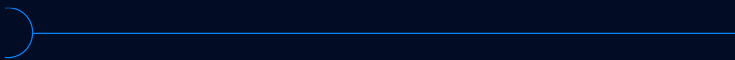# OneRiver
ASSET MANAGEMENT

Convexity, Correlation, and Compounding

Using Overlays to Improve your Total Portfolio

We analyze the impact that correlation, convexity, and Overlay Synergies can have on the long-term compounded value of your Total Portfolio.

Patrick Kazley

JANUARY 2024

Table of Contents

Introduction: Implementation Matters

Compound interest is the eighth wonder of the world. He who understands it, earns it. He who doesn't, pays it.

– Albert Einstein (probably)

Even though Einstein likely never said this, whoever did coin the phrase was onto something. **Exhibit 1** is one such example of the power of compounding. It compares the long-term compounded returns of the S&P 500 (market return) versus the returns of combination portfolios (i.e., 100% exposure to the S&P 500 return plus 100% exposure to an overlay return, such as a hedge fund portfolio, bond future, gold future, etc.). The combination portfolios[1] replicate capital-efficient market + overlay implementations which, through the use of derivatives and leverage, can use one pool of capital to fully achieve both market and overlay exposure, rebalanced monthly, and compounded.

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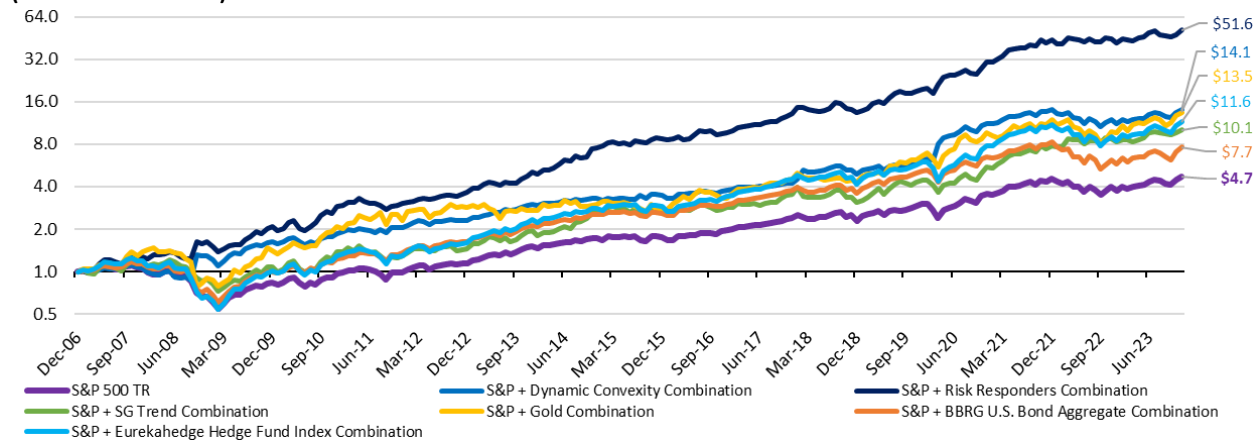
Source: One River, Bloomberg.

These different combination portfolios vastly outperform the long-term compounded value of an S&P 500 portfolio – especially considering that the y-axis is log-scaled. How does $1 grow to $50 over a 17-year period?

Long-term compounding can deliver almost unintuitively outsized impacts over longer periods, especially with regular rebalancing. A combined portfolio like the S&P 500 + Risk Responders (long equity volatility + multi-asset trend) systematically shifts capital between growth (market) and risk mitigation (Risk Responders) over time, such that when one falters the other tends to come through by design.

For instance, this combination automatically uses gains earned through convexity (long volatility) after a market crisis to rebalance into equities at historically cheap levels, and then continues to compound from that elevated portfolio level. The overlay can also outperform during prolonged market declines through multi-asset trend, and generally diversify market returns in normal times, harmoniously rebalancing over time. The portfolio's capital-efficiency, positive convexity, negative correlation, and return levels intersect with rebalancing impacts to deliver combined portfolio outcomes far greater than the simple sum of its parts.

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[1] 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.
[2] 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. All subsequent charts span from Jan 2007 – Dec 2023.

Are these results driven purely by certain events like the GFC, backtest assumptions, or favorable sampling? **Exhibits 1A and 1B** below replicate the chart above, but divide it into two parts. Part 1 is all backtested data for the One River strategies, and includes the GFC. Part 2 begins when One River's Dynamic Convexity strategy (long equity volatility) and Systematic Trend strategy went live in 2015. As can be seen, while the compounding magnitudes are greatly reduced over these shorter periods, the relative results do not change much.

Exhibit 1A: Cumulative Growth of $1 of S&P 500 vs. Combination Portfolios (S&P 500 + Overlay), Log-Scaled
Early Part of Sample (One River Backtested Period) (Jan 2007 – March 2015)
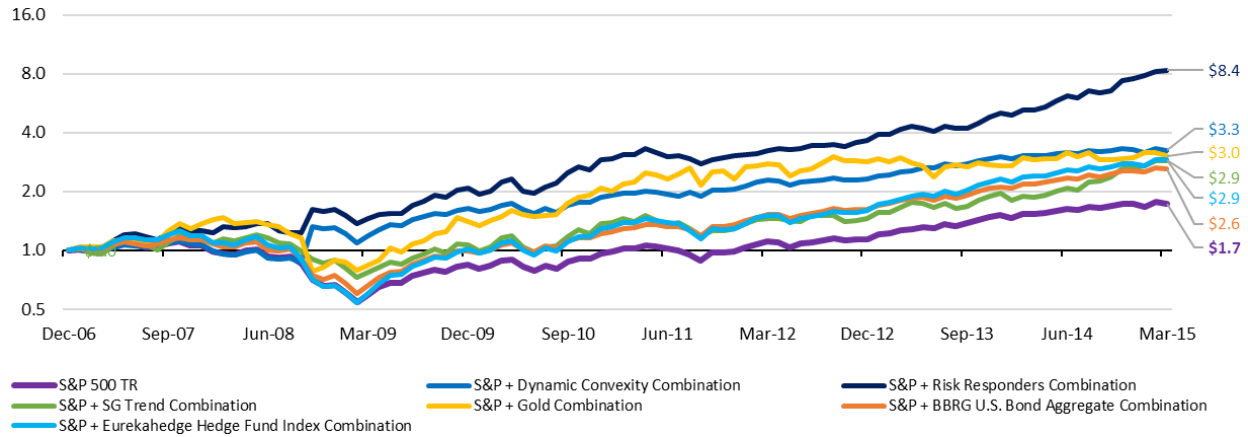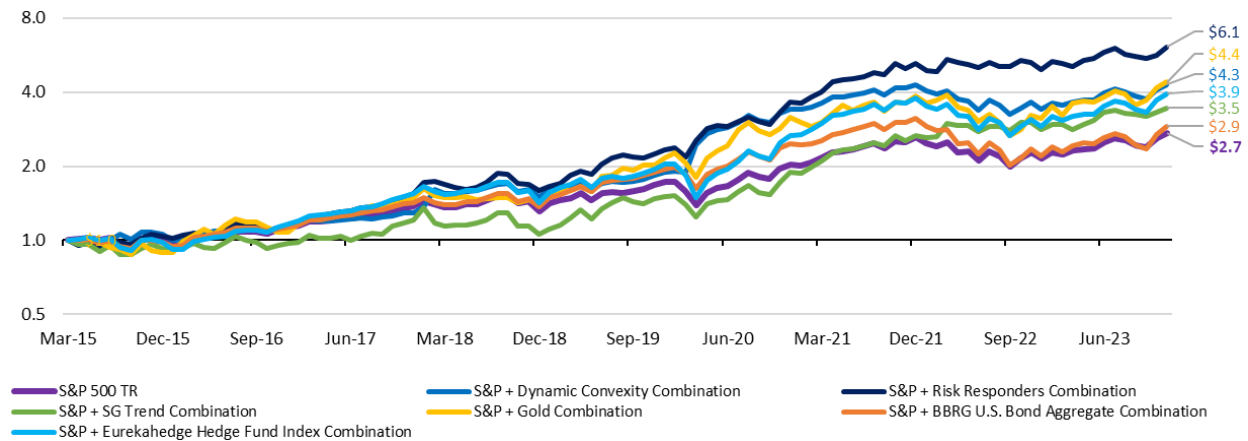

Exhibit 1B: Cumulative Growth of $1 of S&P 500 vs. Combination Portfolios (S&P 500 + Overlay), Log-Scaled
Late Part of Sample (One River Dynamic Convexity / Systematic Trend Inception Date) (April 2015 – Dec 2023)
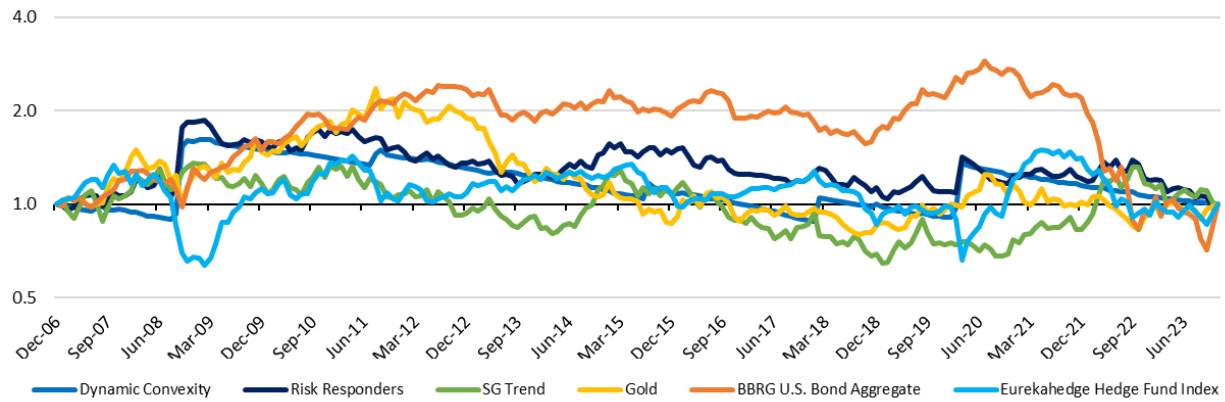

Source: One River, Bloomberg

Of course, the returns of these overlays (information ratio * volatility) are important drivers of long-term outcomes, but how much do other non-return factors matter?

To find out, we run the full sample analysis again - but first neutralize return differences across the different overlays. To do this, we discounted each of the overlay return streams such that they all realized exactly a 0% compounded return full sample and also scaled them all to hit the same volatility level (20% volatility). Since these returns were discounted by subtracting a fixed amount from each month's return, we have fully preserved each return stream's relationship to the S&P 500 and its characteristics – its correlation and convexity profile, etc. **Exhibit 2** below examines the trajectory of those returns.

Exhibit 2: Trajectory of $1 for Standalone Overlay Returns, Adjusted to 0% Return and a 20% Volatility Level[3]
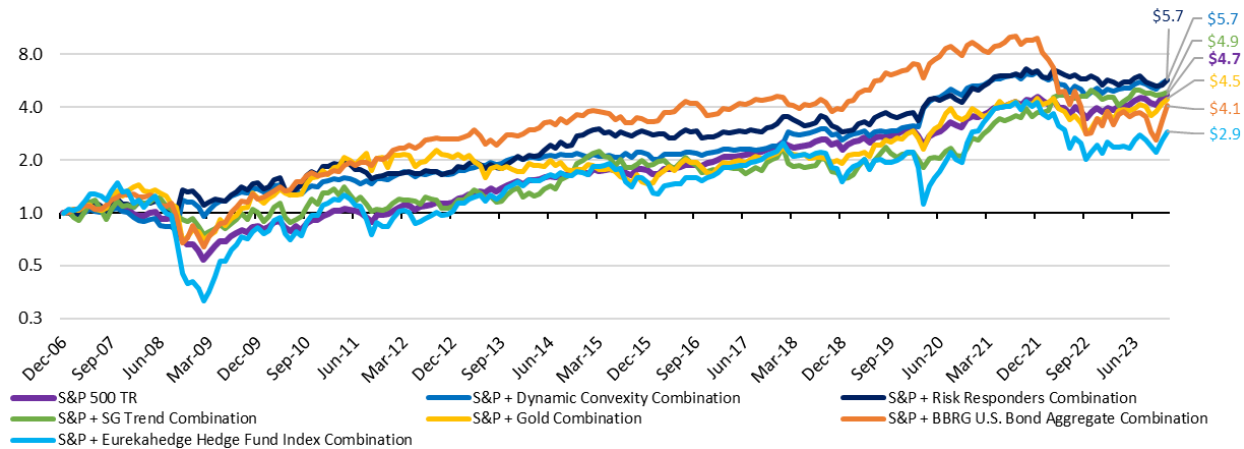

Source: One River, Bloomberg

If we overlay these adjusted returns on top of the S&P 500 and rebalance monthly, one might suspect that these adjusted combination portfolios would more or less produce the same return as that of the S&P 500, since the adjusted overlay return is flat. However, by integrating these two returns together in a combined portfolio, there are nontrivial interaction effects between the S&P 500 return and the overlay return, driven by the overlay's convexity and correlation profile, and the rebalancing impacts over time.

These **Overlay Synergies** are also highly impactful to long-term results, and, we believe, are far more impactful than most would suspect a priori. Overlay Synergies represent how much the addition of an overlay adds to or detracts from a combination portfolio's compounded values. **Exhibit 3** examines what this would look like using the adjusted returns above. Since we have zeroed-out return levels across the different overlays, the differences in the various combination portfolios are driven purely by how the correlation and convexity profile, rebalancing impacts, and return skew interact (positively or negatively) with the equity market return over time. **Exhibit 4** uses a different visual to highlight how each of these 0% return streams, if overlaid on top of the S&P 500, would have either enhanced or impaired a pure S&P 500 investment.
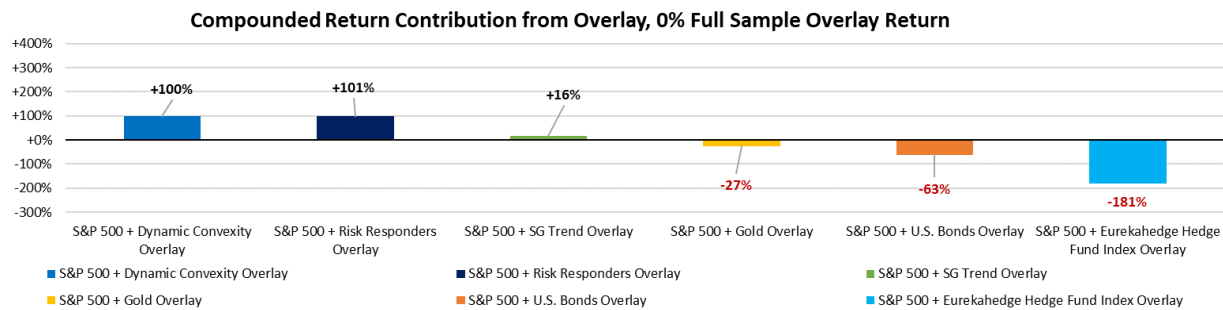
Exhibit 3: Cumulative Growth of $1 S&P 500 vs. S&P 500 + Adjusted Overlay Returns as Shown in Exhibit 2

Source: One River, Bloomberg,

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[3] The volatilities of the various overlay returns were re-scaled to match 20% to control for varied volatility levels. Then, each return stream was discounted to hit a specific Information Ratio, to control for varied levels of excess return.

Exhibit 4: Full Sample Cumulative Return in Exhibit 3, Minus the S&P 500 Compounded Return (Overlay Synergies)

How Much Each Overlay Contributes to or Detracts from Total Compounded Returns, Assuming the Overlay Itself is Flat

Compounded Return Contribution from Overlay, 0% Full Sample Overlay Return

- S&P 500 + Dynamic Convexity Overlay: +100%
- S&P 500 + Risk Responders Overlay: +101%
- S&P 500 + SG Trend Overlay: +16%
- S&P 500 + Gold Overlay: -27%
- S&P 500 + U.S. Bonds Overlay: -63%
- S&P 500 + Eurekahedge Hedge Fund Index Overlay: -181%

Source: One River, Bloomberg,

Surprisingly, by overlaying negatively correlated and positively convex returns (e.g., One River Dynamic Convexity, Risk Responders, and to a lesser extent the SG Trend Index) on top of an equity return, one can meaningfully improve the long-term compounded combination portfolio outcome, *even if those overlay returns generate no standalone return at all*. This is purely through favorable compounding effects that result from convexity, correlation, and rebalancing over time.

Our conclusion is that negatively correlated and positively convex returns, especially when rebalanced alongside equity beta, produce a substantially higher compounding benefit per unit of risk (volatility) and risk-adjusted return (information ratio) than do more highly correlated / non-convex returns. In fact, the more negatively correlated / positively convex the returns are, the less those return sources need to exhibit high returns in order to be beneficial to the total portfolio.

Total Portfolio Approach: A Competition for Capital

Before unpacking these analyses more fully, it is first helpful to discuss a relevant trend in the allocation community. Increasingly there is a focus among allocators on the *total portfolio* impact of allocation decisions. If you ask five investment professionals what it means to take a total portfolio approach, you are likely to receive five fairly different responses. Perhaps the easiest way to understand what a total portfolio approach *is*, is to first define what it *is not*.

In our view, a total portfolio approach *is not* anchoring portfolio-level allocation choices to a "bucketing" framework (e.g., public equities, private equities, fixed income, alternatives), and it *is not* simply seeking to optimize performance within each bucket.

So, what *is* it then? A total portfolio approach is applied with a specific portfolio-level goal in mind (e.g., Cash + 3%, CPI + 2%, 8% average annual total return, etc.), and the consequential allocation scheme across asset classes is more fluid (and potentially dynamic). Further, this total portfolio approach (where appropriate) might involve more commingling of different return sources, such as combining public equities with capital-efficient alternatives to use one pool of capital instead of multiple pools. Practitioners of this approach will often remark that there is a "competition for capital", in which each investment effectively competes with other potential investments for expression in the portfolio (as opposed to "filling up" each distinct allocation bucket as best one can).

Allocators who adhere to these total portfolio principles tend to focus less on asset class exposures and more on broad factor / market beta exposures. This competition for capital usage leads to a premium on capital efficiency. Therefore, these investors tend to make more efficient use of capital through derivatives, and they also tend to make use of more economic leverage when it is beneficial.

With these guiding principles in mind, allocators naturally hunt for synergies across the various return sources that comprise their allocation. These synergies are most readily accessed through the more liquid asset classes such as public equities, public fixed income, and public market / liquid alternatives, as these exposures can be readily implemented using derivatives and are sufficiently liquid to regularly rebalance between these return sources using one pool of capital. Conversely, private markets (e.g., equity, credit, real estate) deliver neither liquidity nor capital-efficiency, and thus afford allocators less ability for improvement through the application of total portfolio principles.

Illustrative Example: S&P 500 + Overlay

In this section, we further examine the return outcomes of the combination portfolios explored earlier. Operationally, these portfolios could be achieved by replicating the equity beta using a future or total return swap, along with using the substantial unencumbered cash to put on a derivatives-based alternatives portfolio or different return source through a future or a swap. This is all done using one pool of capital.

We keep the analysis as simple as possible, by using a monthly periodicity and summing 100% of the S&P 500 total return with different simulated overlay returns.[4] For longer-term cumulative returns, we use a geometric compounded return to observe any compounding impacts over time, which replicates a monthly rebalancing schedule between the S&P 500 and the overlay return sources. We also observe from January 2007 – December 2023, which is the period over which our systematic backtests and live returns span.

Across these analyses, we picked six different overlay return sources:[5]

1. **Dynamic Convexity** One River's systematic long equity volatility strategy

2. **Risk Responders** One River's integrated risk mitigation multi-strategy that combines two systematic multi-asset trend strategies (160+ markets across 5 asset classes) and the above-mentioned Dynamic Convexity

3. **SG Trend Index** for a systematic Trend proxy

4. **Gold** to represent a common commodity-based crisis hedge

5. **U.S. Bonds** as hedge of choice for allocators over the previous few decades

6. **EurekaHedge Hedge Fund Index**, for a higher IR, higher correlated return stream

These different return streams were each picked for their unique portfolio properties. **Dynamic Convexity** is highly convex and persistently negatively correlated to equities, with a low expected IR. **Risk Responders** is also reliably convex with a negative, albeit time-varying, correlation to equities, and a much higher IR expectation given its diversifying complementary underlying return sources. The **SG Trend Index** exhibits a slightly negative correlation, no reliable convexity (as it tends to rely on precedent conditions), and a moderate IR. **Gold** has exhibited meaningful diversification benefit, but has actually produced a slightly positive correlation to the S&P 500 and a modest IR. **U.S. Bonds** have usually realized a negative correlation stretching back to the late 1990s, but have more recently been realizing a positive

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[4] In practice, we should subtract out any explicit financing costs for the overlay solution in the event a total return swap is used for the market beta (or account for contango / backwardation/ rolling costs for a futures implementation), and we should also add back in a certain percentage of the risk-free rate that the additional free cash within the solution would yield. We do this for clients who inquire about overlay simulations, but for this piece, it only complicates the analysis while not changing the conclusions and insights that can be drawn from it.

[5] Three of these return sources are non-investable indices, and One River's strategy returns are backtested in much of the early sample, and mostly live since 2015 (please see footnotes of exhibits for more specific detail). As will be seen in the subsequent analyses, the actual return level is not what is being studied here – but rather the intention is to isolate the interaction effects correlation, convexity, and rebalancing have on compounding effects for an overlay implementation. In practice, we have implemented One River's strategies in an overlay format. However, implementing an index like EurekaHedge Hedge Fund Index would likely prove far more challenging from a leverage perspective. A natural question is if these outcomes change if we limit the sample to exclude the GFC, only use live One River fund data, or do other rebalancing frequencies other than monthly (e.g., quarterly, semi-annually). None of these would change the conclusions drawn here.

correlation (including over this sample on average[6]) and have provided strong crisis performance. The **Eurekahedge Hedge Fund Index**, like many hedge fund indices, exhibits a high realized IR, but a very high equity correlation (with some diversifying properties) and no reliable convexity in crises. Risk and return statistics are summarized in **Tables 1 and 2**, while **Exhibit 5** below highlights both the full sample and rolling correlations for these returns versus the S&P 500.

Tables 1 and 2: Full Sample Return, Volatility, Information Ratios, and Skew for Unadjusted Overlays (Jan 2007 – Dec 2023) [7]

	S&P 500 TR	Dynamic Convexity	Risk Responders	SG Trend	Gold	U.S. Bonds	Eurekahedge Hedge Fund Index
Compound Ann. Return	9.6%	5.5%	14.1%	4.5%	6.7%	3.1%	6.2%
Ann. Volatility	15.9%	20.6%	17.8%	11.7%	17.0%	4.3%	5.4%
Information Ratio	0.60	0.27	0.79	0.38	0.39	0.72	1.15
Skew	-0.56	9.12	4.68	0.02	0.03	-0.09	-0.55

	S&P 500	S&P 500 + Dynamic Convexity Overlay	S&P 500 + Risk Responders Overlay	S&P 500 + SG Trend Overlay	S&P 500 + Gold Overlay	S&P 500 + U.S. Bonds Overlay	S&P 500 + Eurekahedge Hedge Fund Index Overlay
Compound Ann. Return	9.6%	16.8%	26.1%	14.6%	16.6%	12.7%	15.5%
Ann. Volatility	15.9%	19.6%	18.3%	19.2%	24.3%	17.4%	20.6%
Information Ratio	0.60	0.86	1.42	0.76	0.68	0.73	0.75
Skew	-0.56	3.85	0.90	-0.19	-0.44	-0.59	-0.58

Source: One River, Bloomberg

Exhibit 5: Full Sample and Rolling 18-month S&P 500 Correlations
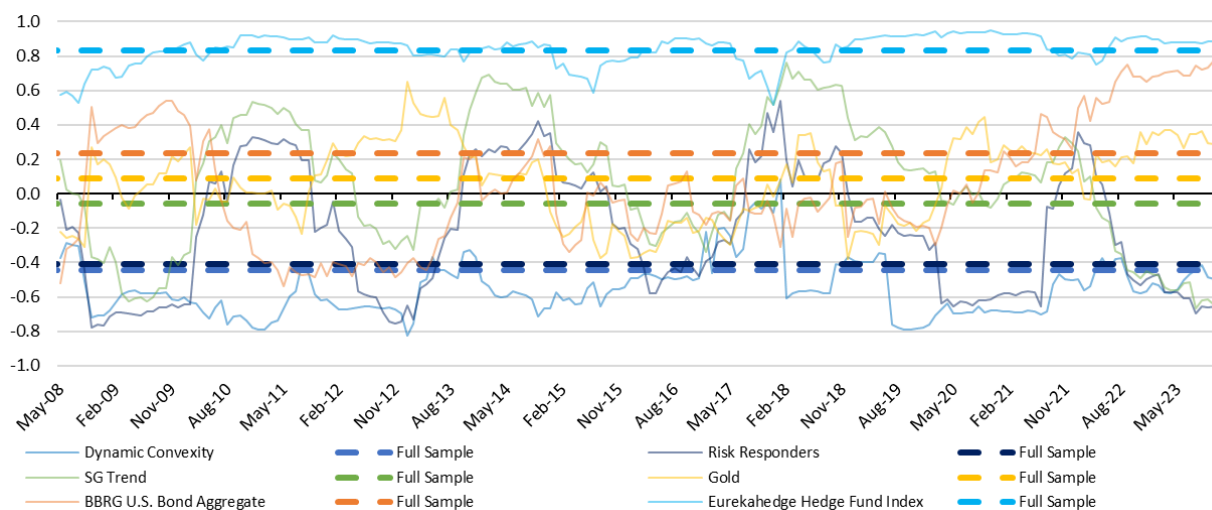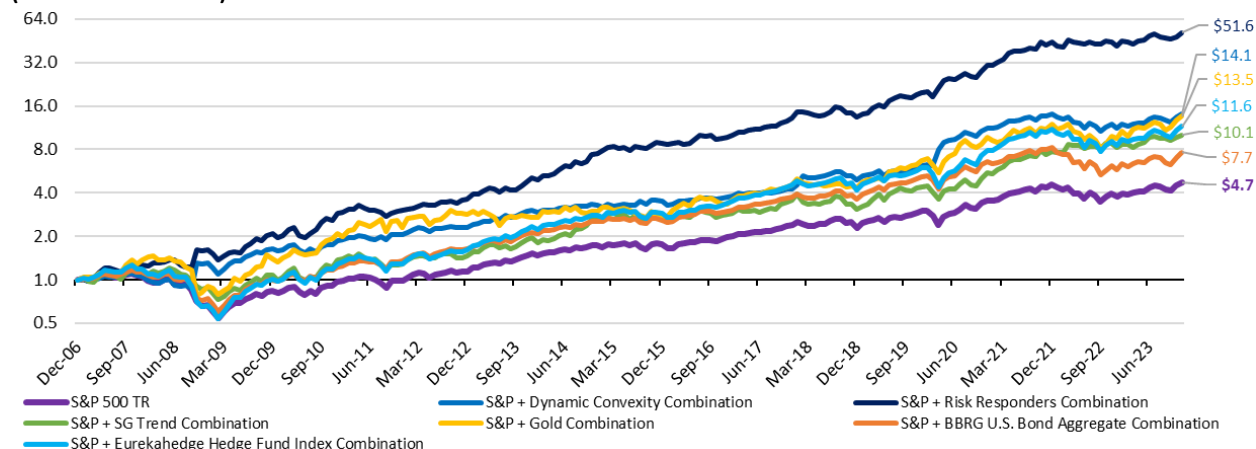

Source: One River, Bloomberg.

Next, in **Exhibit 6** we re-examine the long-term differences in cumulative returns between a compounded S&P 500 Index return versus the different combination portfolios (the same exhibit we reviewed in the introduction, for ease of reference).

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[6] We wrote about this possibility in our September 2021 paper *Regime Change Resilience*. https://oneriveram.com/alternatives-white-papers/April2023/OR-Regime%20Change%20Resilience%20-%20Rebooting%20Risk%20Mitigation%20with%20Structural%20Correlation%20-%20September%202021%20-%20One%20River%20Asset%20Management.pdf

[7] Since we do not incorporate the risk-free rate in these overlay simulations, we are using Information Ratios (Return / Volatility), not Sharpe Ratios ([Return – risk-free rate] / Volatility). Information Ratios are the more appropriate risk-adjusted return measure for such overlay programs, as we are measuring return above a benchmark. Changing these to use actual Sharpes does not change the outcome or insights of the analysis.

Exhibit 6: Cumulative Growth of $1 of S&P 500 vs. Combination Portfolios (S&P 500 + Overlay), Log-Scaled[8] (Jan 2007 – Dec 2023)

■ S&P 500 TR	■ S&P + Dynamic Convexity Combination	■ S&P + Risk Responders Combination
■ S&P + SG Trend Combination	■ S&P + Gold Combination	■ S&P + BBRG U.S. Bond Aggregate Combination
■ S&P + Eurekahedge Hedge Fund Index Combination		

Source: One River, Bloomberg

What drives these large differences in long-term portfolio outcomes? We can deconstruct the difference of a compounded return in the S&P 500 versus that for the different combination portfolio (S&P 500 + overlay) simulations as follows:

$$Comp.Return_{S\&P\ 500+Overlay} - Comp.Return_{S\&P\ 500} = IR_{Overlay} * Volatility_{Overlay} + Synergies_{Overlay}$$

Which can be further simplified as:

$$Comp.Return_{S\&P\ 500+Overlay} - Comp.Return_{S\&P\ 500} = Ann.Return_{Overlay} + Synergies_{Overlay}$$

What are Overlay Synergies?

Overlay Synergies is an overarching term that (in this paper) generally refers to the multitude of interaction effects between a market beta and an overlay return stream, resulting in long-term effects on total compounded portfolio value.

A simple way to conceptualize Overlay Synergies is to think about the behavior of these standalone return streams in a crisis – e.g., the COVID crisis. In March 2020, as the S&P 500 gapped down -12.4%, Dynamic Convexity and Risk Responders provided strong convexity (up roughly +37% and +28% net of fees respectively), SG Trend was mildly positive (+1.8%), Gold was down far less (-0.22%), U.S. Bonds were down similarly (-0.59%), while the EurekaHedge Hedge Fund Index was down roughly -6.6%.

But then, from April through the end of the 2020 calendar year the S&P 500 rallied strongly (+47.3%). Therefore, various combination portfolios all would have benefitted from this market rally, but each would be starting from *meaningfully* different portfolio values. These differences would have been driven by rebalancing from a positively convex return source back into equities, versus rebalancing from non-convex return sources. The differences in the various compounded performance figures for the 2020 calendar year, therefore, are driven collectively by both the overlay returns and these Overlay Synergies.

Overlay Synergies will also pick up other characteristics (beyond correlation, convexity, capital-efficiency, and rebalancing) of the overlay return that might be beneficial or detrimental to compounding outcomes, such as the tendency for a given return source

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[8] 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. All subsequent charts span from Jan 2007 – Dec 2023.

to trend (e.g., Gold, SG Trend Index) or mean-revert (e.g., Dynamic Convexity), return skew impacts, other non-Gaussian statistical impacts such as time-varying volatility, etc.

Of course, Overlay Synergies can also work against such a program, such as if the equity market persistently outperforms the overlay and/or there is insufficient diversification coming from the overlay. In these cases, it is possible to have a negative return contribution coming from these effects over time.

Analyzing Overlay Synergies

Below we replicate the adjustments we outlined earlier, which adjust the full-sample volatilities to be equivalent (20% annualized)[9], and discount the return streams to hit return levels, effectively controlling for excess return differentials and isolating Overlay Synergies.

Exhibit 7 below re-examines the analysis shown in Exhibit 4, but additionally shows how these overlay returns would have benefitted or impaired a pure S&P 500 investment, assuming different annualized full sample overlay returns of: +2%, 0%, and -2% respectively. These three scenarios highlight just how meaningfully these Overlay Synergies grow as the overlay return levels change modestly.

Exhibit 7: Full Sample Overlay Synergies Return at 20% Overlay Volatility (Jan 2007 – Dec 2023)
How Much Each Overlay Contributes or Detracts from Compounded Returns Assuming Different Overlay Return Levels

Compounded Return Contribution from Overlay, +2% Ann. Full Sample Overlay Return

Compounded Return Contribution from Overlay, 0% Full Sample Overlay Return

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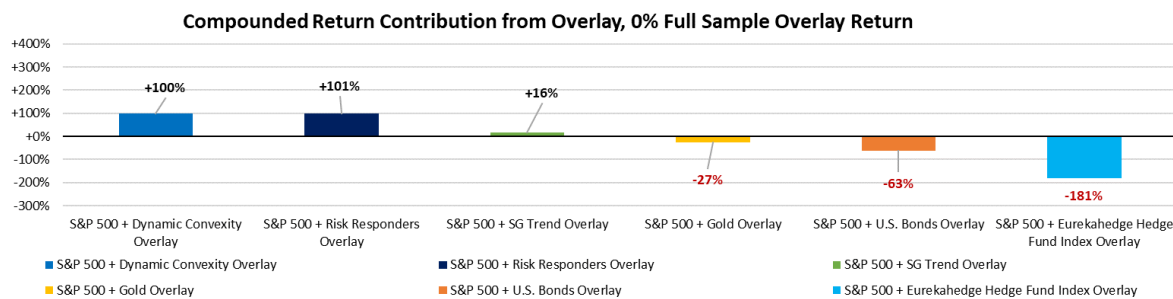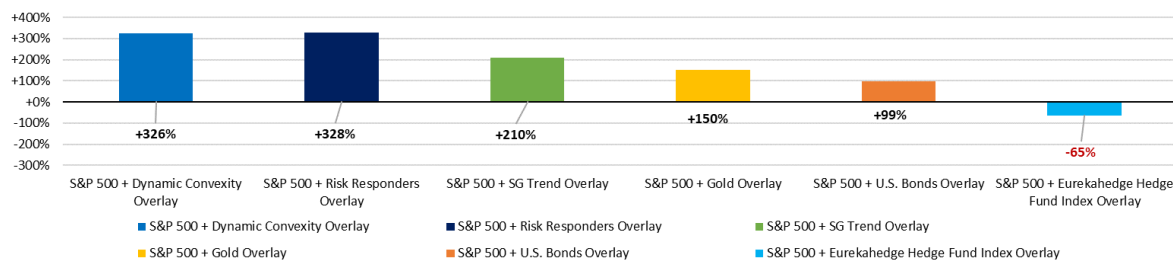
[9] This 20% volatility expected long-term volatility level, it is roughly the same long-term volatility expectation for the overlay implemented in One River's Dynamic Convexity Equity Overlay strategy, and thus in our view represents a reasonable volatility level for an overlay return.

Compounded Return Contribution from Overlay, -2% Ann. Full Sample Overlay Return
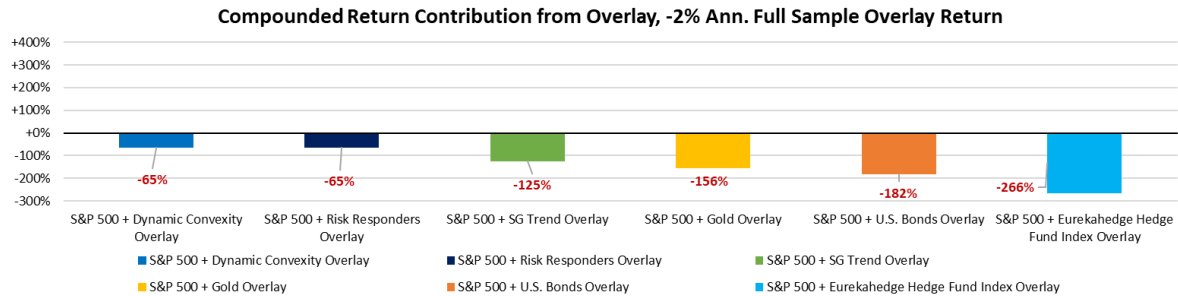
Source: One River, Bloomberg.[10]

Conclusion

Negatively correlated, positively convex strategies can increase portfolio returns irrespective of the strategy's standalone return. Further, the more negatively correlated and the more positively convex the overlay return is, the less strong the overlay's standalone performance needs to be to improve the long-term total portfolio value.

➢ Dynamic Convexity and Risk Responders, even with a simulated 0% full sample return (or even slightly negative return), produce **better** compounded results when paired with the S&P 500 versus a pure investment in the S&P 500. Further, these higher combination portfolio returns also often come with a higher portfolio IR (as seen in **Table 2**).

➢ Positively correlated overlays, such as U.S. Bonds (+0.2) and especially the EurekaHedge Hedge Fund Index (+0.8), would introduce a drag on the portfolio if they produced a 0% return. They also require much higher returns in order to improve portfolio outcomes. **Exhibit 7** demonstrates this.

➢ Very highly correlated overlays can further significantly reduce returns over time. The EurekaHedge Hedge Fund Index actually reduces compounded returns despite producing an +2% annualized overlay return.

The best compounding outcomes result from accessing overlay returns that combine strong convexity with alphas that do not overly dilute the convexity or alter the negative correlation profile.

➢ This is the precise underpinning for why **Risk Responders** was constructed in the manner it was. The dynamic combination of systematic long volatility and multi-asset trend was designed to produce maximum long-term portfolio benefit for an equity-centric investor, without reliance on duration bets (such as bonds) for that diversification.

Much of the portfolio benefit of defensive allocations comes from diversification and convexity properties, not just from expressing these exposures in a regularly rebalanced overlay implementation.

➢ If an allocator is unable to adopt an overlay implementation or rigid rebalancing schedule, then the total portfolio can still meaningfully benefit from a standalone capital-efficient and convex allocation. This can be inferred from Exhibit 6 (total compounding benefit), in which the magnitude of compounded portfolio benefits vastly outstrips that observed in Exhibit 3 (which isolates just Overlay Synergies).

➢ Even with less frequent rebalancing (e.g., quarterly, semi-annually, annually), one can replicate the majority of the rebalancing portfolio benefit produced in these analyses.

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[10] The volatilities of the various overlay returns were re-scaled to match the realized volatility of the full sample Dynamic Convexity return stream to control for varied volatility levels. Then, each return stream was discounted to hit a specific Information Ratio (as noted in the legends of the exhibits), to control for varied levels of excess return. The intention of these adjustments is to isolate the impact of correlation and convexity as it relates to driving compounding benefit or drag over time.

- Capital efficiency is always important, not just when the risk-free rate is high. Making the most of each dollar in a program adds very nontrivial compounding benefits over time. Higher volatility expressions, provided they are well risk-managed, will have the most impact.

- So, while overlay programs with structured rebalancing schedules appear to be the best implementation program for defensively oriented hedge fund returns, a segregated (and capital efficient!) allocation to such exposures can still deliver material benefits long term. [11]

With inquiries on this piece or any general questions on One River's investment strategies, please reach out to:
Patrick Kazley, Solutions Portfolio Manager – **Patrick.Kazley@oneriveram.com**

About One River

Founded in 2013 by Eric Peters, One River Asset Management is an innovative investment manager dedicated to delivering high-conviction diversifying 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 team of investment professionals with deep expertise in volatility, trend, systematic, thematic macro, 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.

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[11] For a comprehensive overview of the benefits of risk-mitigating allocations for portfolios, we encourage allocators to review Meketa's extensive work on this topic, an example is linked here: https://meketa.com/wp-content/uploads/2023/03/MEKETA_Risk-Mitigating-Strategies.pdf

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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.

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