

Quant Corner:

Understanding Active Risk and Tracking Error

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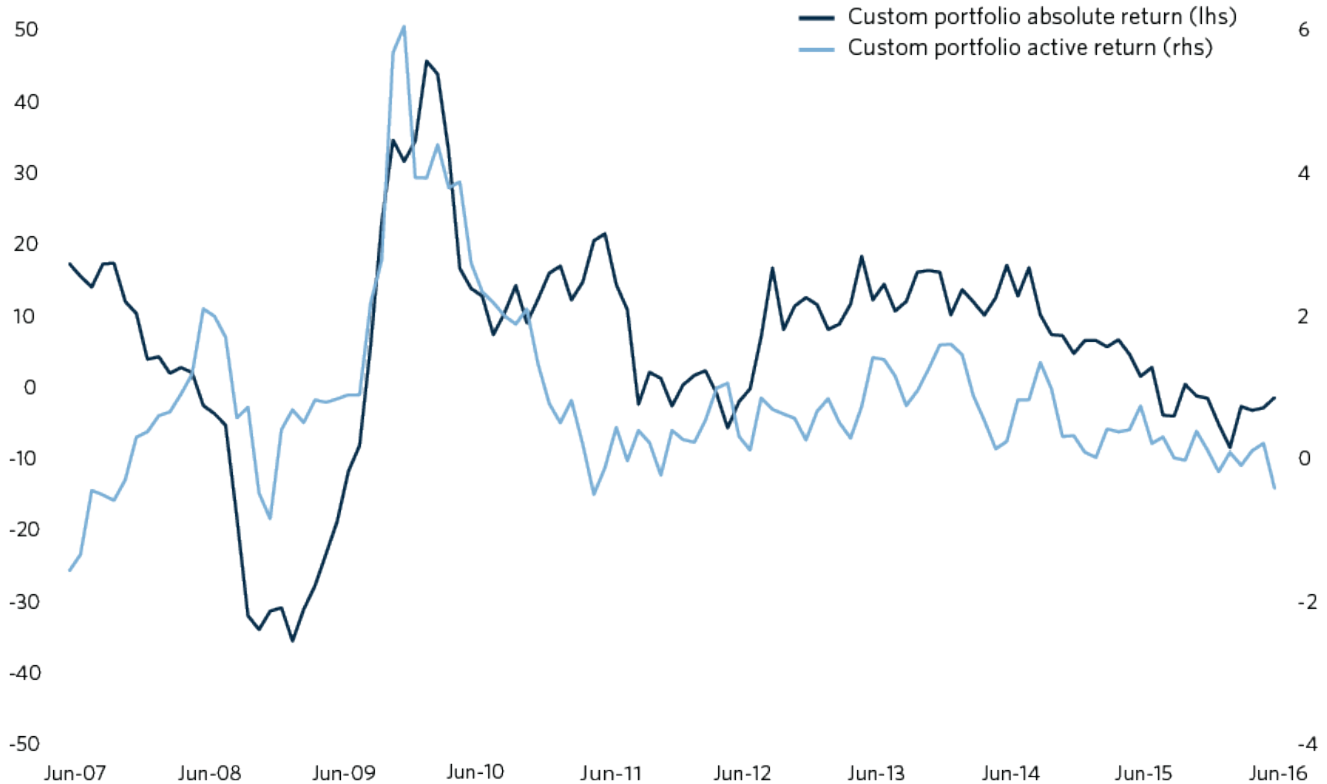


Investors frequently focus on the total return they experience in their portfolios. In periods when absolute returns are high, they feel good; in periods when absolute returns are low, they feel bad.

Yet good performance and bad performance should not be evaluated in a vacuum, they should be evaluated relative to the risks undertaken in their portfolios. Indeed, these risks are typically reflected in the investor's benchmark, or policy portfolio which embodies the tradeoffs between an investor's appetite for risk and desire for return over long periods of time. For instance, an investor may feel that a 70% MSCI ACWI Global Equity Index/30% Barclays U.S. Aggregate Bond Index (70/30) benchmark appropriately captures this tension. When equity outperforms fixed income, the 70/30 investor would be expected to trail an 80/20 portfolio and beat a 60/40 portfolio. Appropriate benchmarking is the first step in the investment decision-making process.

PORTFOLIO ABSOLUTE RETURNS AND ACTIVE RETURNS

12-month rolling | numbers in percent



Past performance is not indicative of future results.

Source: Commonfund Research

The second step is measuring performance relative to that benchmark. This requires a shift in frame of reference from absolute return and absolute risk to active return and active risk.¹ Active return equals the difference in return between a portfolio and its benchmark. Tracking error, as active risk is more commonly called, measures the volatility of active returns. Both tracking error and absolute volatility are measured in units of standard deviation. A portfolio with a tracking error of three percent can be expected to have its active return fall within plus or minus three percent of its benchmark two-thirds of the time. The remaining one-third of the time, it can be expected to fall outside this range.

We illustrate these concepts with a series of line charts. Consider a hypothetical custom portfolio, to be described in detail later, benchmarked against a passive 70/30 portfolio.

¹ In this article, we will use risk and volatility interchangeably. In truth, risk and volatility are not the same. For investors, financial risk connotes downside risk or the potential for loss of capital. Volatility, by contrast, treats risk symmetrically, incorporating both upside and downside risks. At Commonfund, we use a range of risk measures including volatility, value-at-risk, expected shortfall and maximum drawdown.

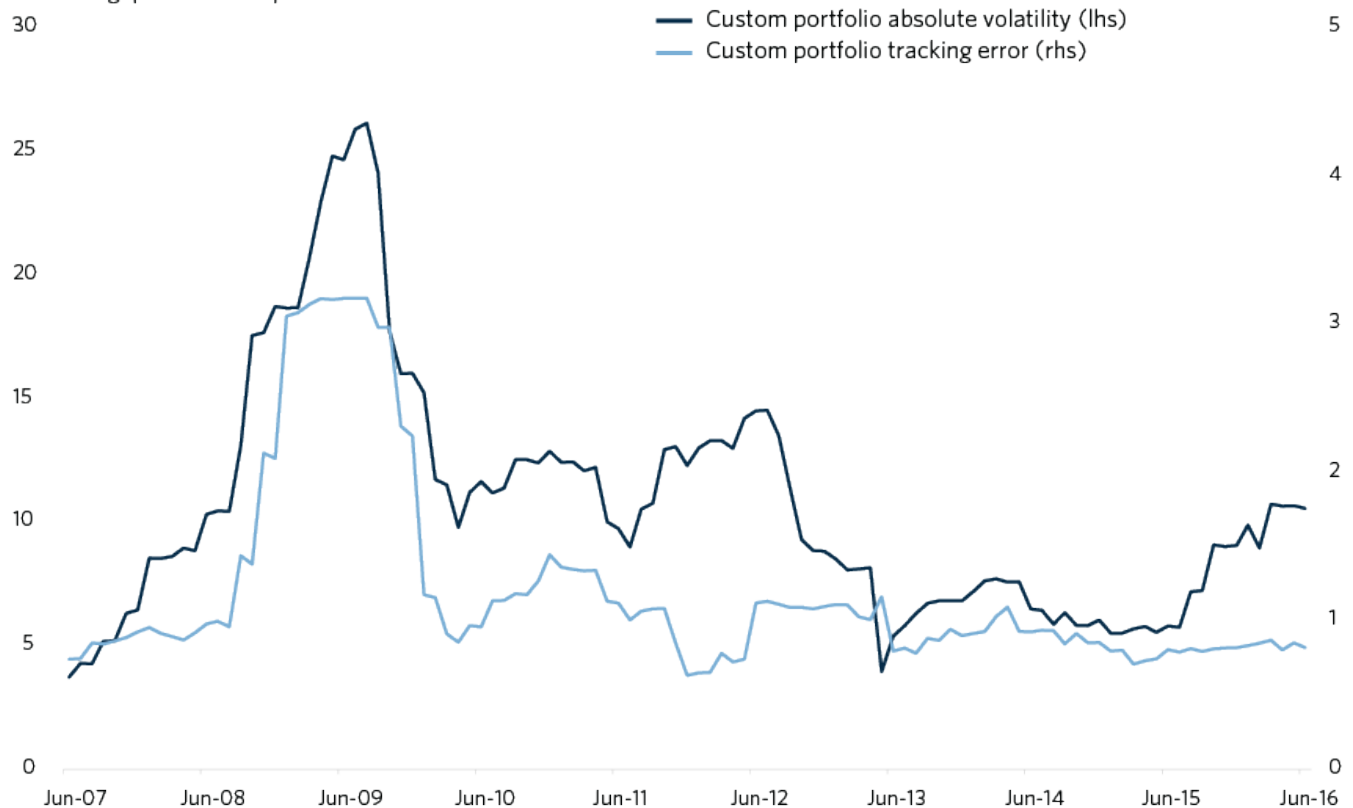
The first chart shows rolling 12-month absolute and active returns for this custom portfolio.

It is evident from the chart that both absolute returns and active returns vary significantly over time and, furthermore, that the volatility of absolute and active returns also changes over time. We can see absolute volatility and tracking error more clearly in the succeeding chart. Thus, for instance, absolute volatility and tracking error both spiked during the credit crisis before subsiding as the recovery took hold.

At Commonfund, we think about tracking error decomposition, or risk budgeting, across three levels: top, middle and bottom. We begin with top down asset allocation across asset classes. At the middle layer, we allocate to strategies within an asset class. At the bottom level, we employ security selection typically through managers. Thus, a top down decision might be to overweight equity versus fixed income. A middle layer decision might be to overweight U.S. equities within global equities. A bottom up decision might be to employ a specific active manager in a U.S. equity mandate.

PORTFOLIO ABSOLUTE VOLATILITY AND TRACKING ERROR

12-month rolling | numbers in percent



Past performance is not indicative of future results.

Source: Commonfund Research

To see how this works in practice, let's examine the custom portfolio portrayed above in more detail. Specifically, we will examine how the active decisions made for the custom portfolio relative to the 70/30 portfolio allocate risk to distinct sources of tracking error. Then we will examine how

those distinct sources interact with one another to produce the active portfolio's tracking error.

The active decisions in the hypothetical custom portfolio differ from the 70/30 portfolio in five ways as detailed in Table 1.

TABLE 1

10-Years Ending June 30, 2016

Level	Active Decision	Custom Portfolio	Benchmark Portfolio
Top / Asset Class	1. Equity underweight	65% equity / 35% fixed	70 equity / 30% fixed
Middle / Strategy	2. U.S. equity overweight	55% U.S. / 45% global ex U.S.	MSCI ACWI weights, roughly 50 / 50 today
	3. High yield allocation	90% Core / 10% High yield bonds ²	100% Core bonds
Bottom / Manager	4. Active U.S. equity	Hypothetical active portfolio	MSCI U.S. Equity index
	5. Active core bonds	Hypothetical active portfolio	Barclays U.S. Aggregate Bond Index

Past performance is not indicative of future results.

Source: Commonfund Research

² High yield bonds allocation uses Barclays Capital High Yield Bond Index.

Of the five active decisions, one is top level asset class-allocation, two are middle level strategy-selection and two are bottom level manager-selection. The equity asset class underweight at the top level reduces absolute risk while the out of benchmark high yield strategy selection at the middle level increases absolute risk. These two active decisions should be partially offsetting for absolute risk. In addition, less equity risk and more credit risk should provide a better diversified portfolio. This example demonstrates that active decisions interact across levels.

Let's examine the characteristics of each of the five active decisions over the trailing ten years in Table 2.

Active returns are positive for each of the active decisions and in aggregate. The sum of active returns by decision approximates total portfolio active returns when strategies are weighted by their size in the portfolio. The difference is interaction, a technical term that reflects the fact that individual portfolio decisions are not truly independent over time.

We now turn to tracking error. In theory, the active decision tracking errors range from 0.85 percent to 2.48 percent when applied at full portfolio weight in isolation. In practice, we do not apply them at a total portfolio weight and they are not applied in isolation. They are sized and implemented

TABLE 2

10-Years Ending June 30, 2016

	Active Decision	Weight vs. Benchmark	Decision Active Return (Annualized)	Decision Contribution to Active Return (Annualized)
		A	B	A * B
Top	Equity underweight	100.0%	0.07%	0.07%
Middle	U.S. equity overweight	65.0%	0.39%	0.25%
	High yield allocation	35.0%	0.29%	0.10%
Bottom	Active U.S. equity	35.7%	0.18%	0.07%
	Active core bonds	31.5%	0.90%	0.28%
Interaction				-0.07%
Total			0.70%	0.70%

Past performance is not indicative of future results.
Source: Commonfund Research

together. For sizing, we use the actual weights at which the active strategies are applied in the portfolio. Thus, the equity underweight occurs at the total portfolio level (100%) while the U.S. equity underweight only applies to the equity portion of the portfolio (65%). Combining applied weights and decision tracking errors produces the standalone tracking error for each of the decisions. The sum of these results far exceeds the actual portfolio tracking error because the standalone tracking errors are not perfectly correlated.

The standalone tracking error measures total tracking error only when all active risks are perfectly correlated. This is

clearly not the case. The difference between standalone tracking error and contribution to tracking error is the benefit from active risk diversification because the active decisions have correlations less than one. The correlations of the active decision excess returns with the total portfolio excess returns provide the component of the active decision tracking errors that are additive. The remainder is diversified away. Thus, for example, 25 percent of the U.S. equity overweight tracking error is additive to total portfolio tracking error (highlighted in tables below). We can think of the correlations as providing the portion of the individual decision tracking errors that are aligned in the same direction. We thus multiply standalone tracking errors

TABLE 3

10-Years Ending June 30, 2016

	Active Decision	Weight vs. Benchmark	Decision Tracking Error (Annualized)	Decision Standalone Tracking Error (Annualized)	Decision tracking error correlation with total portfolio tracking error	Decision contribution to total portfolio tracking error (Annualized)
		A	B	A * B	C	A * B * C
Top	Equity underweight	100.0%	0.85%	0.85%	18%	0.16%
Middle	U.S. equity overweight	65.0%	0.87%	0.57%	25%	0.14%
	High yield allocation	35.0%	1.04%	0.37%	25%	0.09%
Bottom	Active U.S. equity	35.7%	2.48%	0.89%	71%	0.63%
	Active core bonds	31.5%	1.96%	0.62%	50%	0.31%
Total			1.32%	3.30%		1.32%

Past performance is not indicative of future results.

Source: Commonfund Research

TABLE 4

10-Years Ending June 30, 2016

	Active Decision	Decision Active Return (Annualized)	Decision Tracking Error (Annualized)	Decision information ratio	Decision contribution to active return (annualized)	Decision contribution to total portfolio tracking error (annualized)	"Decision contribution information ratio"
		A	B	C: A / B	D: A * w t	E	D / E
Top	Equity underweight	0.07%	0.85%	0.08	0.07%	0.16%	0.45
Middle	U.S. equity overweight	0.39%	0.87%	0.45	0.25%	0.14%	1.79
	High yield allocation	0.29%	1.04%	0.28	0.10%	0.09%	1.14
Bottom	Active U.S. equity	0.18%	2.48%	0.07	0.07%	0.63%	0.10
	Active core bonds	0.90%	1.96%	0.46	0.28%	0.31%	0.92
	Interaction				-0.07%		
Total		0.70%	1.32%	0.53	0.70%	1.32%	0.53

Past performance is not indicative of future results.
Source: Commonfund Research

by these correlations and sum them to get the total portfolio tracking error. In this case, the top and middle layers strategies provide better diversification.

If we look at the ratio of individual decision active returns to tracking error, we have a measure of return relative to risk called the information ratio. Higher information ratios are indicative of better active decisions. As seen in Table 4, the information ratio indicates active core bonds (0.46) and the U.S. equity overweight (0.45) were the best decisions in isolation over this time period. The active U.S. equity decision was the worst.

The "decision contribution information ratio" is one way to view the best decisions in this portfolio given the size at which other active decisions are simultaneously

being taken.³ Considering the active decisions together rather than individually, the U.S. equity overweight and the high yield allocation are the most attractive. The high yield allocation and the active core bonds strategies trade places.

Unfortunately, we cannot know in advance which decisions will outperform or underperform. However, we can better balance the allocation to tracking error across decisions. This is important because tracking error tends to be more stable and predictable than active returns. From this perspective, it is clear that the active U.S. equity decision was significantly oversized. In comparison, the equity underweight, U.S. equity overweight and high yield allocations were undersized.

³ Strictly speaking, these are not decision contributions as the sum across all of the decisions does not yield the total portfolio information ratio. These are akin to marginal, or incremental, information ratios.

Equal risk budgeting would have resized the positions to more similar contributions to tracking error. The allocations to the equity underweight, U.S. equity overweight and high yield allocations would have been larger while the active U.S. equity allocation would have been smaller. In this case, the better balanced set of initial decisions would have delivered a better outcome.

In portfolio construction, we seek to provide a well-balanced set of high quality portfolio decisions. This is true at the absolute level in terms of total risk and total return. It is also true at the active level in terms of tracking error and active return. Just as risk and contribution to risk can enable us to provide a balanced absolute risk portfolio, tracking error and contribution to tracking error can enable us to provide a balanced active risk portfolio. At Commonfund, balance and risk budgeting are a core part of our portfolio construction processes. This applies across asset classes, strategies and vehicles. It also occurs across factors as we explained in an earlier paper [The Curious Case of Risk Exposures in Diversified, Multi-Asset Class Portfolios - A Deep Dive](#). We believe that this disciplined approach to portfolio construction can yield better risk and return tradeoffs for our clients.

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