Portfolio Construction Theory Series - Part 1

Series Introduction

This is the first in a three-part series on portfolio construction theory. Over the coming weeks, we'll build a framework for thinking about how assets fit together in a portfolio, starting with a puzzle that challenges conventional intuition, working through the mechanics of diversification, and ultimately applying these concepts to real portfolio decisions.

The core insight we'll develop: an asset's standalone characteristics can be misleading. How an asset interacts with everything else you own deserves as much attention as its individual return and risk profile. Understanding that interaction requires thinking carefully about three variables — volatility, Sharpe ratio, and correlation — and how they trade off against each other under different constraints.

The Diversification Puzzle

There's a funny phenomenon where a "worse" standalone asset can be a better asset to add to a portfolio than one that appears "better" in a vacuum. As an illustrative example, let's take a portfolio that is simply 100% allocated to the S&P 500 Index ("S&P 500"), and look at two options for adding a second asset (a hedge fund) to that portfolio. Here are the excess return, volatility, and resulting Sharpe ratio for each asset:[1]

	S&P 500	Hedge Fund #1 (Low Volatility)	Hedge Fund #2 (Medium Volatility)
Annualized Excess Return	12.57%	2.50%	5.50%
Annualized Volatility	14.04%	2.00%	7.00%
Sharpe Ratio	0.90	1.25	0.79

Assume further that neither of the hedge funds have any correlation to the S&P 500.

At first glance, Hedge Fund #1, with its higher standalone Sharpe ratio, seems like obviously the better asset to add to the portfolio of 100% long S&P 500. With leverage, this may be the case, though levering up a hedge fund comes with costs and risks that can change the calculus. We'll explore leverage in depth in Part 3, but for now we assume an unwillingness or inability to use it.

[1] S&P 500 excess return and volatility statistics are for the 15-year period from January 2011 through December 2025. 1.50% is the average risk-free rate over the past 15 years (January 2011 through December 2025) and is used to calculate excess return throughout this piece.

Suppose we want to create a portfolio with an expected total return of 10% (including a risk-free rate of 1.50%, so an 8.50% excess return). Which asset is better for that? Surprisingly, the answer is Hedge Fund #2. Even more surprisingly, it's not even close, as you expect over 1% lower volatility at the same expected return. Here's how you would create a 10% expected return portfolio with each of the hedge funds:

	S&P 500	Hedge Fund #1
Expected Excess Return	12.57%	2.50%
Expected Volatility	14.04%	2.00%
Weight	60%	40%
Correlation	0.00	
Combined Excess Return	8.50%	
Combined Total Return	10.00%	
Combined Volatility	8.40%	

	S&P 500	Hedge Fund #2
Expected Return	12.57%	5.50%
Expected Volatility	14.04%	7.00%
Weight	42%	58%
Correlation	0.00	
Combined Excess Return	8.50%	
Combined Total Return	10.00%	
Combined Volatility	7.19%	

How could this possibly be?

Theory: Volatility and the Diversification Sweet Spot

In order to answer that question, we have to step back and cover some portfolio construction theory. In the simple two-asset example where your first asset is fixed (in our case, equity as represented by the S&P 500), there are three levers to adjust what you're getting out of your second asset, and then of course you can adjust the relative weightings between the two assets. The three levers are:

1. Volatility of Asset #2
2. Sharpe ratio of Asset #2 (so, return relative to volatility)
3. Correlation between Asset #1 and Asset #2

Let's cover the first of these, volatility, in depth. We'll address Sharpe ratio and correlation in the next installment.

Volatility of Asset #2

Varying the volatility of your second asset has the obvious effect of changing the volatility of the portfolio, but it's not a simple linear relationship, because of diversification. A closer look at diversification will help us understand how to think of the volatility of the second asset.

If you have two assets that have equal return and volatility, but are uncorrelated to each other, a portfolio with a combination of those two assets will have better risk-adjusted returns than either asset individually. If Asset A and Asset B each have annualized return of 10% and annualized volatility of 10%, moving from a portfolio that is 100% allocated to Asset A to one that is 90% allocated to Asset A and 10% allocated to Asset B will improve risk adjusted returns. Expected return remains at 10%, but projected volatility falls from 10% to 9.06%. An 80%/20% split is even better; volatility falls to 8.25%.

When does adding more of Asset B stop improving risk-adjusted returns? The best combination is 50% allocated to each asset. Any further than that (40% asset A, 60% asset B, etc.) starts to look worse again. The intuition behind this is as follows: We know Asset A and Asset B are diversifying to each other — they have zero correlation. Thus, we want to maximize the amount of "interaction" between them. With a portfolio 50% allocated to each, they are each contributing equal amounts of (uncorrelated) volatility. If we were to shift allocations back to 60%/40%, that portfolio could be viewed as 40%/40% Asset A/Asset B, with an extra 20% allocated just to Asset A, and we know that undiversified 20% has a worse risk/return profile than a combination of the two assets. Not optimal.

The key insight here is that the assets are contributing equal amounts of risk to the portfolio in the optimal case, not that it happens to be 50%/50%. It's only 50%/50% in our example because the two assets have the same volatility. If we were to introduce a third asset, Asset C, that has double the return and volatility of Asset B (20%/20%), then 50%/50% would not be the optimal allocations in a portfolio of Asset A and Asset C. At 50%/50%, you could view that portfolio as 50% Asset A, 50% Asset B at its original 10% return and 10% volatility, and another 50% of Asset B that's undiversified. Instead, the optimal allocations for a two asset portfolio (from a pure diversification standpoint) are 66.7% Asset A/33.3% Asset C, where the assets contribute equal amounts of risk, or expected volatility, to the total portfolio. We call this point where the two assets contribute equal amounts of risk to the portfolio the "Diversification Sweet Spot."

There's a simple way to figure out optimal weights given each asset's volatility: The optimal weights are the inverse of the ratio of the asset's volatilities. Asset A has 10% volatility to Asset C's 20% volatility, so the optimal weights will be the inverse, 20%:10%, or 66.7% Asset A / 33.3% Asset C when scaled to sum to 100%.

Two take-home points:

1. Diversification benefit is maximized when each asset contributes equal risk to the portfolio. Equal risk contribution is achieved at allocations that are the inverse of each asset's relative volatility (e.g. an asset with twice the volatility of another asset in a two-asset portfolio will have half the weight). This diversification benefit sweet spot is the same even when correlations are not 0.0, as we will demonstrate in the next piece.

2. Varying the volatility of your second asset will change the allocation that provides the most diversification benefit. Higher volatility assets will need a lower weight in the portfolio, as at lower weights they will still contribute their fair share of risk.

Preview of Part 2

We've established that diversification benefit is maximized when assets contribute equal risk to the portfolio, which we call the "Diversification Sweet Spot." But diversification is only one part of the equation. What happens when one asset has a higher Sharpe ratio than another? And how does correlation between assets affect these calculations?

In Part 2, we'll complete the theoretical framework by examining how Sharpe ratio differences and correlation levels interact with volatility to determine optimal allocations. We'll also introduce a practical decision framework that converts these three variables into intuitive allocation guidance. By the end, we'll have all the pieces needed to explain why the Medium-Vol/Lower-Sharpe fund beats the Low-Vol/High-Sharpe fund in our opening puzzle, though we'll save the full resolution for Part 3.

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