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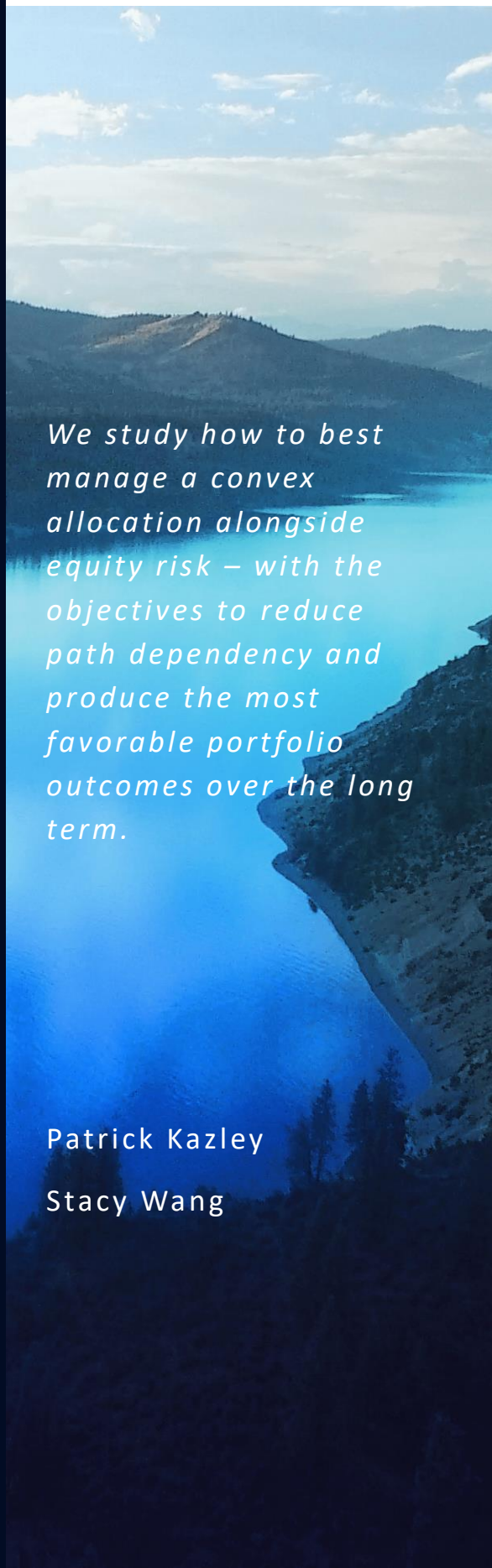
ASSET MANAGEMENT

The Convexity (Re)Balancing Act

How and When to Cash in Your Portfolio Insurance



We study how to best manage a convex allocation alongside equity risk – with the objectives to reduce path dependency and produce the most favorable portfolio outcomes over the long term.

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Introduction: When to Hold 'em, When to Fold 'em

You've got to know when to hold 'em
Know when to fold 'em
Know when to walk away
And know when to run…

Perhaps Kenny Rogers was a vol trader at heart. Managing a long convexity position during a market crisis is not dissimilar from high-stakes Texas Hold'em. As market conditions go from unstable to panicked, a hedged investor tends to struggle with decision-making as it relates to when to "hold", or continue to ride out their hedges that have just risen (meteorically) in value, versus when to "fold", by reallocating the proceeds of their hedge into lower-priced equities.

Beyond the *when* of it, there's also the *how* of it. Should an investor "walk" their position down and reduce their hedge gradually, or perhaps "run" away by reducing all or most of their hedge at certain thresholds? It's a delicate (re)balancing act.

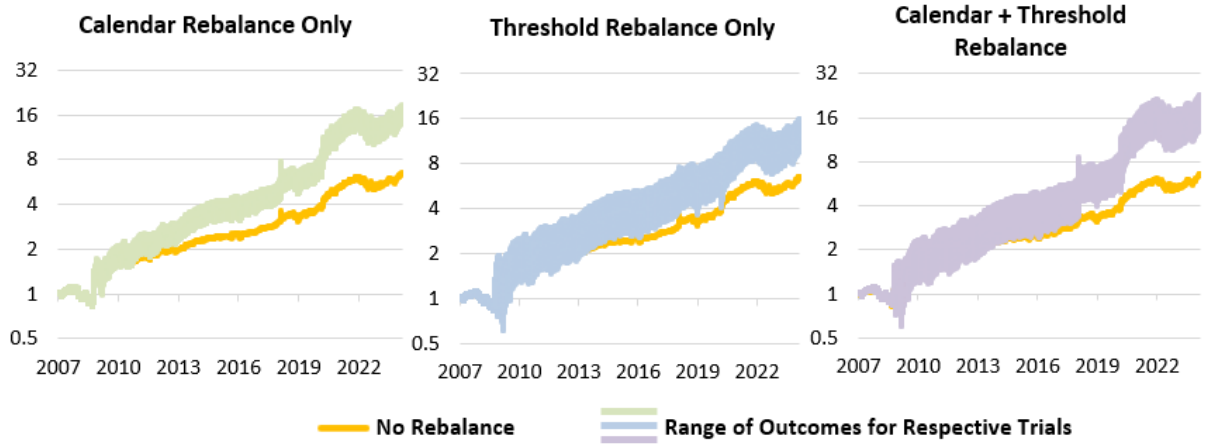
An investor who is long convexity heading into a crisis has made a bet with a portion of their portfolio to hedge market risk (e.g., through a long volatility allocation or long equity puts). However, when that crisis finally arrives, short-term concerns tend to drive decision-making instead of long-term objectives. Thus, even those prepared for a crisis with a healthy allocation to convex strategies find themselves in reactionary decision-making about how and when to take profit before buying back into the market at cheaper prices.

In this paper, we cover best practices for implementing convex allocations for the broader portfolio, and we further study how different rebalancing programs impact long-term portfolio outcomes. In the study, we ran hundreds of trials across an array of rebalancing design choices. More precisely, we explore these rebalancing programs:

1. Recurring **Calendar-based** program, rebalancing to reinforce a strategic weight between the hedge and the market,
2. **Threshold-based** program, using the hedge performance to decide when and how to cut the hedge and buy equities,
3. A combination of **Calendar-and-Threshold-based** parameters, and
4. **No Rebalancing**, permitting the market and hedge exposure to drift over time as the result of each sleeve's performance.

Exhibits 1 and 2 and **Table 1** below summarize the outcomes across hundreds of trials for these rebalancing programs using a derivatives-based overlay portfolio of a 100% market exposure (S&P 500), plus 100% convex exposure (here our Dynamic Convexity strategy, later we test other hedges). The specific parameters for the various scenarios are covered later in this paper.

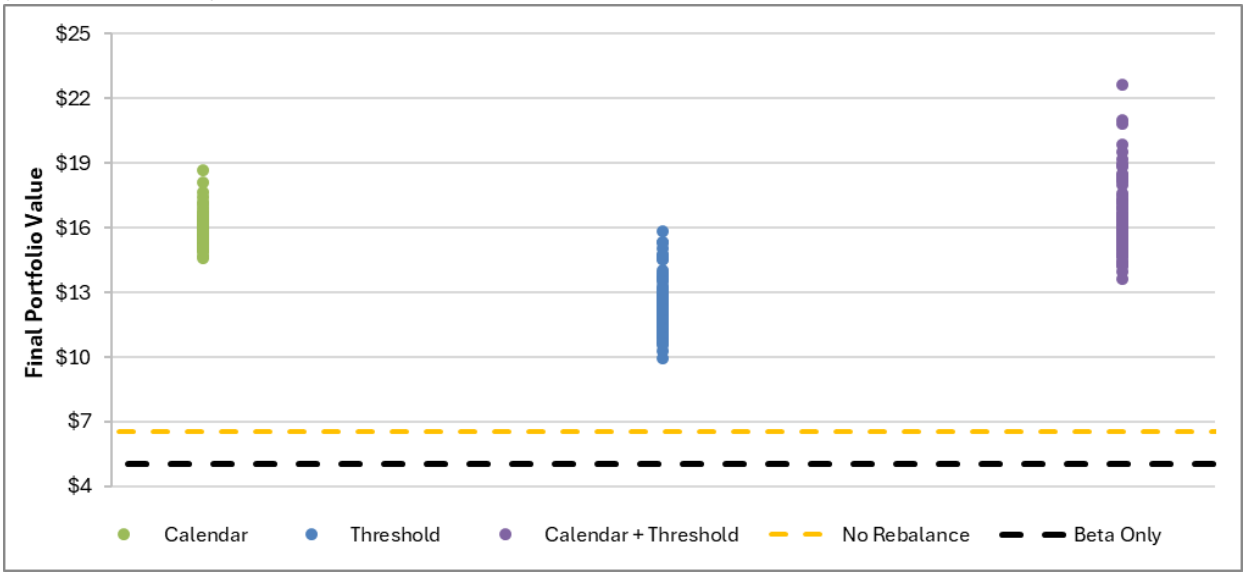
Exhibit 1: Cumulative Growth of $1 Combination Portfolios (S&P 500 + Dynamic Convexity) by Rebalancing Type (Jan 2007 – Feb 2024) Log-Scaled, across Numerous Rebalance Parameters[1]



Source: One River, Bloomberg. Past performance is not a guarantee of future results.

[1]The S&P 500 returns used are the S&P 500 Total Return Index. The One River returns use live gross returns when possible, and backtested gross returns when necessary. Dynamic Convexity begins live returns in April 2015. Performance before those strategy inception dates is backtested, and subject to normal backtest limitations. Please see the methodology portion of this paper for the specific design choices behind each rebalancing type. Please see important disclaimers in the appendix. Past performance is not a guarantee of future results.

Exhibit 2: Final Portfolio Values from Exhibit 1 Across Various Trials by Rebalancing Type: Growth of $1 (Jan 2007 – Feb 2024)



Source: One River, Bloomberg. Past performance is not a guarantee of future results.

Table 1: Summary Statistics of S&P Combination Portfolios (S&P 500 + Dynamic Convexity) and Average Return Outcomes (Jan 2007 – Feb 2024)

S&P - Dynamic Convexity	Calendar Only	Threshold Only	Calendar + Threshold	No Rebal	S&P (Beta) Only
Average Final Value ($)	$15.89	$12.41	$16.49	$6.54	$5.06
Max Final Value ($)	$18.69	$15.82	$22.62		
Min Final Value ($)	$14.56	$9.96	$13.65		
Range of Final Values ($)	$4.13	$5.85	$8.98		
Standard Deviation	+/- $0.81	+/- $1.27	+/- $1.72		
Average Ann. Return	17.5%	15.8%	17.7%	11.6%	9.9%
Average Ann. Volatility	17.9%	17.9%	20.3%	12.2%	20.2%
Average Skew	7.2	0.3	6.4	3.3	-0.3
Average Max DD	-25.8%	-31.6%	-33.4%	-25.8%	-55.3%
Average Information Ratio	1.0	0.9	0.9	0.9	0.5
Average Sortino Ratio (ex-cash)	1.5	1.2	1.3	1.3	0.6

Source: One River, Bloomberg. Past performance is not a guarantee of future results.

From this, we can observe:

- Any and all rebalancing programs added material benefit versus **No Rebalancing**.
- **Calendar-based** rebalancing programs produce the most path-independent and generally better outcomes (lowest standard deviation of outcomes and generally higher final portfolio values).
- **Threshold-based** rebalancing programs have far more path dependency and tend to generate worse long-term outcomes.
- **Combining monthly-and-threshold-based** rebalancing can produce the highest absolute and average final portfolio values, while producing similar path-dependency to the pure threshold-based rebalancing.

As we will cover later on, we favor calendar-based rebalancing programs that are implemented by an investment manager. We generally find that more extreme threshold-based approaches (when combined with calendar-based approaches) produce compelling results and are also more likely to be adhered to in a crisis, considering investor tendencies to actively manage hedges in crisis periods.

Background: Capital-Efficiency and Rebalancing Matter

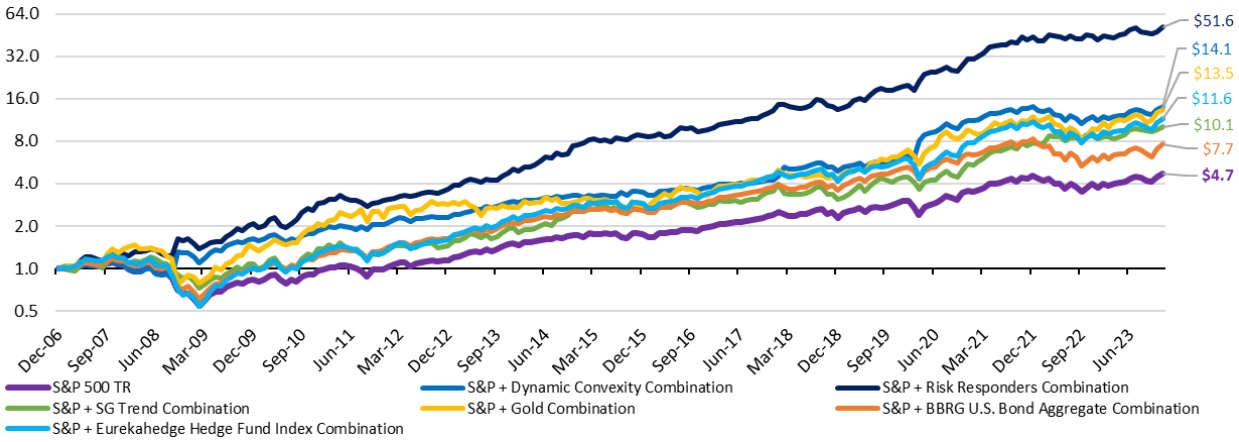
Convex return sources, when implemented through long volatility, tail hedge, or other explicitly defensive strategies, are usually regarded as portfolio insurance - designed to pay off handsomely in the event of a major market crisis, but otherwise necessarily carry negatively during benign markets. Since major market crises don't occur very often (or so we hope), the typical conclusion is that convex allocations help smooth out the ride for the total portfolio, but won't necessarily improve total portfolio returns as the long-term cost of the convex allocation should roughly equate to (or even outweigh) the crisis payouts.

In our most recent paper *Convexity, Correlation, and Compounding*, we challenged this assumption that convex allocations merely reduce drawdowns and smooth out the total portfolio experience. We further demonstrated that these allocations can meaningfully improve portfolio returns if they are implemented in a capital-efficient manner with rebalancing.

To benefit from both capital efficiency and rebalancing effects, we suggest using an overlay implementation to create a combination portfolio that pairs a diversifying return with a market beta (e.g., S&P 500). This means using one pool of capital to achieve both a 100% exposure to the market and 100% exposure to a diversifying return, such as a long volatility strategy, a convex multi-strategy program, trend following, gold, bonds, etc. This can be achieved using equity derivatives for the equity market exposure and derivatives-based implementation to overlay the diversifying return source.

Since the total margin required to put on a full exposure to the equity market and a derivative-based diversifying return is a low percentage of the total allocation, an investor can easily use one pool of capital to pursue growth (equity markets), diversification (long volatility or other diversifiers), and maximize rebalancing benefits that result from the inherent diversification between the sleeves. To study the effects of different rebalancing programs, we used these combination portfolios as test subjects for the various rebalancing programs. **Exhibit 3** below highlights the outcomes for these combination portfolios of the S&P 500 and various other returns, using only a monthly rebalancing schedule to reinforce a 100% exposure to both return sources over time, while allowing for performance-driven drift in between rebalances.

Exhibit 3: Cumulative Growth of $1 of S&P 500 vs. Combination Portfolios (S&P 500 + Overlay), Log-Scaled[2]
(Jan 2007 – Dec 2023)



Source: One River, Bloomberg. Past performance is not a guarantee of future results.

[2] The S&P 500 returns used are the S&P 500 Total Return Index. The gold returns used are the SPDR Gold Shares ETF. U.S. bonds returns used are the Bloomberg U.S. Aggregate Bond Index. The One River returns use live gross returns when possible, and backtested gross returns when necessary. The Risk Responders strategy combines Systematic Trend, Systematic Alternative Markets Trend, and Dynamic Convexity. The Systematic Trend fund begins live returns in April 2015, the Dynamic Convexity begins live returns in April 2015, and Alternative Markets Trend begins live performance in November 2019. Performance before those strategy inception dates is backtested, and subject to normal backtest limitations. Please see important disclaimers in the appendix. Past performance is not a guarantee of future results. The cumulative growth charts use a logarithmic y axis, because if one doesn't make this design choice, the more recent returns will appear to dominate the visual because of compounding effects. Log-scaling helps to neutralize this phenomenon.

Our findings from *Convexity, Correlation, and Compounding* were that negatively correlated and/or positively convex return sources paired most favorably with equity beta in a regularly rebalanced overlay program. More specifically, we found that combining convex returns with equities in a capital-efficient manner produced a material tailwind to long-term compounded returns. First, by naturally monetizing convexity proceeds into cheap equities on the backs of crisis periods, and second, by capitalizing on the negative correlation over time as the two exposures outperformed at disparate times and rebalanced harmoniously into one another. Conversely, we found that positively correlated and/or negatively convex return sources produce the opposite effect (negative rebalancing effects and compounding headwinds).

Allocator Perspectives on Convexity Rebalancing

Through discussions with allocators, we found that many investors with highly convex portfolio allocations tend to use threshold-based triggers (e.g., rebalance 75% out of the hedge if equity markets are down 30% from high watermark, or rebalance 50% out of the hedge if the hedge is up 30% over a certain rolling lookback window), or even ad hoc discretionary triggers during crises to rebalance out of their portfolio hedges and back into equities.

While most allocators acknowledge that the calendar-based rebalances conceptually make sense, we often hear the following feedback:

1. Calendar-based rebalancing does not feel aggressive enough in times of crisis and feels unnecessary in non-crisis periods when performance drift is typically small. Threshold-based programs tend to be more drastic (cutting 50% or more of the convex exposure in one go), and being less frequent, require far less maintenance.

2. CIOs and investment committees can generate immense internal pressure to meaningfully reduce convex exposures in extreme crises and buy equities to "lock in" the accrued benefit. Of course, this crystallization also materially increases portfolio equity beta, which may or may not be well-compensated in the near/medium term.

Given this context above, it is perhaps unsurprising that when we discussed our most recent paper, *Convexity, Correlation, and Compounding*, with clients, the most common question was - *How did you settle on monthly rebalancing for the equity market versus the various return sources?* And (related), *was the monthly calendar-based rebalancing the optimal approach to rebalancing a convex return over time*?

We had used an in-house optimizer to arrive at a monthly rebalancing schedule. Further, avoiding both overly frequent rebalances (too quick to appropriately benefit from the convexity exposures), and overly infrequent rebalances (which may not reinvest crisis proceeds back into lower-priced equities quickly enough) made good sense. However, since this was optimized algorithmically, and so we didn't have a readily available means of showing our work. Our subsequent discussions with allocators suggested the need for this formal study and paper apparent.

Constructing the Study

While designing the parameters of our rebalancing study, it was clear that we needed to examine the potential effects of a **Calendar-based** versus a **Threshold-based** rebalancing program. However, given the allocator feedback above (regarding internal pressures to monetize hedges during major dislocations), we determined that in an extreme crisis (the GFC, COVID, U.S. Debt Downgrade, Aug 2015 Chinese Devaluation, Feb 2018 Vol-Mageddon, etc.), allocators would almost certainly feel the need to enact some sort of threshold trigger and lock in gains from their convex allocation. For this reason, we decided to also study a **Calendar-based approach with additional Threshold-based triggers** to aggressively rebalance in the aftermath of major market events.

Additionally, we tested our results across various equity markets and active return sources to increase the robustness of our findings. As one can imagine, each additional variable spurs a whole new set of permutations to be tested. All in, we ran thousands of permutations and subsequently distilled the results into smaller samples (a couple hundred for each combination portfolio) to simplify the study without changing our findings or losing statistical significance.

For the equity market returns, we tested the **S&P 500** and the **MSCI World**. For the convexity returns, we tested our **Dynamic Convexity strategy** (systematic long equity volatility strategy), our **Risk Responders strategy** (integrated risk mitigation multi-strategy that combines Dynamic Convexity with two systematic multi-asset trend strategies - 160+ markets across 5 asset classes), and a **Monthly Rolling S&P 500 Put Index** (PPUT Index, a passive 5% OTM monthly put on the S&P 500, which we subtract the market return from to isolate the P&L of the rolling put program).

1. For the **Calendar-based** rebalancing program, we chose the following parameters:

   For each combination portfolio, we tested rebalancing frequency between 1 week and 1 year, rebalancing based on calendar week or by calendar month (totaling **62 permutations**)

2. For the **Threshold-based** program, we used the performance of the hedge and the following parameters:

   For each combination portfolio, we tested the rolling 12-month performance for the convex return stream[3], and rebalanced the program based on certain thresholds for that performance. We tested various thresholds between +1 standard deviation through +4 standard deviations[4], and split the resulting return range into 12 equally-spaced increments.

   For each of these thresholds, we modulated the aggressiveness of the rebalancing by cutting the convexity exposure down by 25%, 50%, and 75% (and reinvesting that same balance into the equity market in each instance).

   Lastly, for each threshold and aggressiveness level, we needed to actively consider how long to wait before we "re-size" up the convexity allocation post-crisis. In our experience, this mimics allocator behavior, and without this consideration, one only benefits from the first crisis in any given sample. For this, we tested both half a year after and one full year after the threshold trigger to bring the convexity exposure back to its strategic weight of 100%. (totaling **78 permutations**)

3. For the **Calendar-and-Threshold-based** triggers, a pure intersection of the two prior studies yielded a dizzying number of permutations, and so based on the results of the calendar-based study, we anchored this program to a monthly calendar-based rebalancing (which we were comfortable doing given the fairly path independent nature of the calendar-based results), and then combined that with the above-mentioned threshold conditions. (totaling **78 permutations**)

   For this calendar-and-threshold rebalancing combination program, in order for the threshold-based rebalances to have an impact, we needed to suspend the calendar-based program for a fixed amount of time after each threshold event. Therefore, we suspended the calendar-based rebalancing program until the portfolio had re-sized back to 100% after the threshold event.

Analyzing the Results

For the sake of simplicity, we focus on portfolio outcomes that use the S&P 500 as the market return, and our Dynamic Convexity strategy (systematic long equity volatility) as the convex allocation. In the Appendix, we additionally explore other combination portfolios to test the robustness of these results. We focus primarily on Dynamic Convexity, because this strategy represents a pure convexity exposure, without any multi-strategy or other meaningful factor exposures to muddy the rebalancing analysis. This matches the exact design choices used in Exhibits 1 and 2 earlier in this paper.[5] The results shared here are generally robust to beta selection and type of convex return (so long as that convex return is very positively skewed, mitigates extreme bleed, and is highly convex).

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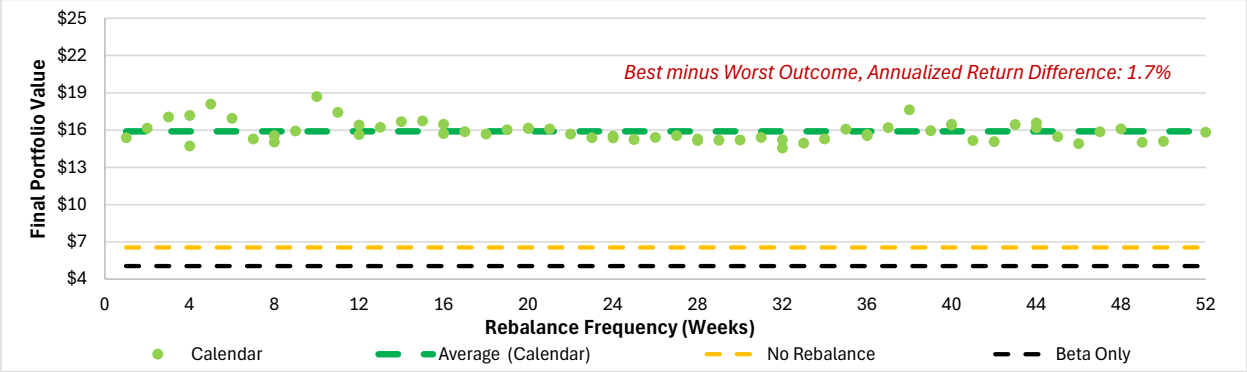
[3] Initially, we thought to condition the threshold-based program on the drawdown in equities instead of the rolling performance of the convex allocation. However, in practice if there are no convexity gains to redistribute, it would seem quite nonsensical to redeploy an insurance policy that had not yet paid off. Thus, we decided to condition the threshold-based rebalancing based on the performance of the hedge itself.

[4] For the standard deviations, we took the long-term expected annualized return as the base-case annual return expectation, and then used the upside volatility of each convex return source to measure a standard deviation (to account for the inherent upside skew in the return stream).

[5] Please see replicated exhibits across the other combinations of S&P 500 or MSCI World for market returns, our Dynamic Convexity and Risk Responders strategies, and a rolling put index for the market hedge.

1. For the **Calendar-based** rebalancing program, we observe the below:

Exhibit 4: Cumulative Growth of $1 for S&P 500 + Dynamic Convexity Portfolios, using Calendar-based Rebalancing (Jan 2007 – Feb 2024)[6]



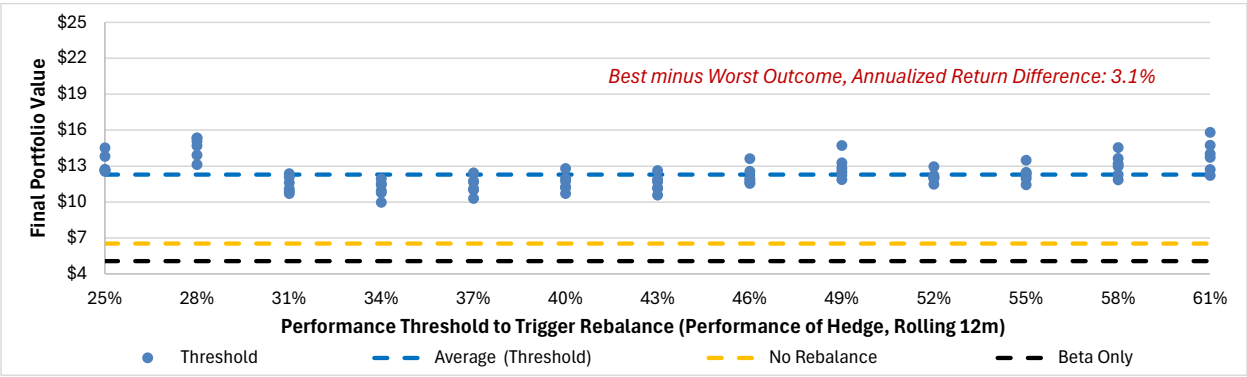
Source: One River, Bloomberg. Past performance is not a guarantee of future results.

In **Exhibit 4**, the y-axis has been set to fit all portfolio outcomes across the various rebalancing programs. As you can see, there is a tight distribution around the average outcome, but there is a higher average. While no methodology will be completely free from path dependence, there is a high degree of consistency across trials for calendar-based rebalancing programs. If one squints at the data, there are a number of higher outcomes in the 3–12-week range, but that general outperformance is not without exception.

What should be comforting to allocators who prefer not to rebalance hedges every couple of weeks is that less frequent rebalances do not result in a great deal of sacrifice. Beyond 6 months in frequency (24 weeks), there are some lower-end-of-the-range outcomes, but ultimately not meaningfully different final outcomes. What matters most is that one rebalances, period. All trials meaningfully outperformed the No Rebalance trial.

2. For the **Threshold-based** program, we observe the below:

Exhibit 5: Cumulative Growth of $1 for S&P 500 + Dynamic Convexity Portfolios, using Threshold-based Rebalancing (Jan 2007 – Feb 2024)



Source: One River, Bloomberg. Past performance is not a guarantee of future results.

In **Exhibit 5**, one should first note that the outcomes for this rebalancing program are generally lower than the outcomes for the calendar-based trials. Second, the distribution is less tightly packed around the average outcome, which can be interpreted as

[6]The S&P 500 returns used are the S&P 500 Total Return Index. The One River returns use live gross returns when possible, and backtested gross returns when necessary. Dynamic Convexity begins live returns in April 2015. Performance before those strategy inception dates is backtested, and subject to normal backtest limitations. Please see the methodology portion of this paper for the specific design choices behind each of the Rebalancing Types. Please see important disclaimers in the appendix. Past performance is not a guarantee of future results.

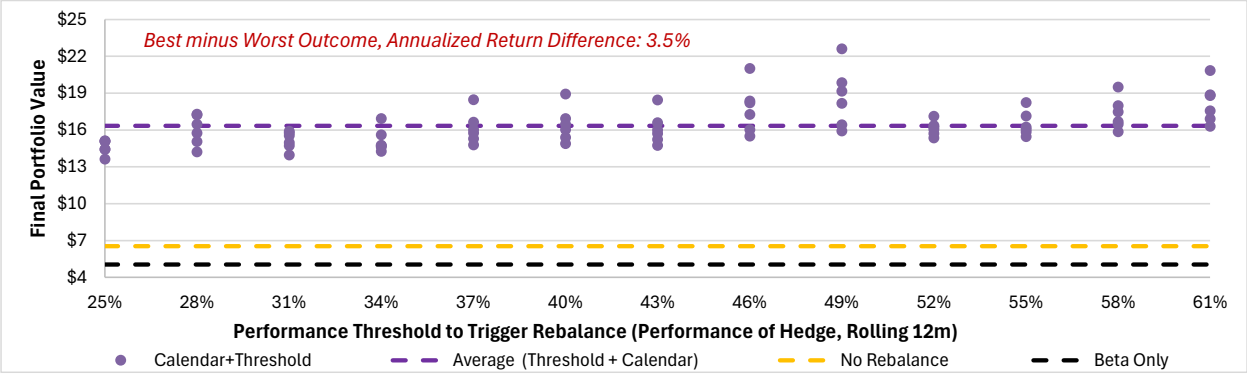
underlying design choices leading to meaningfully different final portfolio values. These long-term outcomes having a high sensitivity to economically insignificant changes to the inputs highlights the path dependency of this approach.

Even for the specific performance thresholds that produce the best outcomes, there are several trials using the same thresholds that produce below-average outcomes, implying that other design choices such as aggressiveness of hedge monetization / redeployment, and time until rebalancing back to strategic weights, can also make a meaningful difference in long-term outcomes. Still, one can observe the tendency for the higher thresholds to produce better average outcomes. This suggests that on balance, investors run a higher risk of pulling their hedges too quickly versus not quickly enough, as most of the worst outcomes are focused on the lower threshold levels.

Lastly, **pure threshold-based programs also run the unique risk of inadvertently failing to trigger a rebalance**, thus producing the same outcome as no rebalancing program at all (yellow line).

3. For the **Calendar-and-Threshold-based** program, we observe the below:

Exhibit 6: Cumulative Growth of $1 for S&P 500 + Dynamic Convexity Portfolios, using Cal. + Threshold-based Rebalancing (Jan 2007 – Feb 2024)



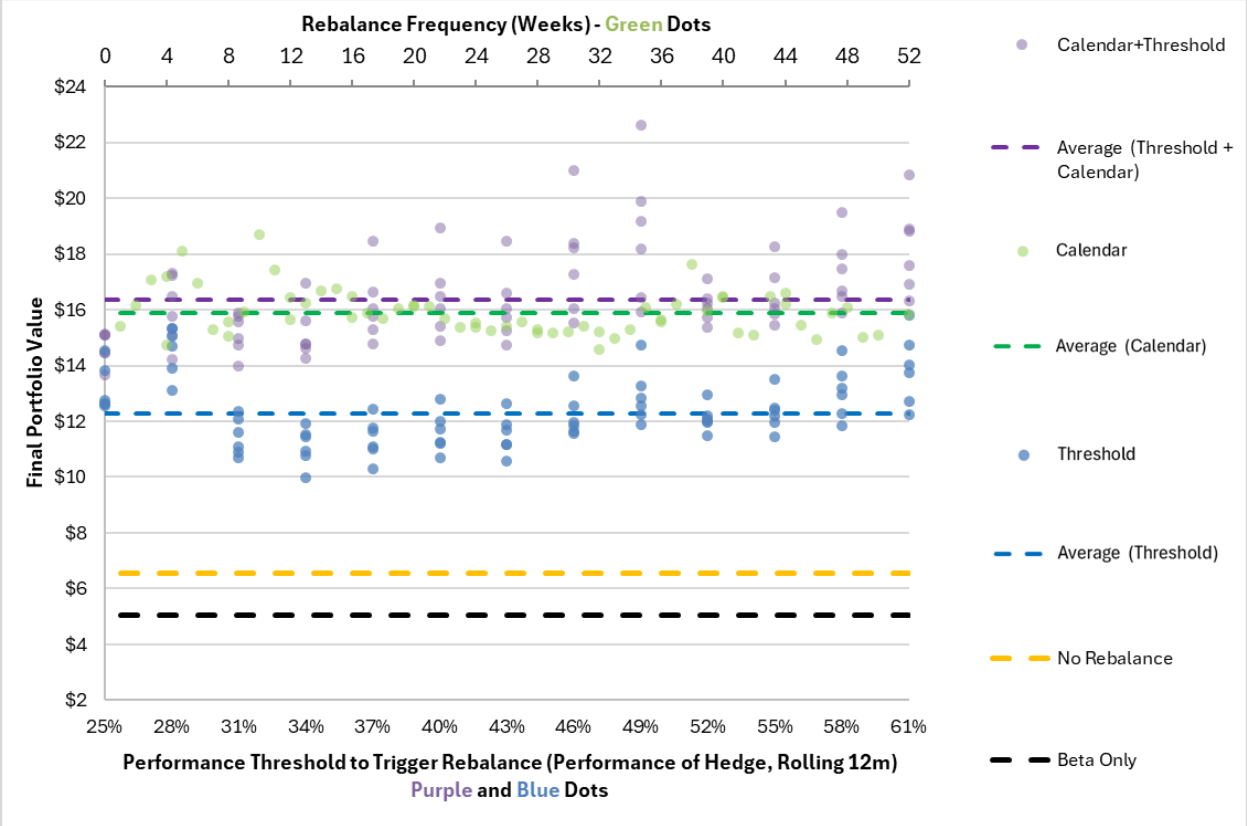
Source: One River, Bloomberg. Past performance is not a guarantee of future results.

Exhibit 6 largely replicates the average return outcomes seen for the calendar-based study above, but also delivers a similar path-dependency seen for the threshold-based study above. All else equal, erring on the side of larger thresholds calibrated to trigger in a major (GFC or COVID) type of crisis would advantageously avoid having a threshold triggered in a minor crisis.

Conclusion

Exhibit 7 stacks the above exhibits for more direct comparability across the different types of rebalancing programs. Here, you can readily observe the primary conclusions from the study.

Exhibit 7: Cumulative Growth of $1 for S&P 500 + Dynamic Convexity Portfolios, across all Rebalancing Types (Jan 2007 – Feb 2024)



Source: One River, Bloomberg. Past performance is not a guarantee of future results.

1. For investors with convex allocations, it is most important to have some kind of pre-determined rebalancing program in place.

    a. From a simplistic, infrequent calendar-based rebalance to an extreme threshold-based program, every rebalancing trial meaningfully outperformed a portfolio without rebalancing, regardless of the parameters.

    b. Reactionary programs that reallocate convexity proceeds based on contemporaneous evaluation of the market environment are more likely to replicate suboptimal investor decision-making in a crisis.

2. Recurring calendar-based rebalancing is the best way to reduce path dependency and produce consistently favorable outcomes.

    a. Conversely, adhering to a purely threshold-based program produces path dependency and worse, compounded portfolio values on average.

3. Combining a calendar-based program with an extreme threshold-based parameter may be the best tradeoff to maximize the likelihood of producing strong portfolio outcomes, while also satisfying the behavioral need to "lock in" hedging returns in a deep crisis (albeit, at the cost of added path-dependency).

a. Enacting additional threshold-based triggers roughly doubles the path dependency of rebalancing parameters, but this path dependency brings far less potential cost with calendar rebalancing than it does without calendar rebalancing.

Appendix

In this section, we expand the scope of the studies covered directly within the paper (which focused on S&P 500 and our Dynamic Convexity strategy), and additionally applied the same rebalancing parameters to other markets (such as MSCI World), and other convex return sources (such as a simplistic rolling S&P 500 put index and our Risk Responders strategy).

Broadly speaking, the conclusions stated above all hold. However, when we first studied the results of the simplistic rolling put index, there were some interesting findings. As can be seen in **Exhibit 8** below, using a monthly 5% OTM put on the S&P 500 (PPUT Index), and rebalancing alongside the S&P 500 return, matches our general conclusions as it relates to path-dependency. However, it produces meaningfully different results as it relates to the magnitude of final portfolio outcomes.

These calendar-based rebalancing trials, while more consistent, actually produced worse outcomes versus no rebalancing at all, and on average produced lower outcomes versus threshold-based rebalancing approaches as well.

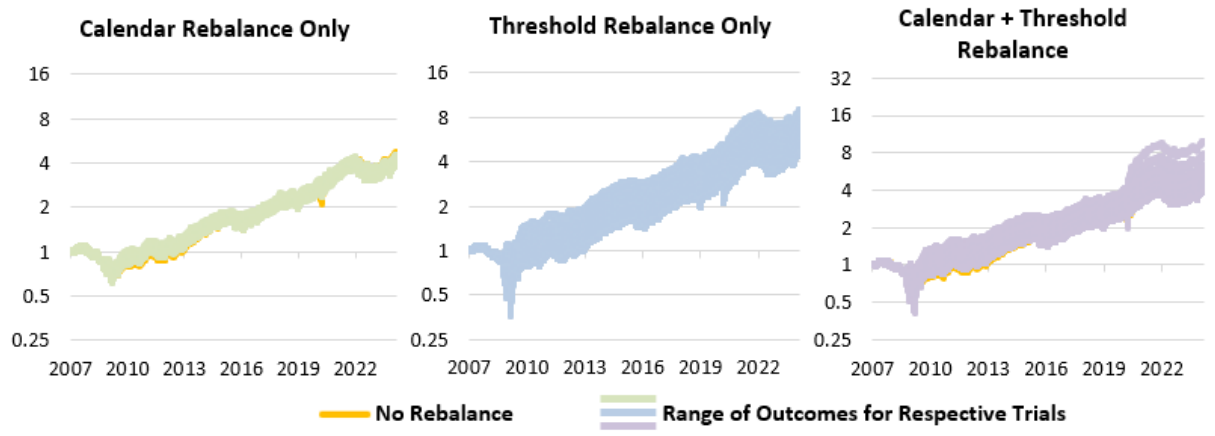
In observing the behavior of the trials in **Exhibit 8,** the reason for the underperformance of the calendar-based approach is that the ratio of bleed versus convexity generation was far too high. In other words, this approach to long volatility produced such punitive bleed in benign times, and such comparatively meager convexity during times of crisis, that the calendar-based program successfully maximized the portfolio's exposure to a highly inefficient risk-adjusted return.

However, in **Exhibit 9**, we took the same rolling put index, but added a fixed amount of return to reach observation such that the full sample information ratio matched the information ratio that our Dynamic Convexity produced over the same period. By adjusting the returns in this manner, we preserved its correlation and convexity to the equity market, but reduced its benign market bleed. Here, we can see that for this adjusted return series, the study produces the same conclusions as reached in the main body of this paper, both with respect to path-dependency and magnitude of portfolio outcomes.

Exhibits 10-12 iterate through the other various permutations of S&P 500, MSCI World, Dynamic Convexity, and Risk Responders. In all of these trials, we reach the same general conclusions as we did for the S&P 500 and Dynamic Convexity that we explored in the main body of this paper.

In summary, this exploration confirmed a truism in long volatility investing – there is no return that is so convex that it can't be rendered useless to the portfolio by poor monetization and negative bleed. Conversely, if you have a well-managed, capital-efficient source of convexity, one should be able to use that defensive source of alpha to amplify compounding effects.

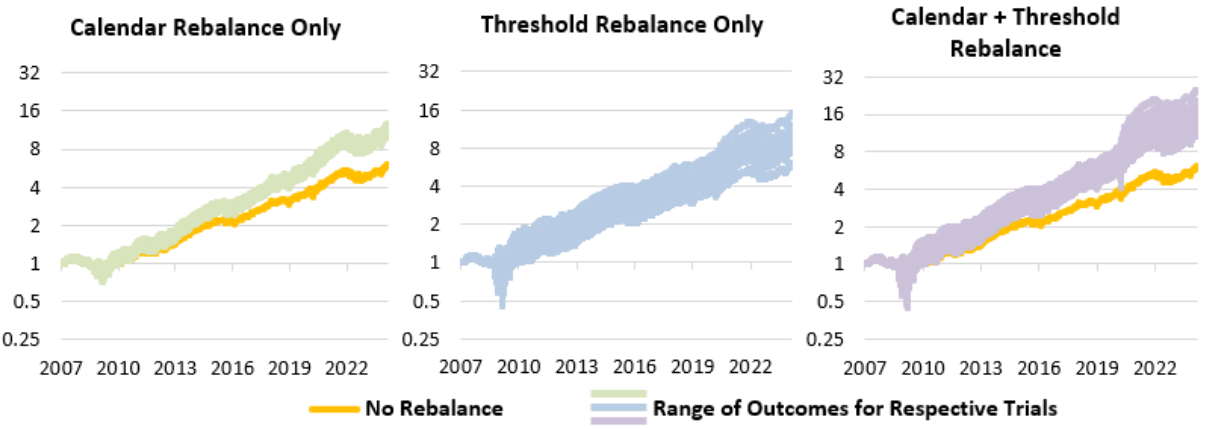
Exhibit and Table 8: Cumulative Growth of $1 Combination Portfolios (S&P 500 + Rolling Put Index[7]) by Rebalancing Type (Jan 2007 – Feb 2024) Log-Scaled, across Numerous Rebalance Parameters



Rolling Monthly Put Index - SPX	Calendar Only	Threshold Only	Calendar + Threshold	No Rebal	S&P (Beta) Only
Average Final Value ($)	$4.23	$5.34	$4.90	$4.78	$5.06
Max Final Value ($)	$4.59	$9.09	$10.01		
Min Final Value ($)	$4.02	$4.78	$4.09		
Range of Final Values ($)	$0.56	$4.32	$5.92		
Standard Deviation	+/- $0.12	+/- $0.96	+/- $1.21		
Average Ann. Return	8.8%	10.2%	9.5%	9.5%	9.9%
Average Ann. Volatility	13.9%	17.9%	15.9%	16.1%	20.2%
Average Skew	-0.2	-0.1	0.0	-0.3	-0.3
Average Max DD	-41.3%	-44.1%	-46.1%	-39.9%	-55.3%
Average Information Ratio	0.6	0.6	0.6	0.6	0.5
Average Sortino Ratio (ex-cash)	0.9	0.7	0.8	0.8	0.6

Source: One River, Bloomberg. Past performance is not a guarantee of future results.

Exhibit 9: Cumulative Growth of $1 Combination Portfolios (S&P 500 + Adjusted PPUT Index[8]) by Rebalancing Type (Jan 2007 – Feb 2024) Log-Scaled, across Numerous Rebalance Parameters



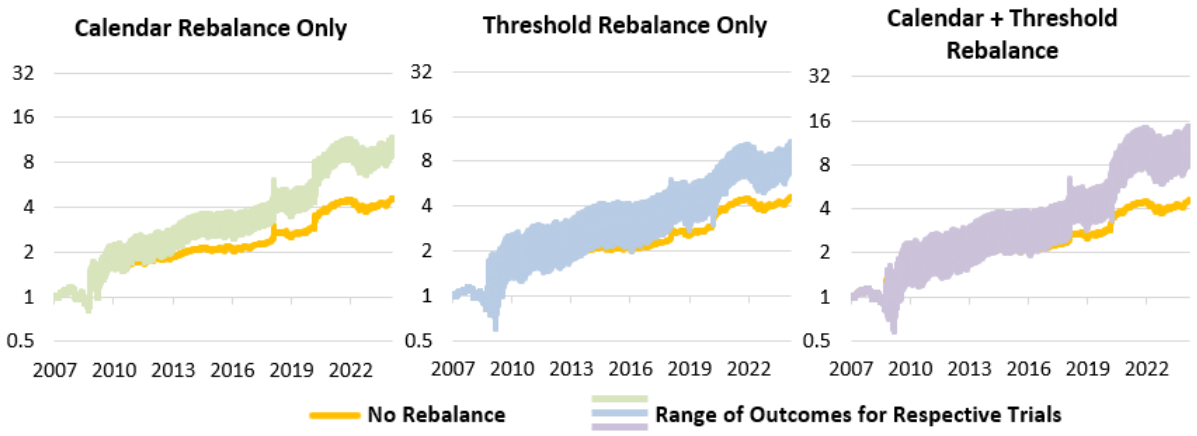
[7] Index used is the PPUT Index, minus the S&P 500 index return, sourced from Bloomberg. The index represents a simplistic 5% OTM monthly put rolling program on the S&P 500. This approach can provide defensiveness, but in practice the success of the hedge relies meaningfully on the prevailing macroeconomic environment, pricing of volatilities at the time of establishing the put, and the path markets take surrounding the establishment / expiry of the options.

[8] The average return of the rolling put index has been adjusted upwards to match the full-sample information ratio that our Dynamic Convexity strategy produced over the same time frame. By doing so, we preserve its correlation and time-varying convexity, but improve its bleed profile.

Rolling Monthly Put Index (Adj.)[8] - SPX	Calendar Only	Threshold Only	Calendar + Threshold	No Rebal	S&P (Beta) Only
Average Final Value ($)	$11.59	$7.94	$13.65	$6.10	$5.06
Max Final Value ($)	$12.78	$15.09	$25.38		
Min Final Value ($)	$10.59	$6.10	$11.55		
Range of Final Values ($)	$2.20	$8.99	$13.82		
Standard Deviation	+/- $0.43	+/- $2.03	+/- $2.80		
Average Ann. Return	15.3%	12.6%	16.3%	11.1%	9.9%
Average Ann. Volatility	13.7%	14.7%	16.2%	11.6%	20.2%
Average Skew	-0.2	-0.1	0.0	-0.3	-0.3
Average Max DD	-34.7%	-34.7%	-41.4%	-28.3%	-55.3%
Average Information Ratio	1.1	0.9	1.0	1.0	0.5
Average Sortino Ratio (ex-cash)	1.5	1.1	1.4	1.3	0.6

Source: One River, Bloomberg. Past performance is not a guarantee of future results.

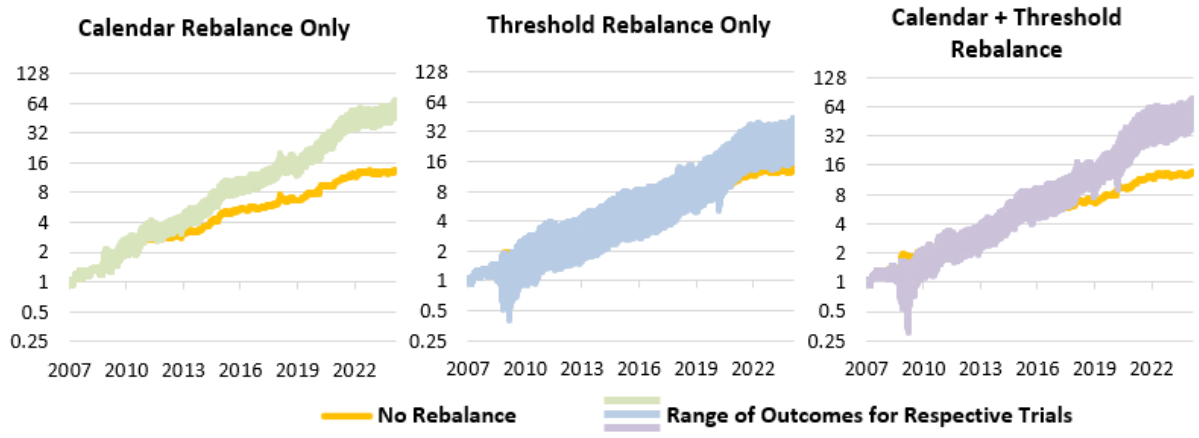
Exhibit 10: Cumulative Growth of $1 Combination Portfolios (MSCI World + Dynamic Convexity) by Rebalancing Type (Jan 2007 – Feb 2024) Log-Scaled, across Numerous Rebalance Parameters



MSCI - Dynamic Convexity	Calendar Only	Threshold Only	Calendar + Threshold	No Rebal	MSCI (Beta) Only
Average Final Value ($)	$10.23	$8.46	$10.47	$4.61	$3.13
Max Final Value ($)	$11.85	$10.78	$14.77		
Min Final Value ($)	$9.26	$7.00	$8.32		
Range of Final Values ($)	$2.59	$3.78	$6.45		
Standard Deviation	+/- $0.54	+/- $0.76	+/- $1.23		
Average Ann. Return	14.5%	13.2%	14.6%	9.3%	6.9%
Average Ann. Volatility	17.0%	15.8%	18.6%	11.9%	17.3%
Average Skew	9.3	0.9	8.6	8.8	-0.5
Average Max DD	-29.4%	-33.0%	-34.2%	-29.4%	-57.8%
Average Information Ratio	0.9	0.8	0.8	0.8	0.4
Average Sortino Ratio (ex-cash)	1.3	1.2	1.2	1.2	0.5

Source: One River, Bloomberg. Past performance is not a guarantee of future results.

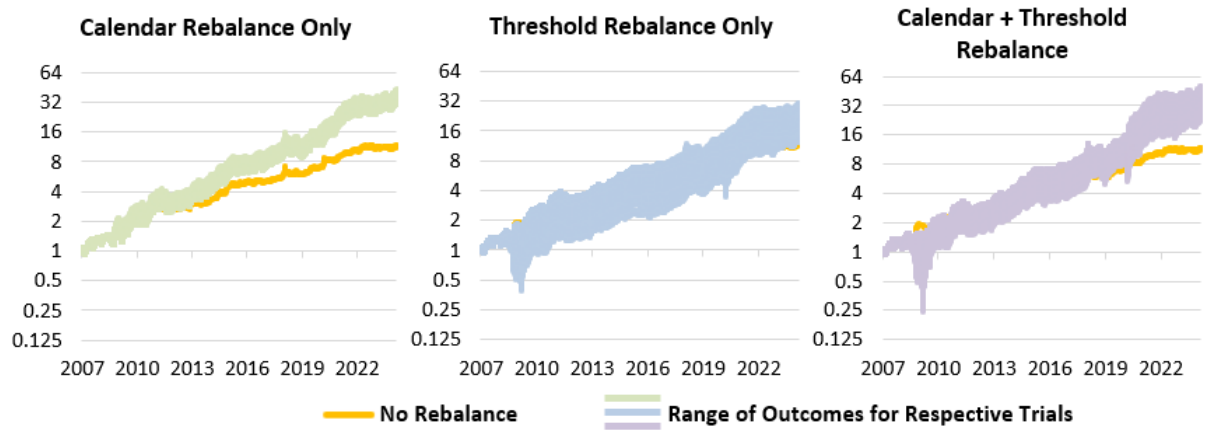
Exhibit 11: Cumulative Growth of $1 Combination Portfolios (S&P 500 + Risk Responders) by Rebalancing Type (Jan 2007 – Feb 2024) Log-Scaled, across Numerous Rebalance Parameters[9]



S&P - Risk Responders	Calendar Only	Threshold Only	Calendar + Threshold	No Rebal	S&P (Beta) Only
Average Final Value ($)	$56.50	$25.38	$59.40	$13.68	$5.06
Max Final Value ($)	$67.88	$44.33	$78.51		
Min Final Value ($)	$50.91	$17.04	$48.24		
Range of Final Values ($)	$16.97	$27.30	$30.27		
Standard Deviation	+/- $2.94	+/- $5.87	+/- $6.04		
Average Ann. Return	26.5%	20.5%	26.8%	16.5%	9.9%
Average Ann. Volatility	19.2%	17.3%	22.3%	12.6%	20.2%
Average Skew	0.5	0.1	0.6	1.7	-0.3
Average Max DD	-23.2%	-28.3%	-35.5%	-16.3%	-55.3%
Average Information Ratio	1.4	1.2	1.2	1.3	0.5
Average Sortino Ratio (ex-cash)	2.0	1.6	1.7	1.8	0.6

Source: One River, Bloomberg. Past performance is not a guarantee of future results.

Exhibit 12: Cumulative Growth of $1 Combination Portfolios (MSCI World + Risk Responders) by Rebalancing Type (Jan 2007 – Feb 2024) Log-Scaled, across Numerous Rebalance Parameters



[9]The S&P 500 returns used are the S&P 500 Total Return Index. The One River returns use live gross returns when possible, and backtested gross returns when necessary. Risk Responders is a combination of Dynamic Convexity, Trend, and Alternative Markets Trend. Dynamic Convexity and Trend both incepted on April 2015, and Alternative Markets Trend incepted on November 2019. Performance before those strategy inception dates is backtested, and subject to normal backtest limitations. Please see the methodology portion of this paper for the specific design choices behind each of the rebalancing types. Please see important disclaimers in the appendix. Past performance is not a guarantee of future results.

MSCI - Risk Responders	Calendar Only	Threshold Only	Calendar + Threshold	No Rebal	MSCI (Beta) Only
Average Final Value ($)	$36.55	$21.34	$35.76	$11.76	$3.13
Max Final Value ($)	$42.96	$30.67	$50.78		
Min Final Value ($)	$33.12	$13.53	$24.25		
Range of Final Values ($)	$9.84	$17.13	$26.52		
Standard Deviation	+/- $1.79	+/- $3.69	+/- $4.96		
Average Ann. Return	23.3%	19.4%	23.1%	15.4%	6.9%
Average Ann. Volatility	17.7%	17.1%	21.0%	13.1%	17.3%
Average Skew	0.7	0.3	0.7	2.4	-0.5
Average Max DD	-25.3%	-33.4%	-41.5%	-18.6%	-57.8%
Average Information Ratio	1.3	1.2	1.1	1.2	0.4
Average Sortino Ratio (ex-cash)	1.8	1.6	1.5	1.7	0.5

Source: One River, Bloomberg. Past performance is not a guarantee of future results.

About One River

Founded in 2013 by Eric Peters, One River Asset Management is an innovative investment manager dedicated to delivering high-conviction absolute-return strategies that help our clients build superior portfolios. We see the world in a period of major economic and political transition, with the investment landscape shifting in ways that will make the coming five years look profoundly different from the past five. Our strategies are built to profit from this dynamic environment while providing strong diversification benefits to traditional investment portfolios. Each is developed and managed in-house by our diverse team of investment professionals with deep expertise in thematic macro, volatility, systematic, and inflation trading/investing. The strategies are delivered at sensible fees via commingled funds, and/or in bespoke combinations for large institutions via fund-of-one structures, managed accounts, swaps or UCITS-compliant structures.

Disclaimers

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Prior to December 2019, the Dynamic Convexity Strategy returns reflect the actual returns of the strategy within a One River managed SPC (Segregated Portfolio Company). Returns for the SPC are available upon request. Prior to December 2019, operating expenses are excluded for the net return calculation. The Dynamic Convexity SP caps expenses at 20 bps if AUM is above USD 250 million.

The Risk Responders Strategy performance from Nov 2019 through Feb 2022 represents a pro-forma combination of live Dynamic Convexity, Trend, and Alternative Markets Trend fund returns as implemented in the live Risk Responders strategy. Returns for the individual funds are available upon request.
HYPOTHETICAL PERFORMANCE RESULTS HAVE MANY INHERENT LIMITATIONS, SOME OF WHICH ARE DESCRIBED BELOW. NO REPRESENTATION IS BEING MADE THAT ANY ACCOUNT WILL OR IS LIKELY TO ACHIEVE PROFITS OR LOSSES SIMILAR TO THOSE SHOWN. IN FACT, THERE ARE FREQUENTLY SHARP DIFFERENCES BETWEEN HYPOTHETICAL PERFORMANCE RESULTS AND THE ACTUAL RESULTS SUBSEQUENTLY ACHIEVED BY ANY PARTICULAR TRADING PROGRAM. ONE OF THE LIMITATIONS OF HYPOTHETICAL PERFORMANCE RESULTS IS THAT THEY ARE GENERALLY PREPARED WITH THE BENEFIT OF HINDSIGHT. IN ADDITION, HYPOTHETICAL TRADING DOES NOT INVOLVE FINANCIAL RISK, AND NO HYPOTHETICAL TRADING RECORD CAN COMPLETELY ACCOUNT FOR THE IMPACT OF FINANCIAL RISK IN ACTUAL TRADING. FOR EXAMPLE, THE ABILITY TO WITHSTAND LOSSES OR TO ADHERE TO A PARTICULAR TRADING PROGRAM IN SPITE OF TRADING LOSSES ARE MATERIAL POINTS WHICH CAN ALSO ADVERSELY AFFECT ACTUAL TRADING RESULTS. THERE ARE NUMEROUS OTHER FACTORS RELATED TO THE MARKETS IN GENERAL OR TO THE IMPLEMENTATION OF ANY SPECIFIC TRADING PROGRAM WHICH CANNOT BE FULLY ACCOUNTED FOR IN THE PREPARATION OF HYPOTHETICAL PERFORMANCE RESULTS AND ALL OF WHICH CAN ADVERSELY AFFECT ACTUAL TRADING RESULTS.

Eric Peters serves as the CEO/CIO of One River Asset Management as well as the CEO/CIO of Coinbase Asset Management, LLC (formerly One River Digital Asset Management, LLC), which are unaffiliated and independent investment advisory businesses. Conflicts of interest could potentially arise as a result of Eric Peters' dual roles. However, we believe such risks are unlikely given the differences in the investment strategies and asset classes of One River Asset Management and Coinbase Asset Management. Additionally, Mr. Peters may not devote all of his time to either business as a result of his dual roles. However, we believe any such conflicts of interest would also be mitigated by the fact that One River Asset Management and Coinbase Asset Management have separate, dedicated investment teams.