Accounting for Total Portfolio Diversification

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Understanding Diversification

One of the most central, but misunderstood, topics in asset allocation is **portfolio diversification**. Everyone talks about diversification as though it is an easy thing to achieve, but many of the portfolios that I see in articles and submitted to us by our clients demonstrate that many people—professionals and individual investors alike—do not fully understand diversification. The simple idea behind diversification is easy enough to grasp: you don't want all of your investment eggs in one basket. For this reason, investors are advised to put their money into a range of asset classes at various allocations. The idea here is that when one asset is down, others may be up—the various assets in the portfolio are not perfectly correlated. The less correlated the assets are, the better off you are. The fundamental problem that many investors run into, however, is that the diversification effects of putting your money into various 'asset classes' are not equal. The reason for this is that the actual diversification effects are determined by how well correlated the returns are among all of the assets in a portfolio. Just because two funds represent different industries does not mean that they are they are not well correlated. Allocating your money into assets or asset classes that are highly correlated will be far less beneficial than putting your money into asset classes that are not correlated with one another. Many of you have read all of this before, but read on. There is a source of correlation between assets that most people are unaware of called non-systematic correlation—and more correlation means that a portfolio is more risky.

Two Basic Sources of Correlation

There are two basic sources of correlation between assets: market-driven correlation and non-systematic correlation. Market-driven correlation is the correlation that is driven by the fact that most assets follow the overall market to some degree. Market-driven correlation is represented by Beta. Non-systematic correlation is the correlation in assets that is specific to the assets, above and beyond market-driven correlation. We can also refer to non-systematic correlation as ***non-Beta correlation***.

Diversifying Beta Effects

It is quite easy to track Beta effects in a portfolio and to think about them in a simple way. If you mix high-Beta assets with low-Beta assets, you will tend to get good portfolio effects. This is why it is obvious to mix bonds or bond funds (which tend to be zero Beta) with market index funds, which tend to have Beta close to 100%. An asset which moves with the market (high Beta) will tend to diversify well with an asset that does not move with the market (zero Beta). Many investors grasp this idea and make use of it. Many investors do not properly manage Beta effects in their portfolios, and if you do not have this component in hand, this is a good place to start. A portfolio tool such as Quantext Portfolio Planner will quickly calculate portfolio Beta and Betas for all portfolio components, allowing you to build a portfolio with offsetting Beta effects. One of the great things that Beta can show you about funds or ETF's, for example, is whether they will increase or decrease your exposure to the U.S. market. Many foreign funds actually have Betas with respect to the S&P500 that are greater than 100%, which means that they actually tend to increase exposure to the S&P500.

Non-Beta Correlation

Now the story becomes more complex. What happens when there is substantial correlation in assets beyond Beta? This does happen. What if there are two funds with low values of Beta but that are highly correlated with one another—such as two utilities funds? This would mean that the two funds are more correlated with one another than either one is to the market as a whole. These two funds exhibit high non-Beta correlation. This effect also tends to be pronounced if you have a concentrated portfolio of individual stocks or very focused funds that tend to be more highly correlated to one another than to the market as a whole.

When evaluating a portfolio on an historical basis or with Monte Carlo simulation, it is very valuable to be able to account for non-Beta (non-market driven) correlation effects on total portfolio risk. Quantext Portfolio Planner captures these effects, as described in more detail later. The other portfolio management / Monte Carlo tools that we have examined cannot effectively capture non-market correlations.

Measuring Diversification

Let's imagine that you mistakenly invested money in two essentially identical utilities-focused index funds or ETF's. Obviously, these two assets provide no more 'diversification' than if you simply invested all of the money in one of these. Wouldn't it be nice to have a portfolio metric that would show you that investing in both of these funds provided no diversification effect? We have created a simple metric of diversification that measures the degree of residual correlation in a portfolio beyond Beta effects. For the technically inclined, this statistic measures the correlations in non-systematic risk across the portfolio. For the user, we may simply note that the Diversification Metric (DM) has a value of zero if you have a portfolio made up of assets with perfect correlation in their non-systematic risk. As portfolio diversification increases, DM increases. DM is distinct from Beta because Beta measures correlation to market returns (systematic risk) and DM measures lack of correlation between the non-market components of returns. We calculate DM from historical data within ***Quantext's Portfolio Planner*** software and these effects are also captured in the forward-looking Monte Carlo simulations. For the examples shown here, we are analyzing three years of market data for the purposes of portfolio evaluation and simulation and assuming a future average rate of return of 8.3% per year for the S&P500, with a standard deviation of 15.07%.

Let's imagine that we have a portfolio which includes two ETF's that focus on U.S. utilities: IDU and XLU. In fact, for purposes of illustration, let's look at a portfolio with only these two ETF's. These two ETF's are very well correlated with one another and have very similar values of Beta, R^2, average historical returns and standard deviation in returns. Having these two ETF's in a portfolio should provide no diversification effects and ideally a portfolio tool will alert you to this. Both of these ETF's have low systematic correlation (low Beta), and the non-Beta correlation between them is very high—the returns on these two ETF's are essentially 100% correlated. If you look at the historical and Monte Carlo analysis shown below, the Diversification Metric (shown at the bottom of the figure) is zero. The Monte Carlo model has correctly determined that

these two funds may as well be exactly the same asset. The projected standard deviation in annual returns on IDU and XLU are 22% and 23%, respectively. The projected standard deviation in returns on this portfolio in the Monte Carlo simulation is 22.2%. If there were any diversification effects between IDU and XLU, you would see a portfolio standard deviation that is lower than the SD's of the portfolio components. We have also verified that this works for a portfolio with just IVV and SPY, but this result was expected because of the high R^2 values for SPY and IVV. While I hope that most investors are savvy enough to know when they are carrying a bunch of non-diversifying assets, I have seen from personal experience that many do not understand that many of their apparently separate assets confer minimal diversification effect.

These effects may sound trivial, but many people have portfolios that include multiple funds with essentially the same style and components. Measuring Diversification Metric to determine whether each fund actually adds diversification would improve many portfolios. Many professionals understand that more is not necessarily better when it comes to the number of portfolio components. A recent interview with John Bogle, founder of Vanguard, about his portfolio holdings revealed that he holds less than ten funds in his entire portfolio (see link to this article at the end of this paper).

Fund Name	Percentage of Funds	Average Annual Return
IDU	50.0%	11.72%
IXC	0.0%	19.15%
IGE	0.0%	19.44%
IVV	0.0%	8.40%
IJH	0.0%	10.55%
IWM	0.0%	13.55%
RWR	0.0%	17.10%
DUK	0.0%	17.84%
EXC	0.0%	14.90%
XLU	50.0%	12.00%
SPY	0.0%	8.48%
-	0.0%	-
-	0.0%	-
-	0.0%	-
-	0.0%	-
-	0.0%	-
-	0.0%	-
-	0.0%	-
-	0.0%	-
-	0.0%	-
Sums to	100.0%	

Portfolio Stats	
Average Annual Return	Standard Deviation(Annual)
11.77%	22.20%

Historical Data	
Start: 4/15/2003	End: 4/15/2006
Average Annual Return	Standard Deviation (Annual)
17.67%	11.44%
Historical Beta: **51.78%**	
Historical Yield: **3.04%**	

Performance of S&P500 over historical period

Average Annual Return on S&P500
11.70%
Annual Standard Deviation on S&P500
7.77%

Market Index (S&P500)	
Average Annual Return	Standard Deviation (Annual)
8.30%	15.07%

Simulated Portfolio Beta
51.78%

Diversification Metric: 0%

Portfolio with only two utilities ETF's

Okay, so we are all smart enough to notice that the two utilities ETF's are redundant, but let's consider some other more subtle cases now. What if we had a portfolio that is equally allocated into IDU, IXC (iShares Global Energy), Duke (DUK), and Excelon (EXC)? Does this confer any real diversification? In fact, it does (see below). Even though this portfolio is concentrated, there is some value in combining these assets in a portfolio as opposed to simply investing in one of the ETF's. In this portfolio, we get a Diversification Metric, DM=20%, suggesting some real diversification effects.

Fund Name	Percentage of Funds	Average Annual Return
IDU	25.0%	11.72%
IXC	25.0%	19.15%
IGE	0.0%	19.44%
IVV	0.0%	8.40%
IJH	0.0%	10.55%
IWM	0.0%	13.55%
RWR	0.0%	17.10%
DUK	25.0%	17.84%
EXC	25.0%	14.90%
XLU	0.0%	12.00%
SPY	0.0%	8.48%
-	0.0%	-
-	0.0%	-
-	0.0%	-
-	0.0%	-
-	0.0%	-
-	0.0%	-
-	0.0%	-
-	0.0%	-
-	0.0%	-
Sums to	100.0%	

Simulated Portfolio Beta
59.99%

Diversification Metric:	20%

Portfolio Stats	
Average Annual Return	Standard Deviation(Annual)
15.80%	25.14%

Historical Data	
Start: 4/15/2003	End: 4/15/2006
Average Annual Return	Standard Deviation (Annual)
24.59%	12.80%
Historical Beta: **59.99%**	
Historical Yield: **3.19%**	
Performance of S&P500 over historical period	
Average Annual Return on S&P500	
11.70%	
Annual Standard Deviation on S&P500	
7.77%	

Market Index (S&P500)	
Average Annual Return	Standard Deviation (Annual)
8.30%	15.07%

Concentrated Energy / Utilities Portfolio

In order to provide some sense of what a Diversification Metric = 20% means, let's consider a more traditional diversification. It is essentially universal among model stock portfolios to suggest putting a fraction in an S&P500 fund (i.e. a large cap fund), a fraction in a mid-cap fund, and a fraction in a small-cap fund. The idea here is that these different groupings by market capitalization will provide diversification. To examine this, we use IVV, IJH, and IWM for large-, mid-, and small-cap respectively. This makes sense intuitively, but is it correct? If we build a portfolio with 1/3 allocated to each of these, do we get good diversification?

Fund Name	Percentage of Funds	Average Annual Return
IDU	0.0%	11.72%
IXC	0.0%	19.15%
IGE	0.0%	19.44%
IVV	33.3%	8.40%
IJH	33.3%	10.55%
IWM	33.3%	13.55%
RWR	0.0%	17.10%
DUK	0.0%	17.84%
EXC	0.0%	14.90%
XLU	0.0%	12.00%
SPY	0.0%	8.48%
-	0.0%	-
-	0.0%	-
-	0.0%	-
-	0.0%	-
-	0.0%	-
-	0.0%	-
-	0.0%	-
-	0.0%	-
Sums to	100.0%	

Simulated Portfolio Beta
133.81%

Diversification Metric: 6%

Portfolio Stats	
Average Annual Return	Standard Deviation(Annual)
10.81%	20.26%

Historical Data

Start:	End:
4/15/2003	4/15/2006
Average Annual Return	Standard Deviation (Annual)
19.36%	11.23%

Historical Beta: **133.81%**
Historical Yield: **1.04%**

Performance of S&P500 over historical period
Average Annual Return on S&P500
11.70%
Annual Standard Deviation on S&P500
7.77%

Market Index (S&P500)	
Average Annual Return	Standard Deviation (Annual)
8.30%	15.07%

Portfolio with 1/3 each in large-, mid-, and small-cap ETF's

When we examine the portfolio with equal allocations into three market-cap ETF's, the Diversification Metric is greater than zero, but it is not all that high at 6% (see above). We are getting some diversification here, but not much. In truth, this should not be too surprising. These three ETF's have Betas of 100% or greater and R^2 of between 73% and 100%. The vast majority of the variability in the returns on these ETF's is market driven so there really is no way for these ETF's to have offsetting risk. The statistics simply bear this out. Allocations to these three funds based on market capitalization are a way to select total portfolio return and total risk associated with broad-based exposure to

the U.S. market, but they do not provide a substantial level of diversification between them.

Fund Name	Percentage of Funds	Average Annual Return
IDU	10.0%	11.72%
IXC	10.0%	19.15%
IGE	0.0%	19.44%
IVV	20.0%	8.40%
IJH	5.0%	10.55%
IWM	5.0%	13.55%
RWR	5.0%	17.10%
ICF	5.0%	17.14%
VBIIX	0.0%	6.72%
VBLTX	30.0%	10.46%
EFA	5.0%	8.74%
EEM	5.0%	14.12%
-	0.0%	-
-	0.0%	-
-	0.0%	-
-	0.0%	-
-	0.0%	-
-	0.0%	-
-	0.0%	-
Sums to	100.0%	

Portfolio Stats	
Average Annual Return	Standard Deviation(Annual)
11.90%	17.19%

Historical Data	
Start: 4/15/2003	End: 4/15/2006
Average Annual Return	Standard Deviation (Annual)
16.75%	7.96%
Historical Beta: **74.30%**	
Historical Yield: **3.09%**	
Performance of S&P500 over historical period	
Average Annual Return on S&P500	
11.70%	
Annual Standard Deviation on S&P500	
7.77%	

Market Index (S&P500)	
Average Annual Return	Standard Deviation (Annual)
8.30%	15.07%

Simulated Portfolio Beta
74.30%

Diversification Metric:	44%

Sample portfolio to maximize Diversification Metric

Now let's look at a more realistic portfolio (above). This portfolio has exposure to developed and emerging markets (EFA and EEM), REIT's (RWR and ICF), bonds (VBIIX and VBLTX), as well as the other asset classes from the earlier runs. We have tuned this portfolio to optimize Diversification Metric (DM), which comes out to be 44% (see above). Many interesting features emerged in this analysis. Intuitively it may seem that one REIT fund would be enough, but the results suggested that the two REIT funds

had low enough correlation between them that including both actually improved the overall portfolio diversification. Oddly, the reverse was true for the inclusion of the two bond funds. Putting 30% of the portfolio in VBLTX yielded a higher diversification metric than any other weighting of this 30% of the portfolio between the two bond funds. This suggests that these intermediate-term and long-term bond funds have so much non-systematic correlation between them that we may as well not include both. This result may surprise those who thin in terms of style analysis, but the statistics over the past three years demonstrate that including both of these bonds funds does not improve diversification of this portfolio.

The diversification score of the portfolio does not determine whether the risk-return balance is appropriate for any individual, and most investors will first want to specify the maximum portfolio risk that they wish to bear or, better yet, to use a Monte Carlo model to determine the risk return balance that maximizes the probability of being able to fund future income (see our paper *When More Risk is Less Risky*, link at end of this paper). Having specified the optimal risk/return balance on the portfolio, it is useful to attempt to maximize the DM. It makes sense to maximize the Diversification Metric because this means that you are offsetting the risks in your portfolio as much as possible. The sample portfolio shown above is a very aggressive portfolio in that it has projected total volatility greater than that for the market as a whole. If you were looking for a portfolio that could be this volatile and you wanted to limit your portfolio to this universe of funds, this portfolio makes good use of diversification effects. What I often see is portfolios with way too many individual components, so that the net diversification effects are far from optimal.

Discussion

Capturing both the market and non-market correlations between portfolio components (and subsequent impacts on total portfolio risk) is quite challenging. William Sharpe, Nobel Laureate in economics, developed a method for describing and simulating total portfolio risks. This approach, called ***Style Analysis***, is used in the Monte Carlo

simulation tools on FinancialEngines.com, the company that Sharpe co-founded. Unfortunately, as Sharpe himself has shown in a paper published in ***The Journal of Portfolio Management*** in 1992 (link to online paper provided at the end of this paper), ***Style Analysis*** can fail to capture as much as 40% of the variance in a portfolio. The fact that ***Style Analysis*** may not capture a substantial fraction of the variance in returns means that this component of returns is automatically treated as being uncorrelated to all portfolio variability (meaning that you are going to miss the non-market correlation between that component and all other portfolio components). ***Style Analysis*** tends to fail when there is substantial non-market volatility and ignoring this can be an important source of risk. The case in Sharpe's paper in which 40% of the variability in returns could not be explained was for a utilities-focused mutual fund, and the reason given in the paper was that this fund was highly concentrated in a single industry. The low Betas and low R^2 values of utility stocks are also factors because ***Style Analysis*** depends on being able to attribute the vast majority of variance in the funds performance to one or more indices. Many investors today include focused ETF's and funds in their portfolios or simply have highly concentrated portfolios of individual stocks because of employee stock ownership programs or as targeted strategy, so this limitation of ***Style Analysis*** has important implications. The errors introduced by this limitation in ***Style Analysis*** will also be amplified for asset classes such as commodities (gold funds tend to have low R^2) and dividend-focused strategies (dividend-focused funds and ETF's tend to exhibit low Betas and R^2 values). Quantext's Monte Carlo simulation models do not use ***Style Analysis***. Our models capture non-market correlations and risk very effectively—even for low Beta or low R^2 assets—as shown in the earlier examples using utility-focused ETF's.

When investors wish to design portfolios that take optimal advantage of diversification effects, it is important to account for both market-driven and non-market sources of correlation and volatility between portfolio components. This is not trivial. These effects are especially pronounced when one is considering whether to include a single representative of an asset class (such as a REIT) or more than one representative. In some cases, more individual components will improve diversification and in other cases

adding additional components makes the portfolio risk-return balance less than optimal---raising the risk of over-diversification. While it is possible to account for these effects, most investors do not have the tools to accomplish this task. Quantext Portfolio Planner has been extensively tested to ensure that it captures non-market and market correlations between portfolio components and these effects often have a major impact on interpreting historical portfolio performance and on simulating future risk and return with Monte Carlo analysis.

FinancialEngines.com, a well-known provider of Monte Carlo portfolio analysis, uses style analysis in analyzing a combination of mutual funds and stocks in a portfolio. Their website says that they utilize ***Style Analysis*** as the basis for modeling portfolio components. Based upon Bill Sharpe's own analysis of ***Style Analysis***, we know that this approach may not be able to characterize highly concentrated portfolios or perhaps those with low Betas and value of R^2. This would mean that a portfolio designed or tuned using the FinancialEngines.com tools will tend to miss important opportunities for diversification---and to tend to underestimate total portfolio risk

The Quantext Portfolio Planner measures and accounts for both market-driven and non-market sources of correlation and their impacts on total portfolio risk. Market risk is fairly easy to calculate for individual components of a portfolio and even for the total portfolio. Accounting for non-market correlations and their impact on total portfolio performance is more challenging. It is, however, easy to test whether a portfolio management solution captures these effects and we have performed these tests for Quantext Portfolio Planner, with an example shown in this paper for utilities ETF's. Accounting for both market and non-market correlations in modeling the total portfolio can substantially improve the overall portfolio.

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Journal of Portfolio Management, Winter 1992, pp. 7-19.

Online: http://www.stanford.edu/~wfsharpe/art/sa/sa.htm