Diversification

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This note discusses one of the most fundamental yet misunderstood concepts in investment management: diversification. We will begin with a basic and hopefully intuitive discussion of the principles of diversification and the mechanics by which it works. Following will be a more technical presentation for those who have an interest in such things. Throughout we will use numeric examples to illustrate the principles involved. Finally, we will look at some typical historic data regarding diversification across asset classes (e.g. stocks, bonds, and cash).

There is a time tested investment analogy: "don't put all your eggs in one basket." In this analogy, the eggs are individual investments and the basket is your overall investment portfolio. The simple logic is that if you "drop the basket," your investment portfolio will be wiped out. Spreading your "eggs" around minimizes the possibility that bad luck for a single investment will adversely affect your overall portfolio. Risk averse investors clearly benefit (and sleep better at night) from diversification. However, some investors seem to defy this logic. Most of us have heard investors bragging about the huge gains they have had by placing a large bet on a single stock or other investment. The reality is we never hear those same investors speak as loudly when their performance is not so stellar. Another analogy applies here. In baseball, swinging for a "home run" often leads to a "strike out." For the rest of this note, let's assume that we agree diversification is a good thing.

Simply stated, diversification results when you spread your investable funds across different assets. By chance, some will do well when others do poorly, thus reducing the overall variability (e.g. risk) of your portfolio. There are numerous methods of achieving diversification. Naïve diversification is done by just randomly choosing a set of assets for your portfolio. The law of large numbers makes this work. If you have 30 randomly chosen stocks in your portfolio, some will naturally go up when others go down, thus reducing overall portfolio risk. But we can do better than this. To maximize the benefits of diversification we should look for assets that tend *not* to move together. We look for some assets to zig when others zag. We can reduce risk more efficiently this way (e.g. achieve the same level of risk reduction with fewer separate investments).

The key to efficient diversification involves the statistical concept of correlation. Correlation measures the degree to which two assets move together. The maximum correlation is 1.0 or 100%. In this case the two assets always move up and down together (though possibly by different amounts) and no diversification is achieved. The minimum correlation is -1.0 or -100%. In this case the two assets always move in the opposite direction and perfect diversification is achieved. For correlations between these extremes, the lower the correlation the more diversification we achieve.

An Illustration

Consider the stocks in Table 1. Each stock has its typical ups and downs. Note, that Stocks 2 and 3 have the same returns but in different years. Also note that Stocks 1 and 2 move together (positive correlation) while Stocks 1 and 3 move opposite of each other (negative correlation).

Table 1: Stock Returns

	Year 1	Year 2	Year 3	Year 4
Stock 1	10%	-5%	15%	-8%
Stock 2	12%	-7%	18%	-10%
Stock 3	-7%	12%	-10%	18%

Table 2 shows the values of two portfolios. Portfolio 1 assumes initial equal $100,000 investments in Stocks 1 and 2, while Portfolio 2 assumes initial equal $100,000 investments in Stocks 1 and 3. Both portfolios are rebalanced to equal 50% weights each year. We will comment on the significance of this below.

Table 2: Portfolio Values; $200,000 Initial Investment

	Year 1	Year 2	Year 3	Year 4
Portfolio 1: Stocks 1 & 2	$222000	$208680	$243112	$221232
Portfolio 2: Stocks 1 & 3	$205000	$210125	$218530	$227271

First, note that Portfolio 1 is much more volatile than Portfolio 2. It fluctuates from a low of $208,680 to a high of $243,112. In contrast Portfolio 2 climbs in value steadily. You would sleep much better at night with Portfolio 2. The lower volatility of Portfolio 2 is a direct result of the lower correlation between Stocks 1 and 3 relative to that of Stocks 1 and 2. Second, note that Portfolio 2 has a higher ending value than Portfolio 1 despite the fact that the stocks in each portfolio have the same period-by-period returns. This result is due to the annual rebalancing of the portfolios. In Portfolio 2 the negative correlation between the stocks, combined with rebalancing causes more weight to be put into a stock after it has fallen and less weight after it has risen. Over time this results in a higher ending portfolio value.

Typical Historic Correlations among Asset Classes

To get a good idea of the correlations that can be expected for various asset classes, we examine historic correlations. Although correlations among assets can change through time, it is reasonable to consider recent history as representative of potential future results. Table 3 presents correlations for eight asset classes that might be considered in building a diversified portfolio. The asset class correlations were calculated by Morningstar™ over the period January 1, 2002 through December 31, 2006 (60 months). The following indexes are presented by number in Table 3:

1) 3 Month CD – cash equivalent
2) Lehman Brothers Global Aggregate – global bonds
3) Lehman Brothers Aggregate Bond – U.S. bonds
4) MSCI EAFE Growth – Europe, Australasia, Far East growth stocks
5) MSCI World ex US – global stocks excluding the U.S.
6) Russell 1000 Growth – U.S. large capitalization growth stocks
7) Russell 2000 Growth – U.S. small capitalization growth stocks
8) Russell Midcap Growth – U.S. medium capitalization growth stocks

Table 3: Historic Correlations among Asset Classes (Represented by Indexes)

	1	2	3	4	5	6	7	8
1	1.0							
2	-0.15	1.0						
3	-0.04	0.72	1.0					
4	0.10	0.13	-0.17	1.0				
5	0.15	-0.35	-0.37	0.84	1.0			
6	0.05	-0.23	-0.32	0.72	0.82	1.0		
7	0.00	-0.13	-0.31	0.77	0.79	0.84	1.0	
8	0.00	-0.17	-0.31	0.76	0.81	0.93	0.95	1.0

First note that all correlations along the diagonal are 1.0. This is simply because each asset class is perfectly correlated with itself. Suppose that an investor bought two index funds, each tracking the Russell 1000 Growth Index, from two different mutual fund companies. The investor will have achieved *zero* diversification when buying the second fund! Hopefully, few investors will make such a mistake. However, many investors have portfolios that contain overlapping asset classes with very high correlations. Such portfolios provide little more diversification than our two fund example.

Next, consider the correlations below the diagonal in Table 3. We will not discus all of the possible combinations of assets. Instead, let's consider examples of asset class combinations that would provide good diversification, versus those that would not. Low, or better, negative correlations lead to good diversification. Here, combining cash, bonds and stocks provides good diversification. Cash is negatively correlated with bonds (column 1, rows 2 and 3) and has near zero correlation with stocks (column 1; rows 4 – 8). Also, bonds are negatively correlated with stocks (columns 2 and 3; rows 4 – 8). Importantly, the correlations among non-U.S. and U.S. stocks and across different market capitalizations for U.S. stocks are quite high (columns 4 – 7; rows 5 – 8). For example, adding small or mid capitalization U.S. growth stocks to a portfolio of large capitalization U.S. growth stocks would provide relatively little diversification.

A diet analogy might apply here. Suppose a patient was quite fond of steak. His doctor realizes that too much steak is unhealthy and recommends that the patient "diversify" his diet. If the patient ads hamburgers and rib roasts, instead of fruits and vegetables, it is easy to see the desired result will not be achieved.

The Math

The volatility of an asset or portfolio is measured by the statistical concept of variance or standard deviation. The standard deviation is simply the square root of variance. The variance of returns on a portfolio of assets depends upon three things: 1) the variances of returns of the assets comprising the portfolio; 2) the correlations among the returns of the assets in the portfolio; and 3) the amounts invested in each asset (the portfolio weights). We will present the case of two assets. Similar formulas exist for more than two assets, but no further insights come from them and the notation becomes more cumbersome.

Portfolio Return Variance = $\sigma_p^2 = w_1^2 \times \sigma_1^2 + w_2^2 \times \sigma_2^2 + 2w_1 w_2 \sigma_1 \sigma_2 \rho_{12}$

Where: σ_p^2 = portfolio return variance

w_1, w_2 = portfolio weights invested in assets 1 and 2

σ_1, σ_2 = standard deviations of returns for assets 1 and 2

ρ_{12} = correlation between the returns on assets 1 and 2

Consider two stocks with standard deviations of 20% and 25%, equal weights (0.50) in each stock and a correlation between the stocks' returns of 0.60. The portfolio variance would be:

$$\sigma_p^2 = 0.5^2 \times 0.2^2 + 0.5^2 \times 0.25^2 + 2 \times 0.5 \times 0.5 \times 0.20 \times 0.25 \times 0.60 = 0.040625.$$

The portfolio standard deviation is the square root of the variance or 0.202 = 20.2%. Note that because the two stocks are less than perfectly correlated (0.60) the portfolio standard deviation is lower than the weighted average of the two stocks' standard deviations (0.5 × 0.2 + 0.5 × 0.25 = 0.225 = 22.5%). If you have the interest you can verify that the lower the assumed correlation between the two stocks, the lower will be the portfolio's standard deviation. For example, if we assume a correlation of 0.3 instead of 0.6, the portfolio standard deviation would fall from 20.2% to 18.2%.

The Bottom Line

The bottom line is that a well diversified portfolio reduces risk without sacrificing returns. The key to efficient diversification is combining asset classes with low correlations. Finally, adding asset classes that are highly correlated with those already in the portfolio is redundant, achieving little benefit but adding to costs.

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