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CORRELATION VS BETA: WHAT IS THE DIFFERENCE AND WHY DOES IT MATTER?

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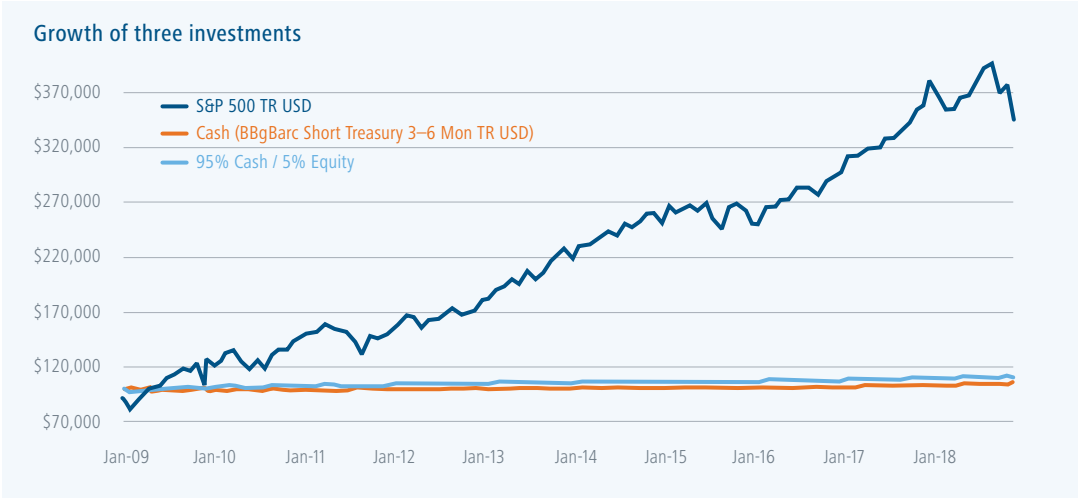
How much will a new investment idea diversify a portfolio? Will it really add something new? Or will it just provide more of the same? To answer that question, many people start with the correlation coefficient.

Correlation, although useful, is often misunderstood. Contrary to popular belief, it only provides a partial description of how two investments move together. Correlation measures the tendency of two data sets to move in the same direction, but it does not account for the relative size of those directional moves. Another key statistical measure – Beta - accounts for both direction and relative volatility and can therefore be more insightful when comparing the return streams of two investments.

To illustrate this point, consider a portfolio with an asset mix of 95% cash (represented by T-bills) and 5% equity (S&P 500). The chart and table below show how such a portfolio and its components in isolation would have grown over 10 years. The correlation and betas of these investments to the S&P 500 are also listed below.



2009–2018	S&P 500	Cash	95% Cash / 5% Equity
Cor (S&P 500)	1.00	-0.09	0.97
Beta (S&P 500)	1.00	0.00	0.05

Source: Morningstar

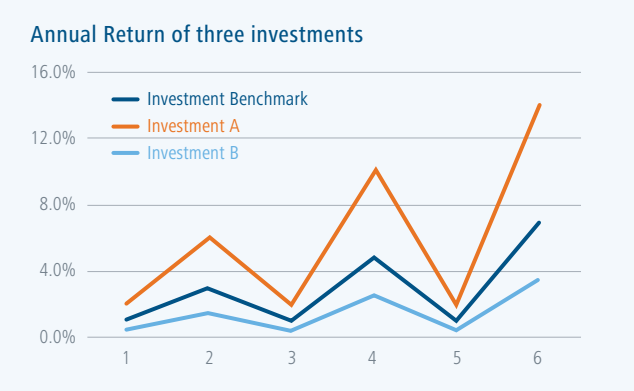
In stark contrast to the S&P 500, the 95% cash, 5% equity portfolio barely grew over 10 years. This should not come as a surprise. What may be surprising however is that despite the wide gap in returns, the statistics show that these two investments are in fact nearly perfectly correlated with one another! How similar is this portfolio to the S&P 500? How much are equities driving the performance in this portfolio? Looking at the data above, it becomes clear that the answer is in the 0.05 equity beta and not in the 0.97 correlation. If your question is, "How much is the portfolio expected to move when equity markets move by 1%?" then beta alone provides the answer, not correlation.

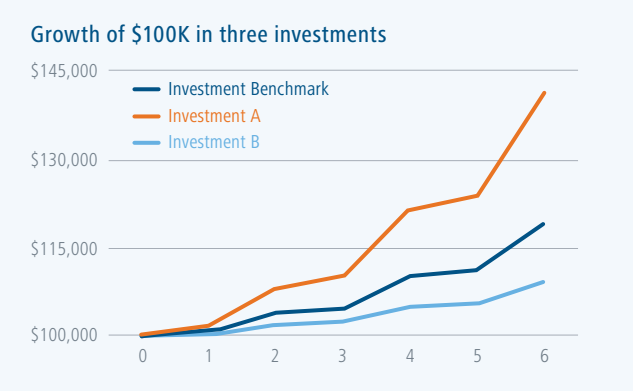
One step further: more on the concepts of correlation and beta with a simple example

Consider hypothetical investments A and B and their benchmark. Below we present 6 years of annual returns for each and display how $100,000 invested in each at T=0 would have grown if fully invested and held for 6 years.

	Investment		
Year	Benchmark	A	B
1	1.0%	2.0%	0.5%
2	3.0%	6.0%	1.5%
3	1.0%	2.0%	0.5%
4	5.0%	10.0%	2.5%
5	1.0%	2.0%	0.5%
6	7.0%	14.0%	3.5%

	Investment		
Year	Benchmark	A	B
0	$100,000	$100,000	$100,000
1	$101,000	$102,000	$100,500
2	$104,030	$108,120	$102,008
3	$105,070	$110,282	$102,518
4	$110,324	$121,311	$105,080
5	$111,427	$123,737	$105,606
6	$119,227	$141,060	$109,302





How are investments A and B correlated with their benchmark and to each other? It will come as a surprise to many that they are all in fact perfectly correlated with one another.

	Correlations		
	Benchmark	A	B
Benchmark	1.0	1.0	1.0
A		1.0	1.0
B			1.0

That is because correlation simply measures the tendency of two data sets to move in the same *direction*. It does not account for the relative size of those directional moves.

What are the betas of these two investments relative to their benchmark?

	Benchmark	A	B
Standard Deviation	2.5%	5.1%	1.3%
Beta to Benchmark	1	2	0.5

The beta figures account for the differences in volatility (standard deviation) between the return series and thus provide a more complete description of funds A and B in terms of the benchmark.

The key take-away is that correlation is a helpful statistic. Yet on its own, it fails to account for the relative risk of the investments we are comparing. The beta measure incorporates the correlation *and* the relative risk, making it a more useful measure of relative investment behaviour.

Beta = Correlation (Investment with benchmark) x (Investment risk / Benchmark risk)

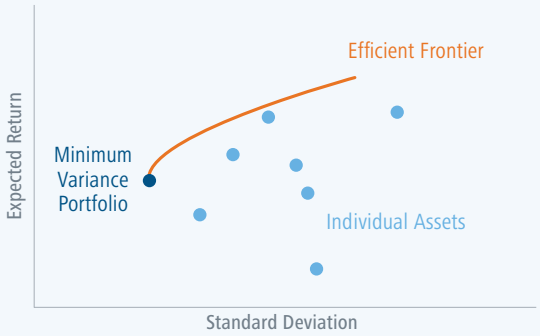
One step further: using correlation and beta to expand the efficient frontier

In modern portfolio theory, an efficient portfolio is one that combines individual investments in such a way as to maximize the expected rate of return for a given level of risk. The range of efficient portfolios is referred to as the efficient frontier. The level of portfolio efficiency (return per unit of risk) is referred to as the Sharpe ratio.

The expected return for a given portfolio is easy enough to calculate. It is simply the weighted average expected return for all assets within a portfolio.

Calculating expected risk, as defined by standard deviation, is a more complicated exercise. To calculate expected portfolio risk, we need to consider the weights of each asset in the portfolio, as well as their individual expected levels of risk and their correlations with one another (this can also be worked out in terms of asset class or factor betas; this also assumes normal distributions for the underlying investments).

The Efficient Frontier



Source: Mackenzie Investments, 2019.

Without diving too deep into the math and assuming we already own an efficient portfolio, is there a quick way to make an informed judgement on whether a given investment should be expected to enhance my risk-adjusted returns? In other words, how do I know it has diversification benefits relative to *my portfolio?*

There is a rule of thumb to determine just that, and it's laid out below. If this relationship holds true, the new investment should be strongly considered:

Generally, when evaluating a new investment for inclusion in a portfolio, there are three variables to look at:

$$\frac{\text{New investment expected return}}{\text{New investment expected risk}} > \frac{\text{Current portfolio expected return}}{\text{Current portfolio expected risk}} \times \text{Expected correlation between new investment and current portfolio}$$

Expected return, expected risk, and expected correlation to whatever you are considering combining it with. Perfect candidates for portfolio enhancement have a higher expected return and less risk than the current portfolio, and minimal (ideally negative) correlation to the current portfolio. All the variables are important to consider, but none should be looked at in isolation.

Referencing the formula for beta from the previous section, this relationship can be rearranged in terms of beta:

$$\text{New investment expected return} > \text{Current portfolio expected return} \times \text{Expected beta of new investment in terms of current portfolio}$$

From this simplified view, a perfect candidate for portfolio enhancement would have both a low beta to the current portfolio and a higher expected return. However, to add value (contribute to a higher expected risk-adjusted return) one may be willing to accept a lower return from the new investment if it also came with a low beta to the existing portfolio.

E.g. The expected return of my current portfolio is 6% and I am looking at ways to enhance my risk-adjusted returns. The new fund I am looking at has a beta of 0.5 to my existing portfolio and an expected return of 4%. Should I consider this investment?

Answer: Yes

Work: 4% > (6% x 0.5 = 3%)

Assuming a beta of 0.5 with the existing portfolio, this new investment must also be expected to achieve a rate of return of at least 3% to be complimentary from a risk/return perspective.

A moderate to low beta to the existing portfolio combined with a positive expected return is attractive from a diversification perspective because it means that much of these returns are being driven by factors not currently at work in the portfolio.

According to modern portfolio theory, the amount ultimately allocated to the new strategy will be the output of an optimization process that considers the expected risk, return, and correlations of all our qualifying investments. It will also depend on our target risk or target return, and will be subject to any constraints that we impose on it.

Although our analysis should not stop here, the simple framework laid out above provides a good way to make an informed initial judgement on the diversification potential of a new investment.

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