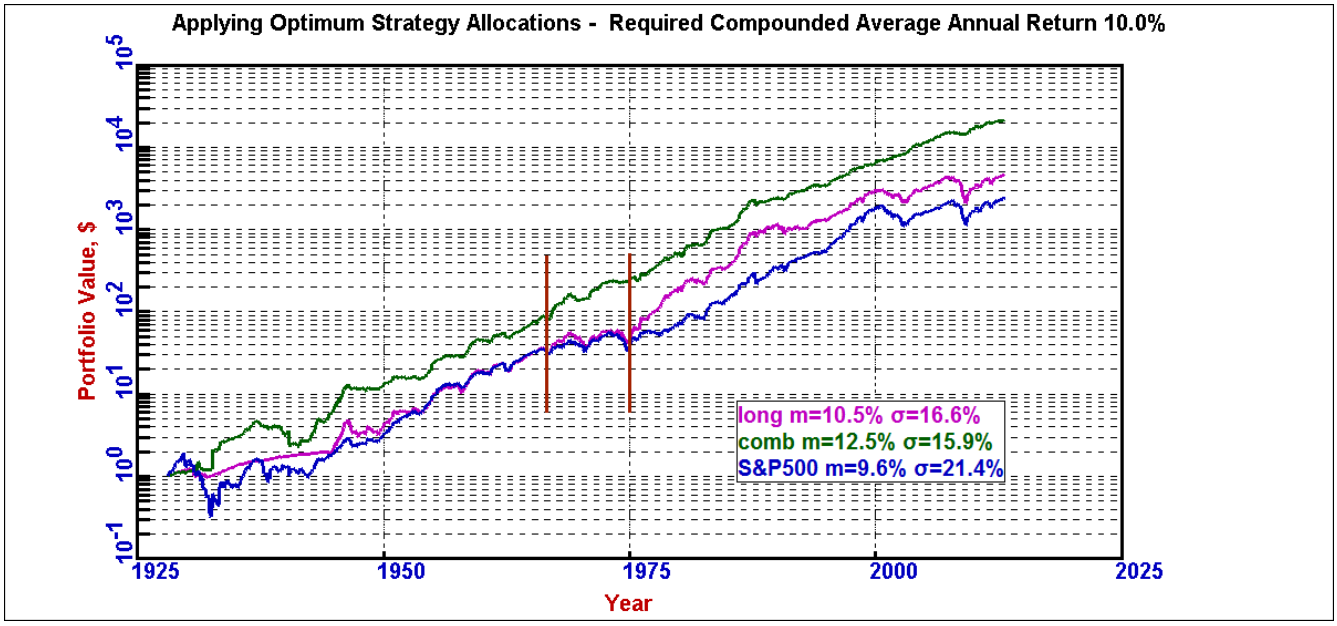
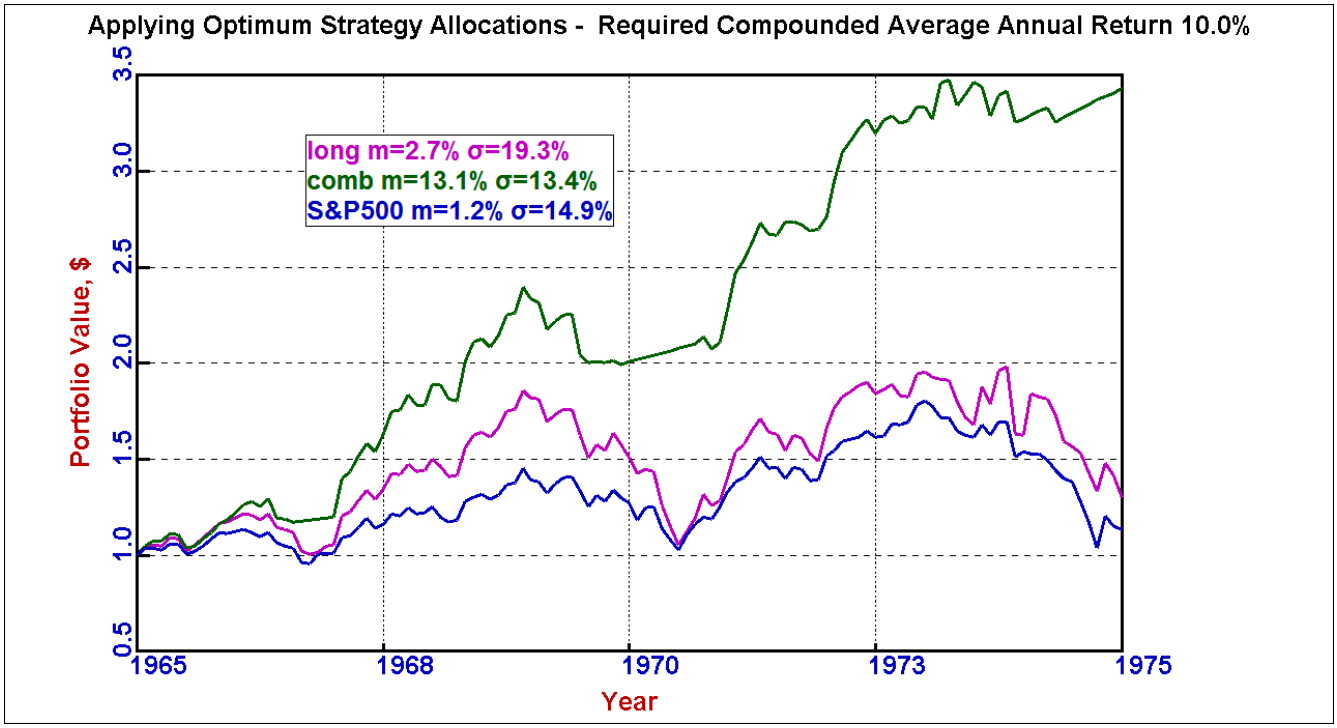


Figure 1 above shows that returns for both the classic MPT portfolio and the S&P 500 remained flat for a decade despite two rallies in the interim. Also shown is the return profile of the MMPT portfolio. (The returns for each model along with its associated risk (σ) during the entire time period (1928 – present) are shown in the embedded window label.)

Figure *2* details the same portfolio returns over the time-frame of interest on a linear scale:

Figure 2. Comparison of MMPT/MPT/SPX returns from Jan 1965 through Dec 1974
(MMPT - green; MPT - magenta; S&P 500 - blue)



During this time frame, the S&P 500 barely provided a positive return (1.2%) while the MPT portfolio only did slightly better (2.7%). On the other hand, not only did the MMPT portfolio achieve its 10% required annual compounded return, but it handily beat it (13.4%). Moreover, it accomplished it at a risk level lower than both of the others.

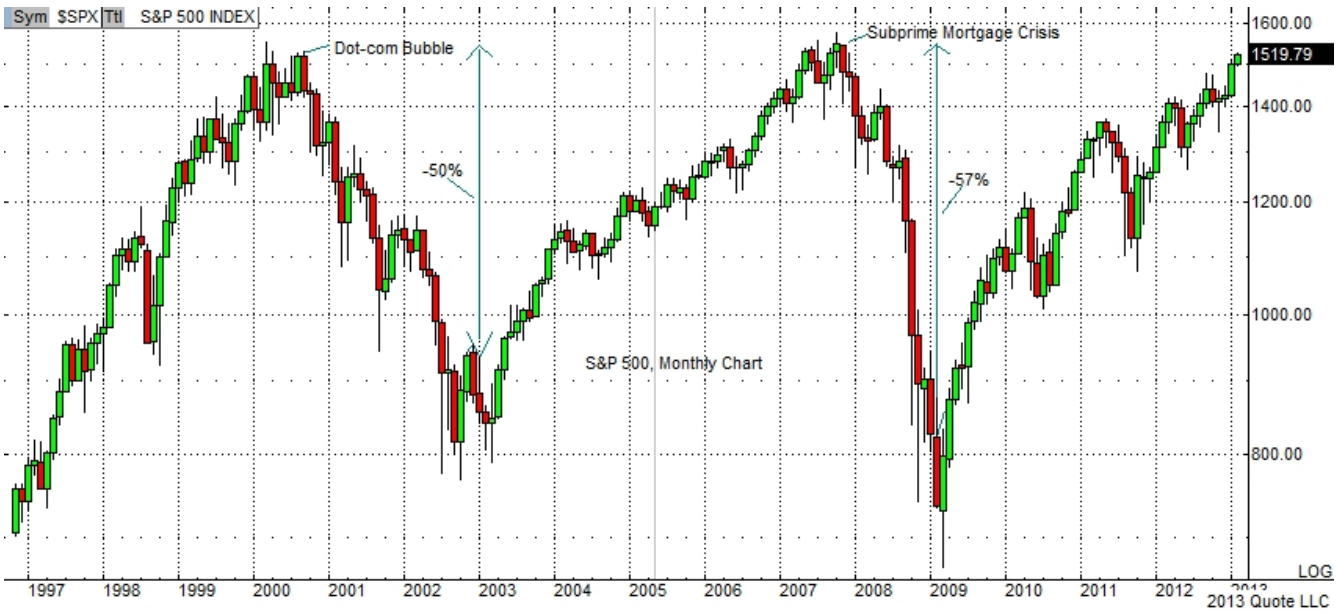
Yes, one can construct a time frame that works for any model, but as can be seen in Figure 1, a long-term investment horizon has the advantage over a short-term one. One problem is that a portfolio can be initiated at any time regardless of market conditions. How that portfolio is able to respond to changing market conditions is critical. In this sense, let's look at two recent periods of extreme market volatility.

2000 – Present: A period of market turbulence

Overview

To realize just how much of an impact the market corrections in the last decade or so have had on portfolios, consider the chart of the S&P 500 (Figure 3). During the 2000-2002 bursting of the dot-com bubble, the index lost 50% of its value. As devastating as that was, it wasn't nearly as bad as the 57% drop from 2007 to 2009 resulting from the sub-prime mortgage crisis.

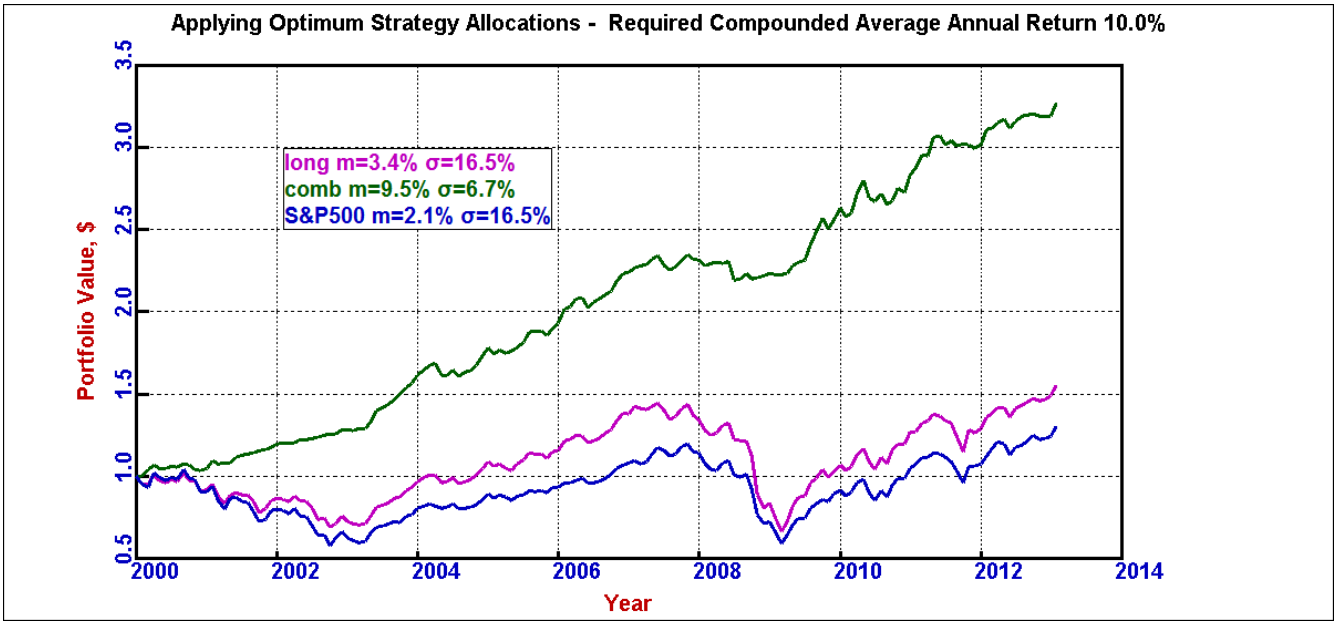
Figure 3. Recent Market Turbulence (2000 - Present)



Comparison of results for the entire time period (2000 – present)

Total returns for both the MPT and MMPT models are plotted along with the total return of the S&P 500 from January of 2000 to February of 2013 in Figure 4.

Figure 4. MMPT/MPT/SPX returns & risks comparisons from 2000 - present
(MMPT - green; MPT - magenta; S&P 500 - blue)



The results show an astounding difference in both return and risk (as measured by the standard deviation of returns about the mean). Because of under-performance in nearly every asset class during this time, the MMPT portfolio was only able to return 9.5% instead of the required 10%. However, it handily beat the classic MPT model which could only return a paltry 3.4%--not very good but still better than the 2.1% return of the S&P 500. It should be noted that the MMPT return is not only significantly higher, but it was achieved at substantially lower risk (6.7% vs 16.5% for both the MPT model and the S&P 500).

Further observations:

- Even from the beginning of the market's decline in 2000, the MMPT portfolio return was always positive--not so for the classic MPT model nor the benchmark S&P 500. It took nearly five years for the classic portfolio to break even and almost seven years for the S&P 500 to do so.

- Following the 2007 mortgage crisis, it took another five years for both the classic portfolio and the S&P 500 to climb back to their pre-crash values. However, this crisis was but a mere pause in the increasingly positive returns for the MMPT portfolio.
- During this time, not only was the return on the MMPT portfolio superior to both the classic model and the S&P 500, but this superior performance was achieved at a greatly reduced risk. This fact alone should be of interest to fund managers and investors alike.

The next two case studies provide an in-depth look as to how MMPT was able to out-perform the classic MPT model and the S&P 500.

Case Study #2: The dot-com bust (2000-2002)

Overview

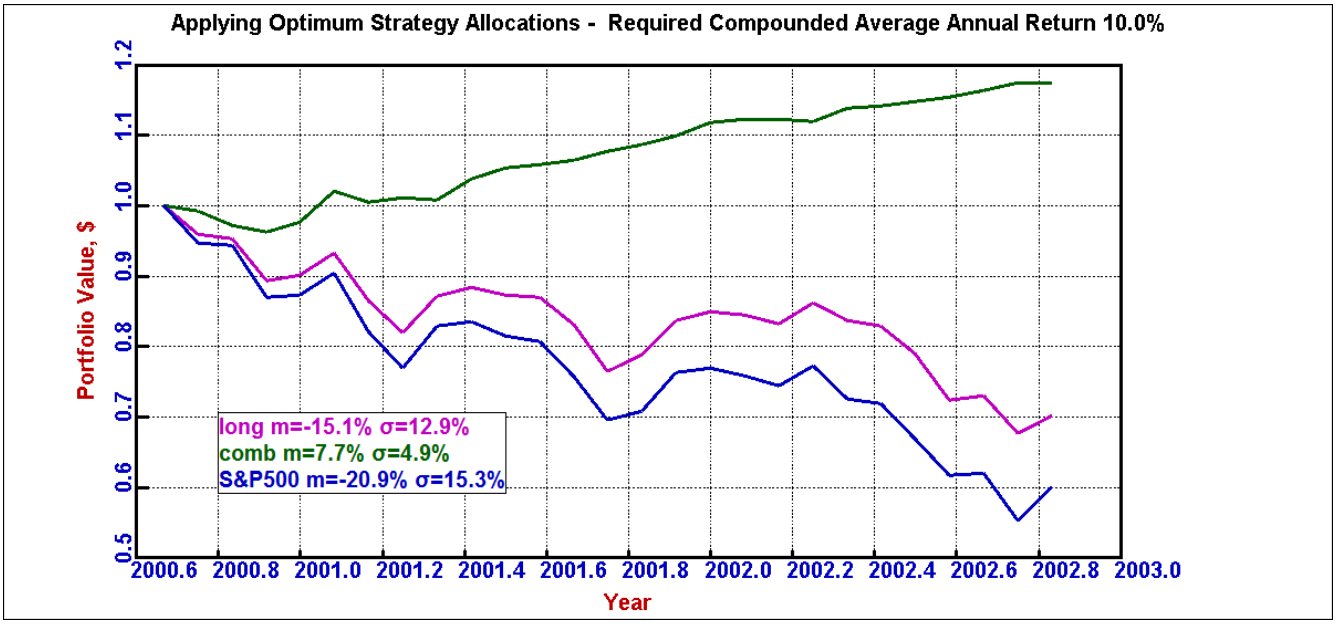
The bursting of the dot-com bubble is chosen because it was the first severe market decline in recent history that most people will remember, though many may not remember it fondly. Investors who were heavily invested in internet-based equities leading up to the dot-com bust experienced unprecedented returns but saw their gains rapidly erode following the mid-2000 market peak.

But that wasn't nearly as tragic as those who began investing at the peak of the bubble; they had to wait seven years just to regain their initial investment. From the September 1st, 2000 peak to the October 10th, 2002 trough, the S&P 500 lost nearly 50% of its value but that was nothing compared with the 78% loss in the tech-heavy Nasdaq. Portfolios heavily weighted in tech got clobbered.

Figure 5 compares the total returns between an MMPT portfolio and the corresponding MPT

portfolio compared to the S&P 500. Please note that the returns cited in these figures are annualized returns.

Figure 5: MMPT/MPT/SPX return comparison from Sept. 2000 – Nov. 2002
(MMPT - green; MPT - magenta; S&P 500 - blue)



The chart shows that both the MPT portfolio and the S&P 500 both declined significantly during the dot-com bust (-15.1% and -20.9%, respectively). On the other hand, the MMPT portfolio was not only able to stay out of the red, but it was able to achieve a 7.7% annualized return realized at much lower risk.

To understand why the classic MPT portfolio under-performed and why the MMPT model was able to provide a decent positive return during this time-frame, we first need to look at the performance of the underlying asset classes.

Annualized total performance of all asset classes (2000-2003)

Table 1 below shows that the annualized total returns for all asset classes except for bonds fared poorly during this time period. Large-cap stocks and international stocks suffered the most. With these returns in mind, we will see how a classically allocated MPT portfolio would

have kept the investor in these poorly performing asset classes.

Table 1: Annualized total returns of all asset classes during the dot-com bust

Large Company Stocks	Small Company Stocks	Long-Term Corporate Bonds	Long-Term Government Bonds	Medium-Term Government Bonds	Treasury Bills	RealEstate Investment Trusts	International Stocks	International Bonds
-18.69%	-3.60%	13.89%	11.98%	12.43%	3.64%	6.95%	-19.36%	8.45%

Comparison of asset class allocations between MPT & MMPT: 2000 – 2003

At the onset of the dot-com bubble, the classically allocated MPT portfolio would have been heavily invested in large-cap stocks with the remaining funds chiefly in intermediate term government bonds. (Please refer to Table 2.)

Table 2. Classic MPT Historical Allocations During the Dot-Com Bust for a Targeted 10% Compounded Annual Return (Sept. 2000 – Nov. 2002)

Allocations At Beginning Of	Standard Deviation	Probability Of Loss	Sharpe Ratio	Large Company Stocks	Small Company Stocks	Long-Term Corporate Bonds	Long-Term Government Bonds	Medium-Term Government Bonds	Treasury Bills	RealEstate Investment Trusts	International Stocks	International Bonds
September 2000	18.3%	0.29	0.21	77.5%	2.8%	2.9%		14.6%			2.2%	
October 2000	18.6%	0.30	0.20	77.0%	4.5%	2.3%		14.5%			1.7%	
November 2000	18.7%	0.30	0.16	81.3%	2.6%	1.2%		14.8%			0.1%	
December 2000	19.1%	0.30	0.19	79.9%	2.2%	10.3%		3.5%			4.1%	
January 2001	19.1%	0.30	0.20	76.9%	2.6%	13.8%		0.2%			6.5%	
February 2001	18.9%	0.30	0.18	75.3%	5.4%	16.2%					3.1%	
March 2001	19.5%	0.30	0.27	74.0%	7.9%	14.6%					3.5%	
April 2001	19.9%	0.31	0.23	74.4%	9.7%	13.5%					2.4%	
May 2001	19.5%	0.30	0.27	74.5%	8.3%	14.6%					2.6%	
June 2001	19.5%	0.30	0.31	72.7%	11.1%	16.2%						
July 2001	19.6%	0.30	0.34	69.8%	13.6%	16.6%						
August 2001	19.7%	0.31	0.32	69.9%	13.8%	16.3%						
September 2001	20.0%	0.31	0.31	67.5%	16.6%	15.9%						
October 2001	20.6%	0.31	0.32	70.7%	16.4%	12.9%						
November 2001	20.5%	0.31	0.36	67.6%	18.1%	14.3%						
December 2001	20.1%	0.31	0.39	68.8%	16.1%	15.1%						
January 2002	20.1%	0.31	0.41	66.4%	17.6%	16.0%						
February 2002	20.1%	0.31	0.41	64.6%	19.1%	16.3%						
March 2002	20.3%	0.31	0.42	64.8%	19.5%	15.7%						
April 2002	20.1%	0.31	0.42	63.5%	19.8%	16.7%						
May 2002	20.3%	0.31	0.40	57.4%	24.6%	18.0%						
June 2002	20.4%	0.31	0.41	58.3%	24.4%	17.3%						
July 2002	20.8%	0.32	0.41	53.3%	27.8%	17.0%					1.9%	
August 2002	21.5%	0.32	0.38	55.6%	24.5%	13.6%				6.3%		
September 2002	21.5%	0.32	0.39	55.2%	24.7%	13.8%				6.3%		
October 2002	22.1%	0.33	0.38	45.6%	27.1%	13.9%				13.4%		
November 2002	21.8%	0.32	0.38	56.9%	29.5%	13.4%				0.2%		

MPT was very slow to respond to the decline in the value of large-cap stocks. This was the main reason for the decline in portfolio value.

On the other hand, the MMPT equivalent model would have taken investors out of both large-cap and small-cap stocks as well as real-estate investment trusts--the other major portfolio investment--as early as November of 2000. The proceeds from the sale of these asset classes were then moved into the safety of intermediate-term government bonds and T-bills. (Please refer to Table 3.) This move was triggered by the shift in the timing oscillator for each of the

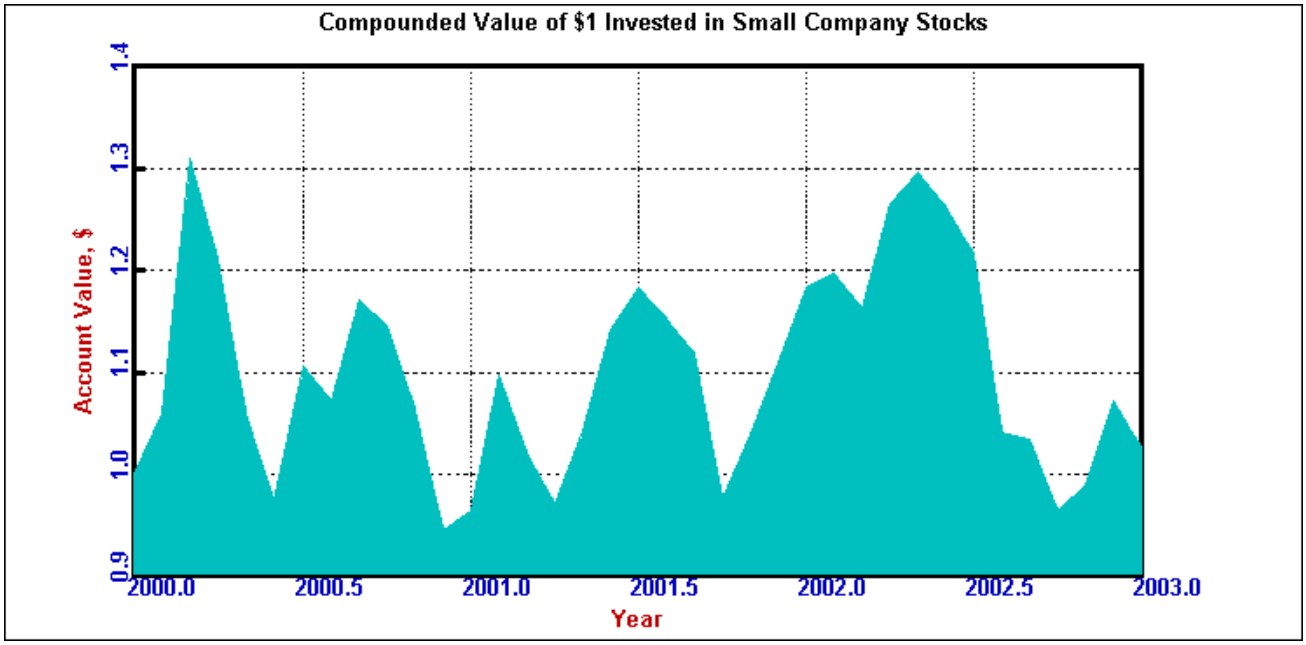
above-mentioned asset classes from positive to negative.

Table 3. MMPT Historical Allocations During the Dot-Com Bust for a Targeted 10% Compounded Annual Return (Sept. 2000 – Nov. 2002)

Allocations At Beginning Of	Standard Deviation	Probability Of Loss	Sharpe Ratio	Large Company Stocks	Small Company Stocks	Long-Term Corporate Bonds	Long-Term Government Bonds	Medium-Term Government Bonds	Treasury Bills	RealEstate Investment Trusts	International Stocks	International Bonds
September 2000	11.8%	0.20	0.33	31.5%	13.4%			24.9%	3.2%	27.0%		
October 2000	12.0%	0.20	0.31	20.9%	14.2%			23.7%	10.6%	30.6%		
November 2000	10.1%	0.16	0.30	24.0%				44.2%	29.1%	2.7%		
December 2000	10.2%	0.16	0.36					44.6%	51.7%	3.7%		
January 2001	10.1%	0.16	0.38		29.0%			44.3%	22.5%	4.2%		
February 2001	10.1%	0.16	0.33		29.6%			45.8%	20.0%	4.6%		
March 2001	10.1%	0.16	0.52					43.6%	52.8%	3.6%		
April 2001	10.0%	0.16	0.46					42.9%	54.7%	2.4%		
May 2001	10.0%	0.16	0.52		29.2%			41.7%	26.3%	2.8%		
June 2001	10.0%	0.16	0.61		29.2%			43.2%	25.0%	2.6%		
July 2001	9.9%	0.16	0.66		28.6%			42.9%	25.9%	2.6%		
August 2001	9.9%	0.16	0.64					42.7%	55.3%	2.0%		
September 2001	9.9%	0.16	0.63					43.1%	53.6%	3.3%		
October 2001	9.8%	0.15	0.67					42.7%	55.5%	1.8%		
November 2001	9.8%	0.15	0.75		28.2%			42.8%	29.0%			
December 2001	9.7%	0.15	0.82		25.6%			43.7%	18.0%	12.7%		
January 2002	9.7%	0.15	0.85		25.2%			43.3%	21.8%	9.7%		
February 2002	9.6%	0.15	0.86		25.4%			44.1%	19.4%	11.1%		
March 2002	9.7%	0.15	0.87					43.9%	44.5%	11.6%		
April 2002	9.7%	0.15	0.87		24.8%			42.8%	21.1%	11.3%		
May 2002	9.7%	0.15	0.84		25.3%			44.2%		13.5%	17.0%	
June 2002	9.7%	0.15	0.86					43.5%	27.1%	13.3%	16.1%	
July 2002	9.7%	0.15	0.87					43.9%	42.3%	13.8%		
August 2002	9.7%	0.15	0.85					44.0%	43.1%	12.9%		
September 2002	9.7%	0.15	0.86					44.1%	43.0%	12.9%		
October 2002	9.7%	0.15	0.85					44.4%	55.6%			
November 2002	9.9%	0.16	0.84		29.6%			44.1%	26.3%			

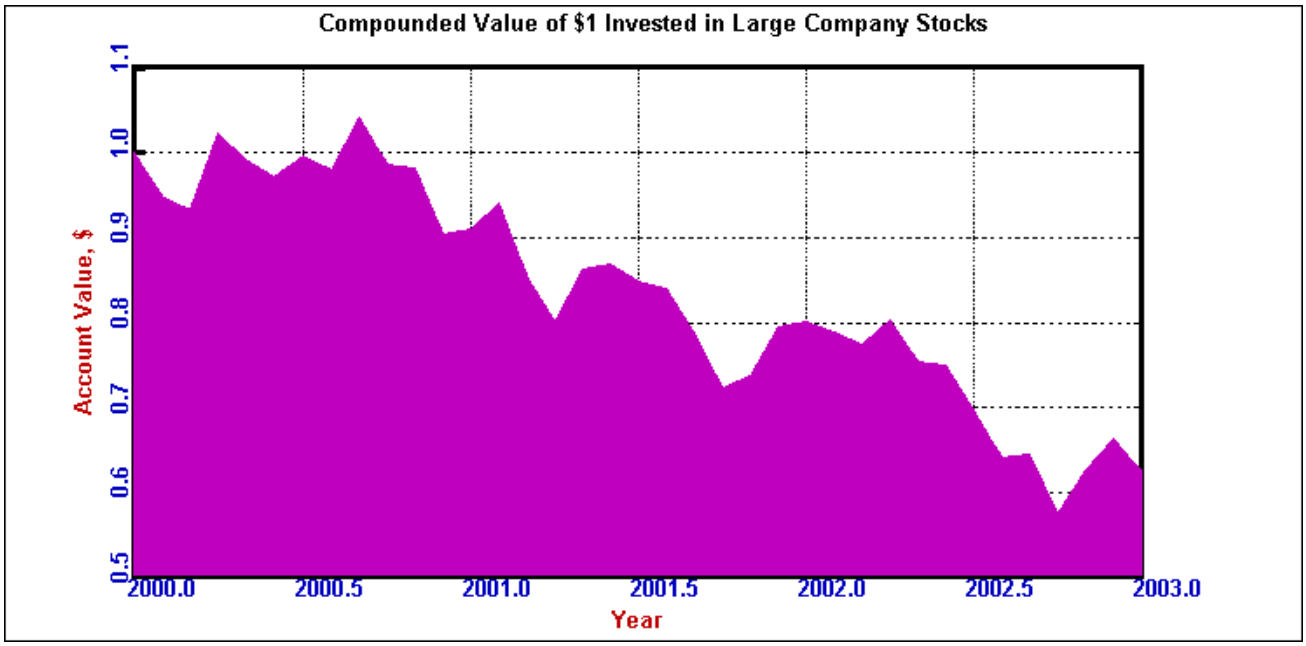
Table 3 shows that for some of the time there was an on and off movement into and out of small-caps. This seemingly fickle behavior can be understood when looking at their total return chart (Figure 6).

Figure 6. Total return: Small-cap stocks (2000-2003)



While the large-cap asset class was collapsing (Figure 7), the small-caps actually hung in there despite fluctuations in value.

Figure 7. Total return: Large-cap stocks



It's interesting to note that out of all of the asset classes, corporate bonds fared the best but MMPT did not allocate funds to them instead preferring the lower volatility and risk of

intermediate-term government bonds. It is important to note that in the MMPT model presented here, the oscillator strategy only applies to non-fixed income asset classes. Bonds are treated just as they are in classic MPT since they are less volatile by nature compared with stocks. (Note that in the *Portfolio Preserver*® software platform, a market-timing oscillator can be applied to any asset class, if desired.)

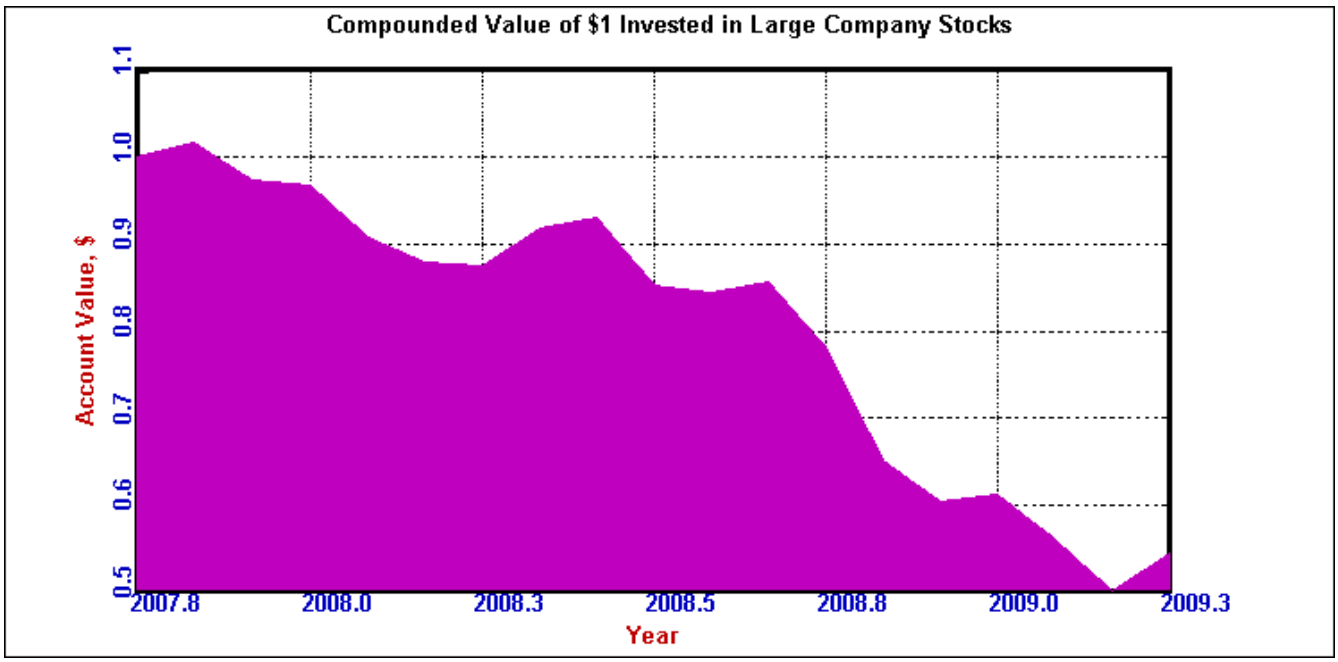
Case Study #3: The sub-prime mortgage crisis (2007 - 2009)

Let's now look at something that wreaked even more havoc on portfolio returns than the dot-com bust—the sub-prime mortgage crisis from October, 2007 through March, 2009. We shall show that an MMPT based portfolio again produces superior returns and at much lower risk than its classic MPT based counterpart.

The devastation of the sub-prime mortgage crisis

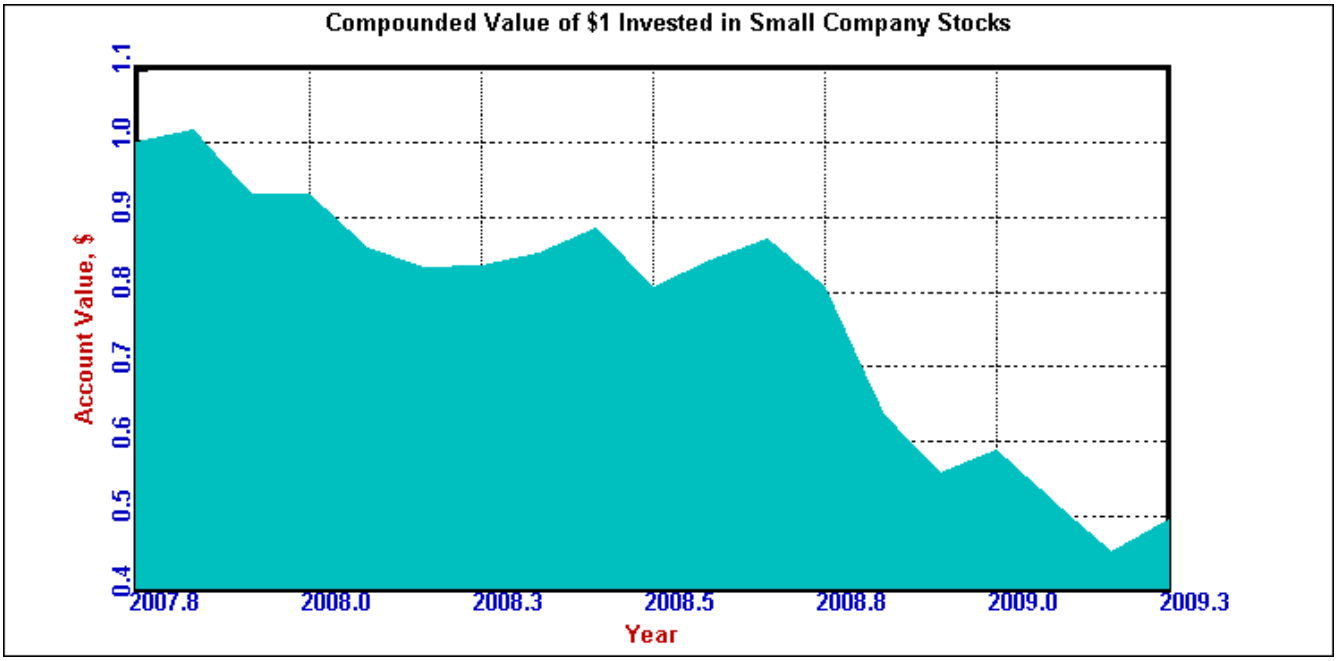
The time frame we'll be using in this analysis begins on October 11, 2007 when the S&P 500 hit an intraday high of 1576 and ends on March 6, 2009 when the S&P 500 reached an intraday low of 667. This represents a loss of over 57%, more than the 50% loss suffered during the dot-com bust. Figure 8 pictorially represents the sharp decline in the S&P 500 during this time. (Note that total return data shown in the figure includes dividends.)

Figure 8. Total Return Derived from S&P 500



The mortgage crisis took an even bigger bite out of small-caps (Figure 9). This was not the case in the dot-com bust where the value of small-cap stocks actually hung in there despite price fluctuations (refer to Figure 6 above).

Figure 9. Total Return Derived from Small Cap Stocks



Annualized total performance of all asset classes (2007-2009)

Table 4 below shows that the annualized returns for all asset classes except for government bonds performed poorly during this time period. Comparing these returns with those during the dot-com bust in Table 1, we can see that each of the asset classes except for government bonds fared much worse during the sub-prime crisis. Not surprising, the hardest hit were REITs which swung from a +7% return during the dot-com bust to a whopping -54% loss during the mortgage crisis.

Table 4. Annualized total returns of all asset classes during the sub-prime crisis

Large Company Stocks	Small Company Stocks	Long-Term Corporate Bonds	Long-Term Government Bonds	Medium-Term Government Bonds	Treasury Bills	RealEstate Investment Trusts	International Stocks	International Bonds
-38.62%	-43.02%	-2.93%	12.16%	8.21%	1.74%	-53.69%	-43.14%	3.57%

Portfolio allocations during the mortgage meltdown

Table 5 below shows that a classic MPT portfolio would have had roughly 60 – 80% of its assets allocated to equities with the rest divided between REITs and corporate bonds—exactly all of the worst performing asset classes during this time period.

Table 5. Classic MPT Allocations During the Sub-prime Mortgage Crisis for a Targeted 10% Compounded Annual Return (Oct. 2007 – March 2006)

Allocations At Beginning Of	Standard Deviation	Probability Of Loss	Sharpe Ratio	Large Company Stocks	Small Company Stocks	Long-Term Corporate Bonds	Long-Term Government Bonds	Medium-Term Government Bonds	Treasury Bills	RealEstate Investment Trusts	International Stocks	International Bonds
October 2007	19.6%	0.30	0.31	18.8%	14.9%	17.7%				22.4%	26.2%	
November 2007	19.5%	0.30	0.31	17.0%	15.2%	17.9%				21.3%	28.6%	
December 2007	19.9%	0.31	0.29	18.6%	17.5%	16.1%				17.3%	30.5%	
January 2008	20.0%	0.31	0.34	21.0%	21.4%	15.9%				11.7%	30.0%	
February 2008	20.4%	0.31	0.34	20.2%	17.9%	14.6%				20.4%	26.9%	
March 2008	20.5%	0.31	0.39	17.2%	19.2%	14.0%				19.2%	30.4%	
April 2008	20.5%	0.31	0.41	15.1%	15.8%	14.2%				25.6%	29.3%	
May 2008	20.3%	0.31	0.43	16.2%	12.6%	14.1%				27.7%	29.4%	
June 2008	20.3%	0.31	0.42	15.9%	14.3%	14.3%				24.9%	30.6%	
July 2008	20.8%	0.32	0.39	14.3%	18.3%	12.9%				22.7%	31.8%	
August 2008	20.9%	0.32	0.39	15.2%	21.0%	13.6%				21.3%	28.9%	
September 2008	21.0%	0.32	0.40	19.9%	23.1%	14.2%				19.5%	23.3%	
October 2008	21.5%	0.32	0.39	20.7%	21.4%	13.0%				27.1%	17.8%	
November 2008	23.2%	0.33	0.40	32.3%	38.0%			9.0%		7.8%	12.9%	
December 2008	23.9%	0.34	0.40	34.3%	43.3%		6.8%				15.6%	
January 2009	23.6%	0.34	0.42	23.5%	44.2%	10.2%				4.4%	17.7%	
February 2009	24.5%	0.34	0.40	31.9%	48.0%	7.3%					12.8%	
March 2009	25.5%	0.35	0.38	30.3%	51.6%	4.5%					13.6%	

By comparison, the MMPT equivalent portfolio (Table 6) was already light in large-cap stocks, having benefited from the experience of the collapse of dot-com bubble. For the entire period of the sub-prime meltdown, the MMPT portfolio was heavily weighted (70-100%) in medium-term government bonds and T-bills with some minor exposure to small-caps and international equities.

Table 6. MMPT Allocations During the Sub-prime Mortgage Financial Crisis for a Target 10% Compounded Annual Return (Oct. 2007 – March 2009)

Allocations At Beginning Of	Standard Deviation	Probability Of Loss	Sharpe Ratio	Large Company Stocks	Small Company Stocks	Long-Term Corporate Bonds	Long-Term Government Bonds	Medium-Term Government Bonds	Treasury Bills	RealEstate Investment Trusts	International Stocks	International Bonds
October 2007	9.2%	0.14	0.66	1.4%	23.8%			43.7%	9.0%		22.1%	
November 2007	9.2%	0.14	0.66	1.1%	23.7%	0.3%		43.3%	8.7%		22.9%	
December 2007	9.2%	0.14	0.63	0.2%				43.5%	33.5%		22.8%	
January 2008	9.2%	0.14	0.73	0.8%				43.4%	33.7%		22.1%	
February 2008	9.4%	0.14	0.73					44.3%	55.7%			
March 2008	9.3%	0.14	0.85					43.7%	56.3%			
April 2008	9.3%	0.14	0.89		24.4%			43.7%	31.9%			
May 2008	9.3%	0.14	0.93		24.4%			43.4%	21.4%	10.8%		
June 2008	9.3%	0.14	0.92		24.5%			43.6%		10.6%	21.3%	
July 2008	9.5%	0.15	0.86					43.0%	57.0%			
August 2008	9.5%	0.15	0.86		25.5%			43.0%	31.5%			
September 2008	9.5%	0.15	0.89		25.6%			43.2%	31.2%			
October 2008	11.1%	0.18	0.75					24.6%	75.4%			
November 2008	11.2%	0.19	0.82					24.6%	75.4%			
December 2008	11.2%	0.19	0.85					24.7%	75.3%			
January 2009	11.2%	0.19	0.88			0.7%		24.1%	75.2%			
February 2009	11.2%	0.19	0.88					24.5%	75.5%			
March 2009	11.3%	0.19	0.87					24.3%	75.7%			

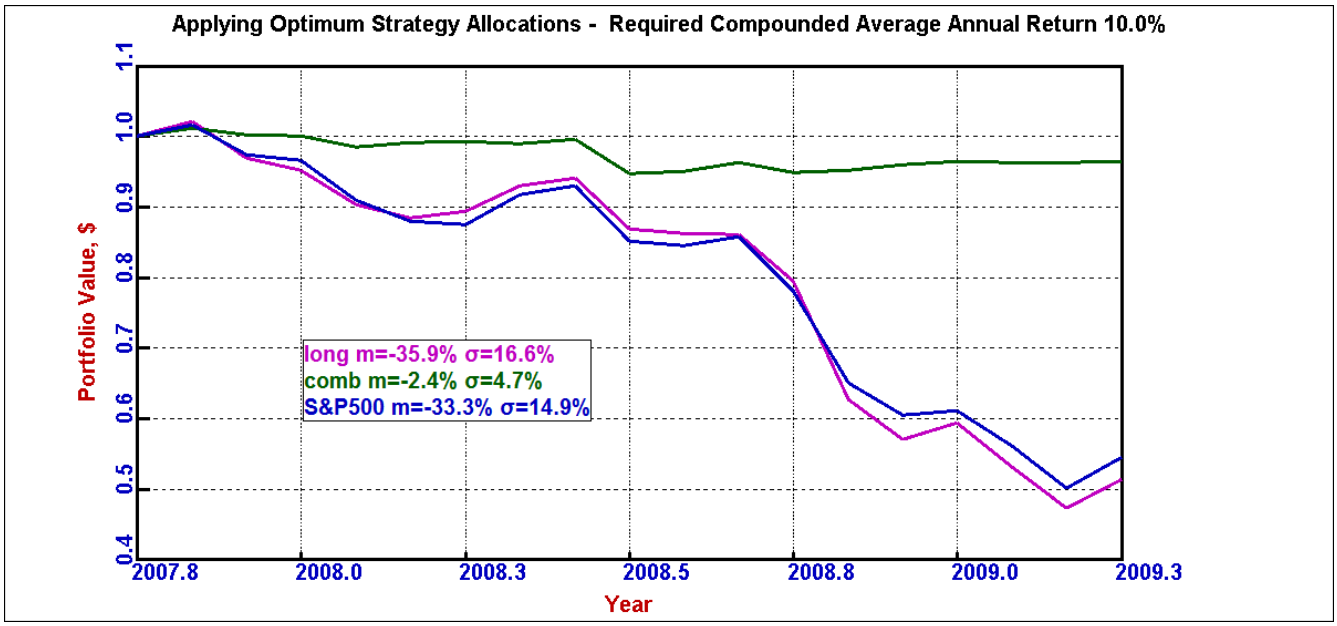
As Table 4 above reveals, it was this exposure to the equity classes that caused the most harm to both portfolios. It's interesting to note that long-term government bonds fared the best in a so-called flight to safety but MMPT did not allocate funds to it instead preferring the historical lower volatility of intermediate-term bonds.

Comparison of portfolio returns

During the months of the sub-prime mortgage crisis, the S&P 500 lost money at an annualized rate of 33.3% (Figure 10). As bad as this was, the classic MPT portfolio performed even worse

losing nearly 36%. Compare the devastation wreaked by both of these to the mild 2.4% dip experienced by the MMPT portfolio. Moreover, there was markedly less volatility associated with the MMPT portfolio (4.7% vs 16.65%). This was because the MMPT portfolio was comprised of asset classes (mainly bonds) of lower volatility. The reason that the MMPT portfolio wasn't able to do better was because of the extreme under-performance of most of the component asset classes as well as due to the mandate of risk minimization.

Figure 10: MMPT/MPT/SPX return comparison from Sept. 2000 – Nov. 2002
(MMPT - green; MPT - magenta; S&P 500 - blue)



Summary of MMPT performance during market corrections

The above case studies show that a portfolio constructed using the MMPT approach not only protects the investor during periods of market under-performance but it does so at a much lower risk than its MPT counterpart and the benchmark index. This is an important added benefit of the MMPT model—it reduces risk without the need for hedging or other costly risk-reduction techniques such as buying put options. In essence, the MMPT model acts as its own

hedge.

As superior as MMPT is to MPT, returns using either model are inherently limited by the performance of the underlying asset classes. Historically, stocks and bonds have been generally negatively correlated to each other meaning that if stocks moved higher, bonds moved lower, and vice-versa. Many commodities, too, were either negatively correlated or completely uncorrelated with other asset classes. A portfolio constructed using a selection of asset classes with varying correlations should be able to provide robust returns at lower risk over most market scenarios.

Lately, all of this has changed. Stocks, bonds, and commodities are becoming increasingly correlated as national economies become more interdependent. For this reason alone, it is even more important to apply a market-timing approach to prevent major portfolio loss, the reason being that a judiciously and properly applied market timing approach to the standard MPT model injects an element of nimbleness and reactivity while still benefiting from historical experience. This is of tremendous value especially in today's volatile markets.

Through these case studies we have demonstrated the superiority of the MMPT approach to the classic MPT model in both risk-reduction and portfolio preservation over market downturns ranging from mild to severe.

Further features of the MMPT model

MMPT offers the investment manager greater flexibility in terms of portfolio construction and investment philosophy compared with classic MPT. Features of the MMPT approach include the following:

1. A portfolio only needs to be re-balanced at most once per month to achieve the superior return/risk results published here. This efficiency of time frees up the investment manager to do other things.
2. Any asset class (other than the traditional ones listed) can be easily added or removed thus providing a mechanism for complete portfolio customization.
3. While this paper only addresses portfolios that are comprised of either being long an asset class or in cash (depending on the value of the oscillator for that asset class), the market-timing approach of the model allows the manager to short an asset class, if so desired. In this way, the manager has more investing options and during times of severe market corrections, he or she may even be able to generate superior returns by taking the short side. For example, taking the short side in stocks and REITs for intermittent periods during the sub-prime crisis could have generated a significant positive total return. (Refer to *Table 4.*) This option is not available in the classic MPT model.
4. The fact that MMPT is a purely quantitative model removes human bias and eliminates guessing as to when to enter and exit an asset class. It also provides for a high level of transparency.
5. The MMPT model is self-hedging meaning that costly external hedging mechanisms are not required to reduce risk.

Appendix

Commodity Channel Index

The Commodity Channel Index (CCI) is a technical trading tool developed by Donald Lambert

who introduced it in an article in the October 1980 issue of *Commodities* magazine (now *Futures*). It has since grown in popularity and is used by traders and investors to identify cyclical trends not only in commodities, but in equities and currencies as well. Although it works best in cyclical markets, it can be also be used in trending markets as well. The CCI was designed to identify cyclical turns in commodities. The assumption behind the indicator is that commodities (or stocks or bonds) move in cycles, with highs and lows coming at periodic intervals.

The CCI is used to identify overbought and oversold conditions. It does this by measuring the relation between price and the mean deviations from a specified moving average:

$$CCI = (Price - Moving\ Average) / (0.015 \times Mean\ Deviation)$$

Essentially, the CCI measures how far away price is from the moving average and how fast it moved to get there. If the price is right at the moving average, the CCI value will be at zero. The constant (0.015) is used in the above equation as a normalizing factor. It restricts about 80% of the values to be between -100 and +100. The theory here is that when the CCI goes way outside either of those two boundaries, the stock is either oversold or overbought.

The moving average term employs an averaging time period factor. This factor is optimized by the MMPT process using a brute force method which simply tries every value between zero and 60 months to determine that value which produces the highest return for that investment when the oscillator is applied to exit and enter that investment. Further, this procedure is repeated for each case of starting point of data at the first month to the last. The resultant composite optimized averaging period is the average of the best for each of these cases.

Because it is an oscillator, the CCI used by itself works best in sideways markets; in trending markets the CCI alone will lead to false buy and sell signals. This is when you need to loosen your interpretation of the indicator and only pay real attention to it when it crosses the zero line. This last idea is the crux of this MMPT process. The actual numerical value of the CCI is ignored except when it moves from positive to negative or negative to positive. A value of zero is positive.

Moving Average Convergence/Divergence

Developed by Gerald Appel, Moving Average Convergence/Divergence (MACD) uses two moving averages to include some trend-following characteristics. These indicators are turned into a momentum oscillator by subtracting the longer moving average from the shorter moving average. The resulting line oscillates above and below zero and has no upper or lower limits. Standard usage of the MACD is the difference between an asset class's 26-day and 12-day exponential moving averages (EMA). The MMPT model, however, will optimize these averaging periods separately for each asset class. Shorter moving averages produce a more responsive indicator, while longer moving averages will produce a slower indicator.

MACD measures the difference between two EMA's. A positive MACD indicates that the shorter term EMA is trending above the longer term EMA. A negative MACD indicates that the shorter term EMA is trending below the longer term EMA. If MACD is positive and rising, then the gap between the short-term EMA and the long-term EMA is widening. This indicates that the rate of change of the faster moving average is higher than the rate of change for the slower moving average; positive momentum is increasing thus indicating a rising asset class value. If

MACD is negative and declining, then the negative gap between the faster moving average and the slower moving average is increasing meaning that negative momentum is increasing thus indicating lower asset class value. Zero-line crossovers occur when the faster moving average crosses the slower moving average.

The formula is as follows:

$$MACD = (Short\ term\ exponential\ moving\ average) - (Long\ term\ exponential\ moving\ average)$$

and,

$$EMA_{this\ period} = \alpha\,(asset\ class\ value\ this\ period) + (1-\alpha)\,EMA_{previous\ period}$$

where,

$$\alpha = 2/(n+1),\ n = averaging\ period$$

The averaging periods are optimized using a similar method as that used for the CCI oscillator. Analyses conducted indicated that it does not matter which moving average is optimized first.

Rate Of Change

The Rate of Change (ROC) indicator is a very simple oscillator that computes the percent change in asset class value from a previous time to the present.

ROC = ((Current Asset Class Value - Asset Class Value n Periods Ago) / (Asset Class Value n Periods Ago)) x 100

The oscillator fluctuates above and below the zero line as the Rate of Change moves from up and down from positive to negative or negative to positive. We optimize the value of n to maximize gains. The larger the value of n, the greater the fluctuations in the indicator.

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