Is It Worth It?
Quantifying the Value of Risk-Managed Investing

By Jerry Miccolis, CFA®, CFP®, FCAS, MAAA, CERA; Marina Goodman, CFA®, CFP®; Rohith Eggidi

Executive Summary

- To meet their long-range financial goals, most investors need a sizeable allocation to "risk assets" such as equities in their portfolio, but large drawdowns in these assets are quite frequent. The S&P 500 Total Return Index, for example, has suffered drawdowns of -10% or worse 29 times since 1935, a frequency of once every 2.7 years on average.

- Risk-managed investing (RMI) attempts to take traditional portfolio management — typified by diversification, asset allocation, and rebalancing — to the next level by explicitly dampening portfolio volatility and/or limiting downside potential.

- This paper addresses fundamental questions about RMI, including why it should be considered, and how low its cost needs to be to add long-term value.

- Qualitative considerations and an array of quantitative demonstrations document the potential economic value of RMI.

- Volatility-dampening is shown to add value by reducing risk drag, mitigating sequence risk, exploiting tax effects, and capturing the economic benefit long recognized by institutional investors.

- Downside protection is shown to add value by taking advantage of return asymmetry; even a modestly effective RMI strategy can support a cost — in terms of performance drag in rising markets — of several hundred basis points of return per year.

- The quantitative techniques in the paper can be used by investment professionals to objectively test the efficacy of proposed RMI solutions in the marketplace.

Introduction

There is considerable interest throughout the investment community in the subject of portfolio risk management. And much debate.

Some believe that going beyond traditional approaches — primarily, strategic asset allocation and rebalancing — to more explicitly manage portfolio risk may be the next great conceptual breakthrough in the science and practice of investment management. Others maintain that this attempt — whether through tactical portfolio adjustments, quantitative strategies, or sophisticated hedging techniques — is a waste of time and effort, and may mislead a susceptible public. The risk management advocates typically base their belief on the premise that improving the risk/return profile of a portfolio is always in the long-term best interests of the investor. The skeptics argue that the costs of risk management — both direct costs and the apparent need to sacrifice some upside potential — are doomed to make the whole enterprise a breakeven proposition, or worse.

In recent years, there has been a proliferation of products and solutions that have made attempts at explicit investment risk management, and depending upon which of those you examine, either side of the debate can be right. This paper will not address any particular product or solution. Instead, it will address the question more broadly and conceptually, but also with quantitative rigor, so that the efficacy of any proposed solution might be assessed in an informed, objective way.

Specifically, in this paper we will critically evaluate the rationale for considering risk-managed investing (RMI). In the process, we will attempt to quantify the economic value, if any, of improving the return stream of an investment or portfolio by:

- Dampening its volatility; and/or
- Limiting its downside potential.

Through this quantification, we will estimate an upper bound on the acceptable cost of RMI devices aimed at delivering these improvements.

We hope that this paper helps establish a sound scientific foundation for investment professionals to fairly evaluate developments in this critical area.

Fundamental Questions

Much of the dialogue on risk-managed investing (RMI) can be captured in three key questions:

- Why should I consider it?
- How much should I be willing to pay for it?
- If I have a long-term investment horizon and little concern for short-term volatility, is it even relevant to me?

So, let's address them directly.

Reasons One Might Consider Risk-Managed Investing

As it turns out, there are a number of compelling reasons, both qualitative and quantitative, that a prudent investor might wish to explore RMI.

On the qualitative side, many investors place high emotional value on predictability and peace of mind, often above most other considerations. This, by itself, may be sufficient cause for some people to embrace RMI. But there is also a much broader group of people for whom a similar sentiment more subtly holds sway.

Virtually all investors, however conservative or aggressive, need a healthy dose of "risk assets" (see note[1]) in their portfolio. Why? Because higher-risk investments tend to carry higher-return expectations. And without them, the low-risk/low-return investments that are left are simply not, in general, sufficient to preserve the purchasing power of the portfolio. In other words, the actual economic value of the portfolio, even if its nominal value stays stable or slightly increases, will tend to decline over time as inflation eats away at it. Inflation may not

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[1] We will use "risk assets" to denote any asset that exhibits volatility higher than that of cash and investment grade bonds. Risk assets typically include equities, real estate, commodities, and other alternative investments.

seem like much at any given moment, but over the time horizon of most investors — which is measured in decades — inflation is the single biggest financial threat they face.

The best defense (and offense) against inflation? Risk assets. A well-diversified portfolio held over a long period can help investors capture the high returns associated with risk assets while mitigating their risks at the portfolio level. Indeed, that is the whole point behind asset allocation. But, many investors simply cannot tolerate the volatility in those risk assets long enough for the benefits to play out. Their fear of uncertainty denies them access to one of the most potent tools they have to best secure their financial future.

RMI can be a way for these investors to become comfortable enough with risk assets that they will stick with them when they should. It can help these individuals control their fear, and let asset allocation work for them. The value of that result, while qualitative, can be immense.

That last statement cannot be overemphasized. Consider, for example, that some investors were so traumatized by the market collapse of late 2008/early 2009 that they exited the markets altogether in 2009. By the time they returned, long into the inevitable rebound, they had forfeited forever the "wealth re-creation" that the markets delivered to those who stayed the course. If RMI had helped keep those investors from making ill-informed, fear-driven decisions, the positive difference in their long-term financial future would have been enormous — of a magnitude that might easily outstrip any other impact we discuss in this paper.

There is another consideration in the qualitative realm, though this is more of a stretch. To the extent that someone is comfortable that the risk to his/her nest egg is well managed, to the point of supreme sleep-at-night serenity, then that person may be more willing to explore and undertake unrelated prudently-risky endeavors that may have high-reward potential in his/her life or career. Fear can be limiting; lack of fear can be liberating, and foster higher quality of life.

Quantitative Considerations — Volatility-Dampening

Let's tackle the quantitative side of the discussion in two parts. We'll first assess the economic value of volatility-dampening. We'll then do the same for downside protection.

A Very Simple Example

What's better, a stable 8% return or a volatile 9%? The answer, as you might imagine, depends on how volatile the 9% is. In the simple example below (Exhibit 1), we compare a rock-steady 8% annual return with a fairly erratic return stream that happens to average 9%.

Exhibit 1

	Portfolio A		Portfolio B	
	Annual Return	Account Balance	Annual Return	Account Balance
Beginning Balance		**$100**		**$100**
Year 1	8%	$108	23%	$123
Year 2	8%	$117	-14%	$106
Year 3	8%	$126	-7%	$98
Year 4	8%	$136	20%	$118
Year 5	8%	$147	16%	$137
Year 6	8%	$159	14%	$156
Year 7	8%	$171	-18%	$127
Year 8	8%	$185	27%	$162
Year 9	8%	$200	-2%	$158
Year 10	8%	$216	32%	$208
Ending Balance		**$216**		**$208**
Average Return	8.0%		9.0%	
Compound Annual Return	8.0%		7.6%	
Standard Deviation	0.0%		18.0%	

The 9%-return portfolio results in lower ending wealth than the 8%-return portfolio. It seems clear from this that there is demonstrable economic value in stability of returns. This can be quantified more generally.

The mathematically astute reader may recognize the difference between the 9.0% average return and the 7.6% compound annual return in Portfolio B of the above example as the difference between the arithmetic mean return (AMR) and the geometric mean return (GMR), respectively. GMR is the measure that corresponds to ending wealth, and so should be the measure most relevant to investors. It is a mathematical fact that, for a given return stream, GMR is always less than or equal to AMR. The difference between the two grows with volatility (a phenomenon some call "risk drag"), and a crude approximation formula is GMR ≈ AMR – V/2, where V is the variance (standard deviation squared) of the return stream (see note[2]).

Thus, if volatility can be dampened (i.e., if the V in the approximation formulas can be reduced), we can calculate the value added very directly, in terms of increased compound return (GMR) and, therefore, ending wealth.

Sequence Risk

Return stability has additional economic benefits. One relates to a phenomenon called "sequence risk." Sequence risk occurs when the specific sequence of periodic returns is such that it impairs the financial condition of the investor, relative to a more favorable sequence *of the same periodic returns*.

Suppose, for example, that a severe market downturn occurs immediately before the investor needs to make a significant portfolio withdrawal to cover a major living expense, such as a house purchase. This has worse long-term consequences than if the downturn occurred after the withdrawal. In the first case, the investor had to withdraw a larger percentage of the now-diminished portfolio than he/she would otherwise have needed to, leaving relatively fewer assets in the portfolio to enjoy any subsequent market recovery. In the second case, the withdrawal actually protected a meaningful part of the portfolio from harm, and the house was purchased with "pre-depreciated" assets.

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[2] See, for example, *Diversification, Rebalancing, and the Geometric Mean Frontier*, William J. Bernstein and David Wilkinson (1997) and *On the Relationship between Arithmetic and Geometric Returns,* Dimitry Mindlin (2011), which also offer the following approximations (using Excel notation):
GMR ≈ AMR – V / (2*(1 + AMR)), and
GMR ≈ (1 + AMR)*(1 + V*(1 + AMR)^(-2))^(-0.5) - 1
Another is:
GMR ≈ (1 + AMR)*(1 + V/(1 + AMR)^2)^((1-N)/(2*N)) - 1, where N is the number of compounding periods.

This phenomenon is illustrated by the following example (Exhibit 2), using the same "Portfolio B" we introduced in Exhibit 1. We have added Portfolio B1, which has the same periodic returns as Portfolio B, but they are sequenced differently so that the lowest returns occur first. We also have added Portfolio B2, in which the same periodic returns are sequenced in reverse order compared to Portfolio B1. In Scenario 1 of Exhibit 2, there are no flows into or out of the portfolio. Note that the ending balances for Portfolios B, B1, and B2 are all the same as in Exhibit 1 in this scenario. In Scenario 2, we introduce a $65 withdrawal at the beginning of year 5. The difference in ending balances among the three assets in this scenario is striking — in fact, Portfolio B1 is wiped out. This is sequence risk.

Exhibit 2

Scenario 1: No Portfolio Flows

	Portfolio B		Portfolio B1		Portfolio B2	
	Annual Return	Account Balance	Annual Return	Account Balance	Annual Return	Account Balance
Beginning Balance		**$100**		**$100**		**$100**
Year 1	23%	$123	-18%	$82	32%	$132
Year 2	-14%	$106	-14%	$70	27%	$168
Year 3	-7%	$98	-7%	$65	23%	$206
Year 4	20%	$118	-2%	$64	20%	$248
Year 5	16%	$137	14%	$72	16%	$288
Year 6	14%	$156	16%	$84	14%	$327
Year 7	-18%	$127	20%	$101	-2%	$319
Year 8	27%	$162	23%	$124	-7%	$296
Year 9	-2%	$158	27%	$158	-14%	$255
Year 10	32%	$208	32%	$208	-18%	$208
Ending Balance		**$208**		**$208**		**$208**

Scenario 2: $65 withdrawal at Beginning of Year 5

	Portfolio B		Portfolio B1		Portfolio B2	
	Annual Return	Account Balance	Annual Return	Account Balance	Annual Return	Account Balance
Beginning Balance		**$100**		**$100**		**$100**
Year 1	23%	$123	-18%	$82	32%	$132
Year 2	-14%	$106	-14%	$70	27%	$168
Year 3	-7%	$98	-7%	$65	23%	$206
Year 4	20%	$118	-2%	$64	20%	$248
withdrawal*		-$65		-$65		-$65
Year 5	16%	$62	14%	$0	16%	$212
Year 6	14%	$70	16%	$0	14%	$241
Year 7	-18%	$57	20%	$0	-2%	$235
Year 8	27%	$73	23%	$0	-7%	$219
Year 9	-2%	$71	27%	$0	-14%	$188
Year 10	32%	$94	32%	$0	-18%	$154
Ending Balance		**$94**		**$0**		**$154**

* Note that the $65 withdrawal represents 55% of Portfolio B at the time of the withdrawal, but over 100% of Portfolio B1, and only 26% of Portfolio B2. These relative differences are the essence of sequence risk.

Recent retirees with low non-portfolio income and high, early, lumpy expenses are particularly vulnerable to sequence risk.

There are a few ways to mitigate sequence risk. One is to have no flows — deposits or withdrawals — into or out of the portfolio (see note[3]). But this is patently unrealistic for most investors. Another way is to successfully avoid making withdrawals for a time after a significant decline in the portfolio's value. This might be accomplished by keeping a sizeable cash reserve outside the portfolio to cover this contingency. However, the size of the reserve necessary to achieve meaningful immunization against contingencies of unknown frequency and severity is large that the long-term "cash drag" on performance tends to outweigh the benefits, as a number of studies in the financial literature have demonstrated (see note[4]).

The most productive way to control sequence risk is to not have an erratic series of returns — the more stable the return stream, the less the sequence risk. A perfectly smooth return stream, such as that of Portfolio A in Exhibit 1, has precisely zero sequence risk. (This is a given, since all sequencings of identical periodic returns are indistinguishable from each other.) It does not matter when deposits or withdrawals occur in such a portfolio. While no practical RMI technique can totally eliminate return volatility, every step in that direction adds value from a sequence risk perspective.

To recap, the value of stability to mitigate sequence risk is very clear, and can be quantified using the approach in Exhibit 2.

Tax Effects

If the investments in question are in a taxable account, and the investor is subject (as in the U.S.) to a progressive tax rate structure, then there may be additional quantitative value in stability. Without getting into the vagaries of the tax code (and the treatment of different categories of gains and income, let alone deductions, loss carry-forwards, etc., etc.), this value

[3] By the way, we have found that this is not well understood, even by professional investors. If there are no flows into or out of the portfolio, the sequence of returns does not matter — there is no effect on ending wealth. This should be clear from Scenario 1 of Exhibit 2. In fact, you can rearrange the sequence of returns in any way you like, and you will get the identical end result.

[4] See, for example, "Sustainable Withdrawal Rates: The Historical Evidence on Buffer Zone Strategies" by Walter Woerheide and David Nanigan, *Journal of Financial Planning*, May 2012; and "Research Reveals Cash Reserve Strategies Don't Work... Unless You're A Good Market Timer" by Michael Kitces, *Retirement Planning*, June 2012.

is readily appreciated by considering that downward deviations in investment returns save less in avoided tax liabilities than upward deviations generate in additional tax liabilities. The example below (Exhibit 3) illustrates this effect, using two three-year return streams that each total the same pre-tax amount — one stable, and one volatile. The stable return stream generates a higher after-tax result.

Exhibit 3

	Stable Return Stream			**Volatile Return Stream**		
	Investment Gain	**Income Tax**	**Net Result**	**Investment Gain**	**Income Tax**	**Net Result**
Year 1	$100	$15	$85	$100	$15	$85
Year 2	$100	$15	$85	$50	$5	$45
Year 3	$100	$15	$85	$150	$30	$120
3-Year Total	**$300**	**$45**	**$255**	**$300**	**$50**	**$250**

hypothetical tax rate table:

10%	of first	$50
20%	of next	$50
30%	of excess	

Since tax effects are very specific to each individual, generic quantification cannot be done. All that can be said in a tax context is that the economic benefit provided by stability is non-negative, and can be considered "icing on the cake."

Institutional Investor Perspectives

There are a number of quantitative studies of institutional investor behavior that support the premise that return stability adds economic value.

The Casualty Actuarial Society (see note[5]) has attempted to quantify the value of risk management in a number of ways. We will not recite the various methodologies here, but suffice it to say that the notion of risk management providing economic value is rigorously established.

[5] See, for example, *Assessing the Value of Risk Reduction*, Gary Venter and Alice Underwood, Casualty Actuarial Society (2014).

In studies conducted by the international consulting firm Towers Perrin (see note[6]), it was documented that publicly traded companies that exhibited stable earnings enjoyed higher relative market valuations than companies that did not, even after normalizing for other valuation drivers such as return on capital and earnings growth. This, despite the conventional notion that such stability is not assigned positive value by the market under the premise that single-company volatility can be diversified away.

These studies, and others like them, repeatedly demonstrate that knowledgeable investors indeed place measurable value on volatility dampening.

Quantitative Considerations — Downside Protection

If more stable returns — which enjoy both upside and downside volatility dampening — add demonstrable value, then it stands to reason that a return stream with strictly downside dampening should add even more value, as upside variations remain unimpeded. This proposition is dealt with in the balance of this paper.

Return Asymmetry

Let's start very simply. It is a well-known but underappreciated fact that positive and negative returns are asymmetric — that is, every -1% decline requires greater than a +1% recovery to get the investor back to break-even. On an initial investment of $100, for example, a -10% loss (to $90) requires a subsequent +11% gain ($100/$90 – 1) to get back to $100. The larger the percentage, the more pronounced the asymmetry. This is generalized in the following table (Exhibit 4).

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[6] See, for example *RiskValueInsights: Creating Value Through Enterprise Risk Management*, a Tillinghast—Towers Perrin monograph (2002).

Exhibit 4

negative return	necessary offsetting positive return
-10%	+11%
-20%	+25%
-30%	+43%
-40%	+67%
-50%	+100%

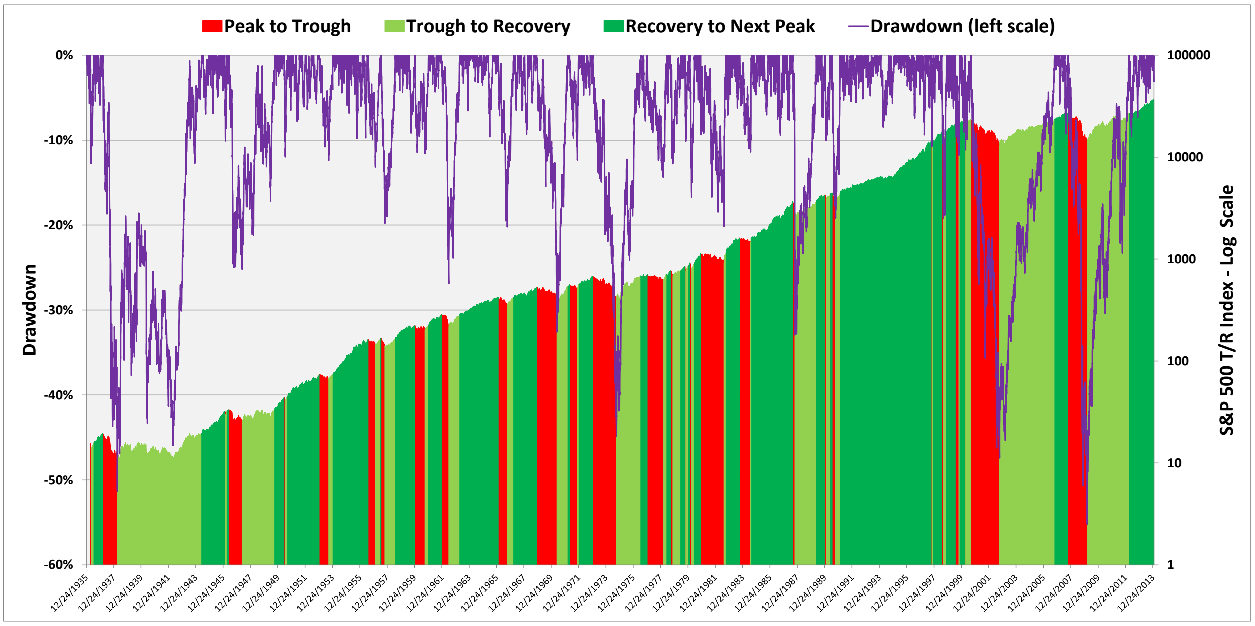
The immediate takeaway from this observation is that **it is more valuable to avoid a decline than it is to capture a gain of the same magnitude**. This has major ramifications, which we explore below.

A Look at Equity Market History

The capital markets are characterized by recurring periods of decline and recovery. Taking the U.S. equity market, as represented by the S&P 500 Total Return Stock Index, as our example in this section, the long-term average annual return is approximately +10.5%. This overall upward tendency has been interrupted fairly often by periods of substantial decline.

As the Appendix and Exhibit 5 below show, over the 78-year period from the beginning of 1936 through the end of 2013, there have been 29 separate, non-overlapping episodes of market declines that were each worse than -10%. Note that this equates to a frequency of once every 2.7 years, on average.

Exhibit 5



The average decline during those peak-to-trough periods (the red regions of Exhibit 5) has been approximately -21%, and the average episode has persisted for about eight months. Representatively, the subsequent trough-to-peak upswing (the combined light- and dark-green regions of the exhibit) has been roughly +65% cumulatively, and has lasted around 24 months (i.e., before the next -10%-or-worse downswing began) (see note[7]). Assuming a $100.00 initial investment in this market at the beginning of a representative downdraft, it would decline to $79.00 over the first eight months, and then rebound to $130.35 over the next 24 months. Note, as a consistency check, that these figures are consistent with a long-term annual average return of approximately +10.5%, as cited above (see note[8]).

Quantifying the Impact of RMI Strategies

Now let's consider a downside RMI strategy that succeeds in modestly reducing the decline on the initial $100.00 investment, from -21% to -15.5% (i.e., by half the excess decline beyond -10%), net of the cost of the strategy. In that case, if the subsequent +65% upturn is unimpeded,

[7] Does the average 32-month term of the full cycle sound short? It initially did to us. But if it were any longer, there could not have been 29 of them in the last 78 years.
[8] Using Excel notation: ((1 - 0.21)*(1 + 0.65))^(12/(8+24)) - 1 ≈ 0.105.
Alternatively, ($130.35/$100.00) ^(12/(8+24)) - 1 ≈ 0.105

the result after the full 32-month cycle would be $139.43, a much better result than $130.35, and one that would imply a long-term average annual return of +13.3% instead of +10.5%.

Here is the interesting, and most practical, part. It is unrealistic to assume that an RMI strategy could successfully reduce the downside, however modestly, and not have some cost, in terms of a performance drag on the upside. The simple 32-month model above gives us an excellent way to estimate how large that upside performance drag could be without negating the benefit of the downside protection. Specifically, if the 8-month decline on the $100.00 investment is -15.5% (net of the cost of the strategy) instead of -21%, then the subsequent 24-month bull market run need only be +54.3% cumulatively instead of +65% to achieve the breakeven value of $130.35.

What does the above result mean in terms of the annual tolerable cost? Well, the annualized version of the +65% 24-month return is +28.5%, while the annualized version of the +54.3% return is +24.2%. The difference is 425 basis points. So, finally, here is the result we've been seeking: **an RMI strategy that reduces only large declines in the equity markets (i.e., those worse than -10%), and reduces them only modestly (i.e., by half their excess beyond -10%), adds measurable value as long as its cost (i.e., its performance drag during bull markets) does not exceed 425 basis points per annum.** This kind of RMI strategy is not a stretch by any means — it is quite realistically achievable. RMI strategies such as this seem well worth pursuing.

To give some additional texture to this result, consider an RMI strategy that reduces the impact of portfolio downturns by 50% of the excess downturn beyond -10% (as in the example above) whose cost amounts to an annual performance drag of 325 basis points — that is, 100 basis points better than the 425 basis point breakeven level derived above. And consider its impact over the investment horizon of a newly-married couple just leaving college. The probability of at least one spouse living into his/her late nineties is sizeable enough that prudent financial planning should consider a horizon of 75 to 80 years. If these years are anything like the last 78 years, every dollar invested by the newlyweds in the RMI portfolio will have grown to roughly *twice* as much as it would have in a non-RMI portfolio over that horizon.

Generalizing the Results

Rounding out the analysis, below is a table (Exhibit 6) showing the tolerable cost of other theoretical RMI strategies that have varying levels of impact on mitigating downturns. To generate this table, we used the same simple 32-month model that we introduced in the previous section.

Exhibit 6

RMI downside impact*	typical market decline	effective decline	tolerable cost** (in bps)
25%	-21%	-18.3%	**218**
50%	-21%	-15.5%	**425**
75%	-21%	-12.8%	**622**
* portion of excess decline beyond -10% mitigated by RMI strategy, net of the cost of the strategy ** in terms of annual performance drag in bull markets			

It may seem less than rigorous to pin such an important conclusion on such a simple model of market reality. We agree. It can be dangerous to apply an operation to an *average input* and expect the result to be representative of what you are really after, which is the *average result* obtained by applying the operation to each input separately. This has been referred to as the "flaw of averages" (see note[9]). Therefore, in the Appendix, we take a much more painstaking approach to the issue, by building a detailed model using actual daily returns of the S&P index cited above. There, we apply the same RMI strategies as above to each of the 29 peak-to-trough-to-peak cycles in the S&P 500 Total Return Index history (each cycle with its own unique

[9] See, for example, *The Flaw of Averages: Why We Underestimate Risk in the Face of Uncertainty*, Sam Savage, Wiley (2012), in which examples are cited such as how one can drown in a river with an average depth of three feet, and why a drunk staggering down the middle of a busy highway remains alive if you consider only his average position.

period and magnitude), and across a variety of investment horizons. Naturally, this approach leads to a range of tolerable costs (see note[10]), which are summarized in Exhibit 7 below.

Exhibit 7

RMI downside impact*	typical market decline	effective decline	range of tolerable cost** (in bps)
25%	-21%	-18.3%	**150 - 356**
50%	-21%	-15.5%	**294 - 669**
75%	-21%	-12.8%	**433 - 948**

* portion of excess decline beyond -10% mitigated by RMI strategy, net of the cost of the strategy
** in terms of annual performance drag in bull markets; range is determined as the 25th to 75th percentile of the rolling five-period results, as derived in the Appendix

As you can see, the results in Exhibit 7 are entirely consistent with those of Exhibit 6. In our judgment, the quantification is robust and can be relied upon. Having said that, we want to remind readers that there were, in fact, outlier episodes with results beyond these ranges, and there is no guarantee that the next episode will not be another outlier.

Please note that the tolerable cost estimates derived in this section are conservative. They do not give any consideration to other beneficial effects outlined earlier in this paper, such as sequence risk mitigation, tax effect considerations, containment of fear, peace of mind, and quality of life. Explicitly considering these benefits would make the tolerable costs higher still. In particular, as we've noted, helping investors find the fortitude to stay true to their long-term allocation to risk assets during turbulent times may deliver the biggest benefit of all, and therefore support a tolerable cost well beyond those we've attempted to directly quantify.

It is possible to generalize the results further. There are many ways to characterize the impact of an RMI strategy. We have chosen to use for illustration a measurement based on mitigating — to various degrees — an equity market decline beyond a -10% threshold. Other decline thresholds might be chosen and the quantification would proceed precisely along the lines we

[10] For example, an episode with a shallow decline below -10% and an exceptionally long subsequent bull market period would lead to a tolerable cost that would be at the low end of the range.

have outlined above (see note[11]). Some RMI techniques, however, may not lend themselves to measurement along those lines. For example, some may follow the same general risk management approach (i.e., protection beyond a threshold), but their impact may be less precise or certain than implied above. Those situations can easily be modeled following our example — that is, by applying the strategy directly to the relevant historical episodes and deriving the tolerable performance drag during the succeeding or preceding bull market period. Whichever way a particular RMI strategy may deliver its mitigating effect, we hope our quantification approach provides a rough roadmap to measuring the economic value of that effect.

Summary and Conclusions

Let's return to our fundamental questions, and recap our answers to them.

Why should I consider RMI? We uncovered a number of qualitative reasons to strongly consider RMI. Whether the RMI strategies under review have impact on dampening portfolio volatility, limiting downside potential, or both, these reasons include predictability, peace of mind, fortitude to fight inflation with higher-risk assets, freedom to take other prudent chances in life and career, success in mitigating sequence risk, and opportunity to minimize tax effects. Sophisticated institutional investors concur that RMI has material value. We also documented an array of quantitative analyses to demonstrate the value of RMI.

How much should I be willing to pay for RMI? The detailed quantitative modeling we have done indicates that a cost of several hundred basis points per year, in terms of performance drag during bull markets, is justified by RMI. The tolerable cost can be calibrated specifically, depending on the mitigating impact a particular RMI strategy may have on downside market moves. The non-quantified, but very real, qualitative benefits outlined above render this calibration conservative.

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[11] Directionally, at least, those results can be predicted. At the risk of stating the obvious, a threshold of -5% instead of -10%, for example, would lead to higher tolerable cost levels, while a threshold of -15% would result in lower levels.

If I have a long-term investment horizon and little concern for short-term volatility, is RMI even relevant to me? In a word, yes. Even the most aggressive investor, who does not customarily view investments through a risk-management lens, should be interested in an approach that increases long-term returns, as RMI can. Moreover, since the value of RMI is realized most fully over several bull-and-bear market cycles, the longer an investor's investment horizon, the more value is potentially added by RMI.

We hope that, with this paper, we have helped establish a solid foundation for the fair evaluation of products and solutions that have been, and will be, brought to market in this important area.

Based on our work to date, it is our firm conclusion that RMI should be utilized as a potent weapon in the arsenal of every serious investment professional.

APPENDIX — Historical Model

To provide the raw data to support the quantitative analyses of downside protection, we compiled the history of one of the longest-recorded and most-closely-followed risk assets, U.S. large-cap stocks, as measured by the S&P 500 Total Return Index (see note[12]). In Exhibit 8, below, we reproduce the graph we introduced in Exhibit 5, and include below it a table which contains key information on each of the 29 episodes (shaded red in the graph) during which the index suffered a drawdown of -10% or worse. Specifically, for each episode, we note the date of the local peak of the index; the index value at that peak; the date of the subsequent local trough (i.e., after the -10%-or-worse decline); the index value at that trough; the length of drawdown (peak-to-trough) period; the percentage drawdown; the date of recovery (when the index re-achieves its prior peak); the length of that recovery period; the recovery percentage; the date of the next local peak (i.e., just prior to its beginning its next -10%-or-worse decline); the index value at that peak; the length of cyclical bull (trough-to-peak) period; and, finally, the percentage increase during the bull period. Note that the recovery period is a subset of the bull period (in terms of the graph, the recovery period is shaded light green, and the bull period is the combined light- and dark-green-shaded sections). Note also that the figures in red at the end of the table denote that the final bull period is not yet complete — we simply terminated the series at 12/31/2013.

The detailed table in Exhibit 8 allows the evaluation of any number of RMI strategies; we can apply a given RMI strategy to each episode separately, calculate its impact, summarize the results over several episodes, and draw conclusions.

Consistent with the main text, let's first focus on an RMI strategy that is successful in reducing the impact of a drawdown by half of its extent beyond -10%, net of the cost of the strategy. For example, a -30% drawdown would be reduced to -20%, a -20% drawdown would be reduced to -15%, and a -10% drawdown would be reduced not at all and remain at -10%. In Exhibit 9, we apply this strategy to each of the 29 episodes. It is a straightforward matter to then calculate

[12] Source: Bloomberg

the tolerable performance drag during the subsequent bull period of each episode, such that the resulting performance over the episode's full cycle is no worse than would have been the case without the RMI strategy. These calculations are spelled out in the notes to Exhibit 9. Column H of the exhibit shows the tolerable performance drag for each episode in isolation. Since the length of each episode's full cycle is generally much shorter than a typical investor's investment horizon, we show the results of successive rolling-five-episode periods in column I. From column I, we derive the 25th and 75th percentiles shown in Exhibit 7 of the text.

We performed similar analyses for RMI strategies that provide different levels of protection (namely, 25% and 75%) of the drawdown below -10%. These calculations are not reproduced here, but are straightforward versions of those just described, and the results are summarized in Exhibit 7 of the text.

Note that we have not included an RMI strategy that protects 100% of the downside below -10%. This is because we believe it is a practical impossibility. While a 10%-out-of-the-money put option on the S&P 500 Total Return Index may appear to provide such protection, it does not. To provide true 100% protection against any drawdown worse than -10%, the put strike would need to be revised upwards each day that the index rises above its prior peak. Furthermore, any time that the put was exercised (and, to provide true 100% protection, it would need to be exercised immediately on the day that the index falls -10% from its prior peak), it would need to be replaced seamlessly with another put, but this put would need be at-the-money. The chance of needing to exercise that put in the near future is almost a certainty — at which point it would need to be replaced with another at-the-money-put, and so on. Aside from being extremely expensive, this method of protection is not feasible as a practical matter. In contrast, RMI strategies that deliver protection of less than 100% are indeed feasible — examples include the tail risk hedges described in "Integrated Tail Risk Hedging: The Last Line of Defense in Investment Risk Management" (see note[13]).

It may be instructive to graph some key results.

[13] *Journal of Financial Planning*, June 2012

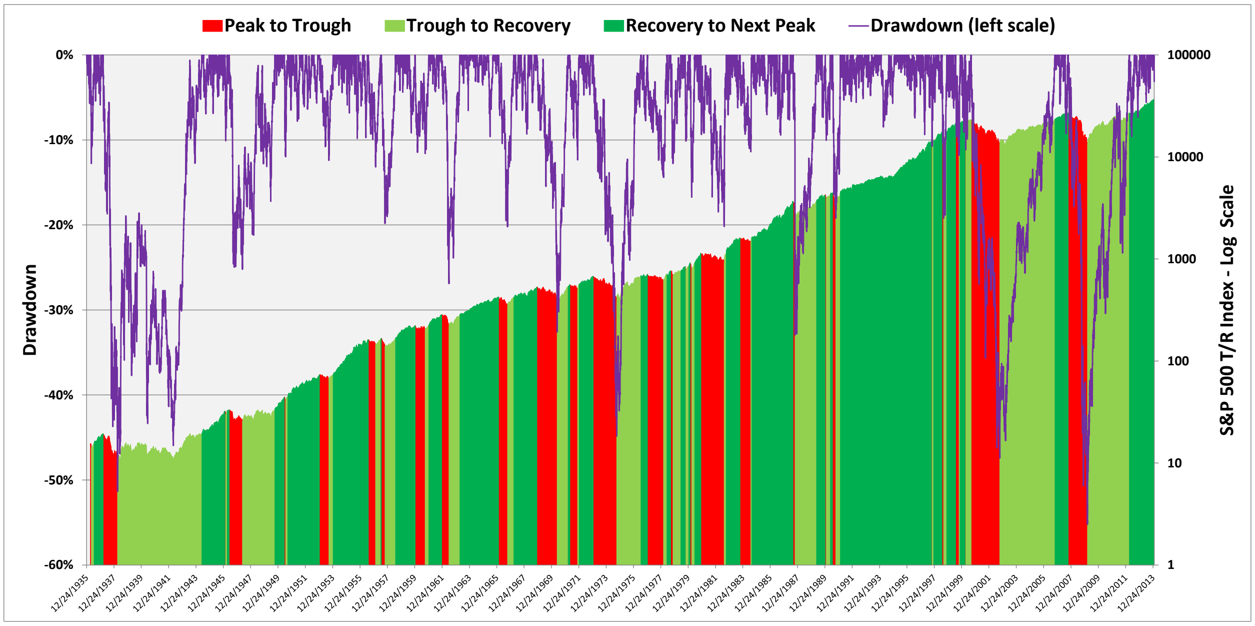
In the text (and in Exhibit 6), we estimated that a particular RMI strategy — i.e., one that reduces equity market declines by half of the excess decline below -10% — adds value as long as its "cost" (performance drag during bull markets) does not exceed 425 basis points per annum.

Exhibit 10 shows the "payoff profile" (see note[14]) of such an RMI strategy whose cost is precisely 425 basis points. On the left side of the graph, we plot — for each of the 29 drawdowns in our historical record — the net returns of a portfolio with this RMI strategy (in red), compared to the corresponding returns of the same portfolio without the strategy (in blue). On the right side of the graph, we plot — for each of the 29 subsequent bull periods — the annualized returns of the corresponding portfolios.

In our final graph, in Exhibit 11, we show the cumulative performance (on log scale) of the same two portfolios described immediately above.

[14] The "payoff profile" graph is commonly used in visualizing various option strategies (calls, puts, collars, straddles, etc.), and we assume the reader is familiar with its interpretation.

Exhibit 8



Episode	Date of local peak	Index at peak	Date of local trough	Index at trough	Length of drawdown period (in trading days)	Drawdown %	Date of recovery (achieve prior peak)	Length of recovery period	Index at Recovery	Recovery %	Date of next peak before a 10% drawdown	Index at next peak	Length of cyclical bull period	Trough to peak increase %
1	4/6/1936	15.6	4/29/1936	13.6	16	-12.8%	7/10/1936	52	15.6	14.7%	3/10/1937	19.5	216	43.9%
2	3/10/1937	19.5	3/31/1938	9.5	267	-51.3%	5/31/1944	1543	19.6	106.1%	2/5/1946	32.3	1960	239.9%
3	2/5/1946	32.3	2/26/1946	29.0	13	-10.1%	4/8/1946	29	32.3	11.4%	5/29/1946	33.4	65	15.1%
4	5/29/1946	33.4	5/19/1947	25.0	243	-25.2%	9/30/1949	595	33.7	34.8%	6/12/1950	44.6	766	78.4%
5	6/12/1950	44.6	7/17/1950	39.2	24	-12.0%	9/13/1950	41	44.9	14.4%	1/5/1953	73.9	615	88.2%
6	1/5/1953	73.9	9/14/1953	64.7	176	-12.4%	1/6/1954	76	73.9	14.2%	8/2/1956	162.5	726	151.2%
7	8/2/1956	162.5	2/12/1957	141.1	132	-13.2%	7/3/1957	98	164.4	16.5%	7/15/1957	166.7	105	18.1%
8	7/15/1957	166.7	10/22/1957	133.6	70	-19.8%	7/31/1958	195	166.7	24.8%	1/5/1960	224.2	554	67.7%
9	1/5/1960	224.2	9/28/1960	198.2	186	-11.6%	1/4/1961	66	224.3	13.2%	12/12/1961	285.4	302	44.0%
10	12/12/1961	285.4	6/26/1962	208.7	135	-26.9%	4/15/1963	201	285.5	36.8%	2/9/1966	423.3	913	102.9%
11	2/9/1966	423.3	10/7/1966	337.7	167	-20.2%	3/23/1967	114	423.7	25.5%	11/29/1968	533.0	516	57.8%
12	11/29/1968	533.0	5/26/1970	359.3	369	-32.6%	3/15/1971	203	538.5	49.9%	4/28/1971	561.6	234	56.3%
13	4/28/1971	561.6	11/23/1971	492.2	146	-12.4%	1/5/1972	29	565.6	14.9%	1/11/1973	679.0	285	38.0%
14	1/11/1973	679.0	10/3/1974	374.8	436	-44.8%	7/9/1976	446	680.7	81.6%	12/31/1976	711.2	567	89.8%
15	12/31/1976	711.2	3/6/1978	608.8	296	-14.4%	6/6/1978	64	712.2	17.0%	9/12/1978	769.1	132	26.3%
16	9/12/1978	769.1	11/14/1978	670.8	45	-12.8%	6/12/1979	144	770.2	14.8%	10/5/1979	848.3	225	26.5%
17	10/5/1979	848.3	10/25/1979	762.4	14	-10.1%	1/10/1980	52	849.7	11.5%	2/13/1980	919.8	76	20.6%
18	2/13/1980	919.8	3/27/1980	766.0	30	-16.7%	6/18/1980	57	920.1	20.1%	11/28/1980	1140.4	170	48.9%
19	11/28/1980	1140.4	8/12/1982	910.4	430	-20.2%	10/7/1982	39	1156.0	27.0%	10/10/1983	1621.9	294	78.1%
20	10/10/1983	1621.9	7/24/1984	1437.4	199	-11.4%	8/21/1984	20	1638.7	14.0%	8/25/1987	3681.9	781	156.1%
21	8/25/1987	3681.9	10/19/1987	2469.4	38	-32.9%	5/15/1989	397	3684.3	49.2%	1/2/1990	4279.4	557	73.3%
22	1/2/1990	4279.4	1/30/1990	3849.5	20	-10.0%	5/21/1990	77	4316.6	12.1%	7/16/1990	4469.4	115	16.1%
23	7/16/1990	4469.4	10/11/1990	3611.4	62	-19.2%	2/11/1991	84	4562.1	26.3%	10/7/1997	14487.9	1767	301.2%
24	10/7/1997	14487.9	10/27/1997	12930.2	14	-10.8%	12/5/1997	28	14539.0	12.4%	7/17/1998	17695.3	181	36.9%
25	7/17/1998	17695.3	8/31/1998	14299.7	31	-19.2%	11/23/1998	59	17813.3	24.6%	7/16/1999	21447.4	220	50.0%
26	7/16/1999	21447.4	10/15/1999	18916.8	64	-11.8%	11/16/1999	22	21558.6	14.0%	3/24/2000	23286.9	111	23.1%
27	3/24/2000	23286.9	4/14/2000	20693.0	15	-11.1%	9/1/2000	97	23304.4	12.6%	9/1/2000	23304.4	97	12.6%
28	9/1/2000	23304.4	10/9/2002	12254.8	525	-47.4%	10/23/2006	1017	23352.7	90.6%	10/9/2007	27030.4	1258	120.6%
29	10/9/2007	27030.4	3/9/2009	12105.0	355	-55.2%	4/2/2012	774	27065.3	123.6%	12/31/2013	36636.9	1213	202.7%

Exhibit 9

	A	B	C	D	E	F	G	H	I
Episode	Drawdown %	Adj'd Drawdown %	Trough to peak increase %	Adj'd (breakeven) trough to peak increase %	Length of cyclical bull period	Annualized Trough to peak increase %	Annualized Adj'd (breakeven) trough to peak increase %	breakeven cost in bps p.a.	rolling 5-period avg
1	-12.8%	-11.4%	43.9%	41.6%	216	52.4%	49.6%	275	
2	-51.3%	-30.7%	239.9%	138.6%	1960	16.9%	11.7%	516	
3	-10.1%	-10.1%	15.1%	15.1%	65	72.0%	71.6%	39	
4	-25.2%	-17.6%	78.4%	61.9%	766	20.8%	17.0%	376	
5	-12.0%	-11.0%	88.2%	86.1%	615	29.3%	28.7%	59	253
6	-12.4%	-11.2%	151.2%	147.8%	726	37.3%	36.7%	64	211
7	-13.2%	-11.6%	18.1%	16.0%	105	48.6%	42.3%	628	233
8	-19.8%	-14.9%	67.7%	58.1%	554	26.3%	22.9%	334	292
9	-11.6%	-10.8%	44.0%	42.7%	302	35.2%	34.2%	100	237
10	-26.9%	-18.4%	102.9%	81.9%	913	21.4%	17.8%	358	297
11	-20.2%	-15.1%	57.8%	48.3%	516	24.7%	21.0%	369	358
12	-32.6%	-21.3%	56.3%	33.9%	234	61.1%	36.6%	2457	724
13	-12.4%	-11.2%	38.0%	36.1%	285	32.6%	31.1%	154	688
14	-44.8%	-27.4%	89.8%	44.3%	567	32.6%	17.5%	1510	970
15	-14.4%	-12.2%	26.3%	23.2%	132	55.7%	48.4%	731	1044
16	-12.8%	-11.4%	26.5%	24.5%	225	29.8%	27.5%	226	1016
17	-10.1%	-10.1%	20.6%	20.6%	76	85.4%	84.9%	44	533
18	-16.7%	-13.4%	48.9%	43.1%	170	79.5%	69.4%	1014	705
19	-20.2%	-15.1%	78.1%	67.5%	294	63.4%	55.0%	835	570
20	-11.4%	-10.7%	156.1%	154.2%	781	35.1%	34.8%	33	430
21	-32.9%	-21.5%	73.3%	48.0%	557	28.0%	19.2%	875	560
22	-10.0%	-10.0%	16.1%	16.1%	115	38.3%	38.3%	7	553
23	-19.2%	-14.6%	301.2%	279.6%	1767	21.7%	20.8%	95	369
24	-10.8%	-10.4%	36.9%	36.3%	181	54.2%	53.3%	89	220
25	-19.2%	-14.6%	50.0%	41.9%	220	58.5%	48.9%	965	406
26	-11.8%	-10.9%	23.1%	21.9%	111	59.7%	56.1%	361	304
27	-11.1%	-10.6%	12.6%	11.9%	97	35.8%	33.6%	222	346
28	-47.4%	-28.7%	120.6%	62.7%	1258	17.0%	10.2%	687	465
29	-55.2%	-32.6%	202.7%	101.1%	1213	25.6%	15.5%	1015	650

Notes to Exhibit 9:

- Columns A, C, and E are from Exhibit 8
- Column B is derived by applying the RMI strategy to column A
- Column D is calculated as (using Excel notation): (1+C)*((1+A)/(1+B))-1
- Columns F and G are annualized versions of columns C and D, respectively. E.g., column F is calculated as: (1+C)^(250/E), since there are approx. 250 trading days per annum
- Column H is the difference between columns F and G, expressed in terms of basis points per annum
- Column I is the rolling-five-episode average of column H

Exhibit 10

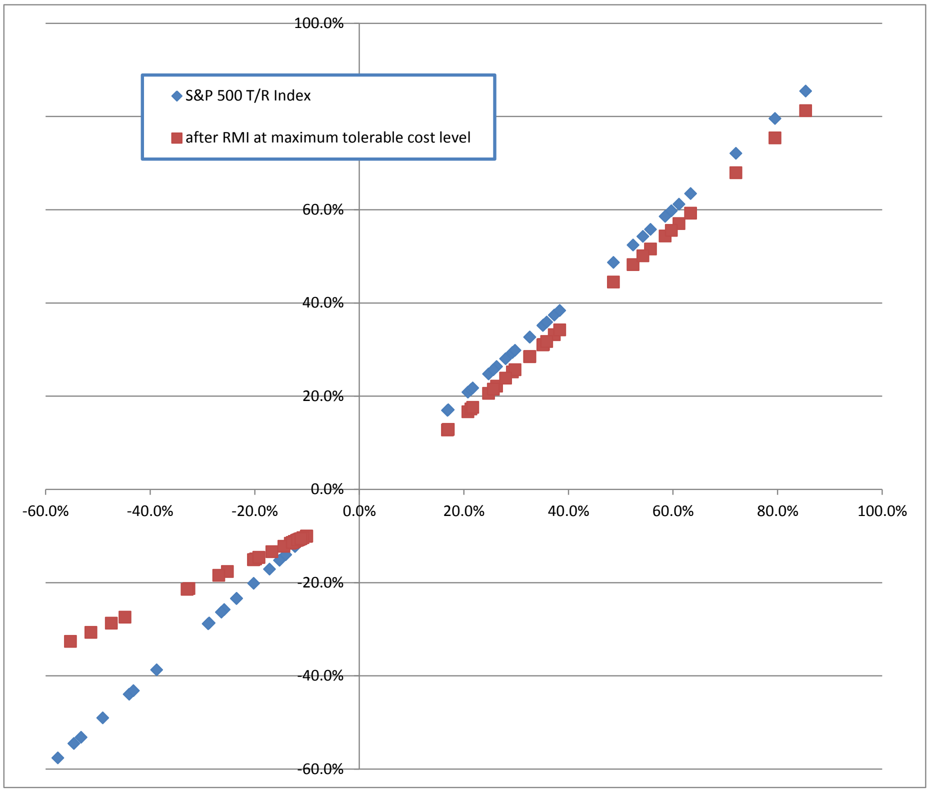
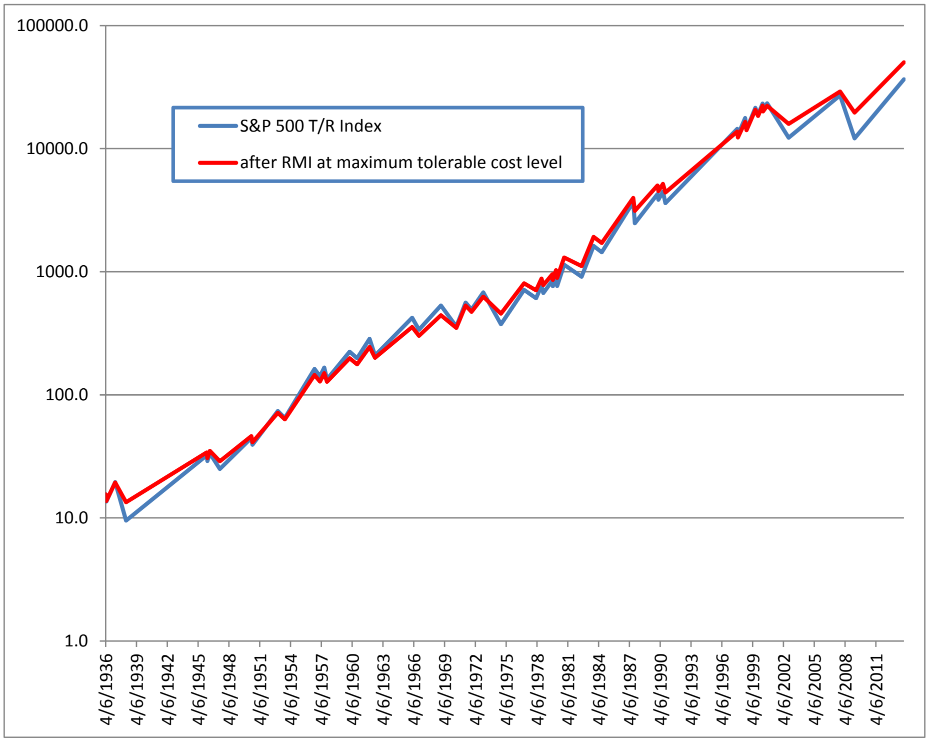


Exhibit 11



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