



## **Diversification:**

**The most important thing you forgot to measure**

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## Abstract:

We present a simple method to measure portfolio diversification. Perhaps the most fundamental of all investment management techniques, investors and their advisors often fail to understand or achieve diversification. Diversification suffers from vague generalities. Worse, all investors think they know it. Eggs and baskets no longer suffice. As the axiom goes...measuring is managing.

Intra-Portfolio Correlation (IPC) is a means to quantify diversification. It measures a weighted average for all unique asset correlations in a portfolio.

We calculate the IPC as:

$$Q = \sum_i \sum_j X_i X_j P_{ij}$$

- Where Q is the intra-portfolio correlation
- $X_i$  is the fraction invested in asset i
- $X_j$  is the fraction invested in asset j
- $P_{ij}$  is the correlation between assets i and j
- The expression is computed when  $i \neq j$

The range is from -1 to 1, with -1 being the most diversified and 1 being the least. We translate the range of values in percentage terms; pairing a -1 average correlation to 100% and an average correlation of 1 to 0%. Exhibit I translates the weighted average correlation values to diversification percentages.

## Exhibit I

Notional IPC	IPC % (% of Diversifiable Risk Eliminated)
1.00	0.00%
0.75	12.50%
0.50	25.00%
0.25	37.50%
0.00	50.00%
-0.25	62.50%
-0.50	75.00%
-0.75	87.50%
-1.00	100%

The measure is a pure measure of diversification and should not be confused with a measure of risk.

Diversification is a powerful tool that reduces the variance of a portfolio and consequently helps to stabilize performance, potentially enabling returns that are more consistent and mitigating risk. Diversification is a cornerstone of judging the prudence of a fiduciary. Diversification is the investment attribute that generates perhaps the greatest consensus as to its efficacy as a management attribute.

Despite the widespread acceptance of diversification, investors suffer from no way to measure it. In fact, investors are so accustomed to thinking of diversification as only an abstract that risk measurement is often mistaken for a true diversification measurement.

A statistical measurement of the relationship of assets is an indication of diversification. Traditionally co-variances and correlations measure a unique relationship between any two single assets in the portfolio. Because the portfolio represents the entire composition of all these relationships, the measure of any one single relationship fails to indicate the actual level of portfolio diversification. We must account for all component relationships in the portfolio in order to get a true measurement of diversification.

Another common misunderstanding of diversification is beta or R squared. Beta is a measurement given to a portfolio that describes the amount of performance of that portfolio that is determined by the market forces. R squared measures the percent of the funds performance that an external source may explain. Both Beta and R squared are, in some way, a measurement of diversification. Nevertheless, they have limitations. Both require the presence of another portfolio external to that portfolio for which we are analyzing. Conventionally, this portfolio may be the S&P 500 or other broad index. This index is thus an approximation of the market. This has several problems, one of the largest being that defining the market is inherently problematic.

Beta and R squared have some utility for measuring relative diversification. However, there is little efficacy in comparing the portfolio to the market. Such a comparison begets the same logic as those who would say the market is down ten percent, but we are only down eight. Beta and R squared are relative measurements. Whereas a measurement of diversification that would better help investors to construct and manage portfolios for performance purposes would not be concerned with items external to the portfolio but only those assets comprising the portfolio. A holistic measurement of diversification, independent of any market benchmark or index, is desirable by investors seeking performance.

Diversification measurement via the IPC provides a measure that is both holistic and independent. Because this is a portfolio level measurement, it has several advantages over a relative measure such as Beta in that it is not concerned with external factors. Owners of portfolios care only about their portfolio and care less about what the market in general does. A holistic measurement is advantageous in that its focus is solely on the pertinent portfolio.

Some investors and their advisors consider diversification as the number of assets held. Measuring diversification in this way fails to account for disparate weightings of assets and fails to account for the commonality of assets. To illustrate, consider a 10-asset portfolio consisting of ten equally weighted portfolios, having each asset perform identically to another asset. This portfolio has the overall performance of only one asset, despite holding ten different investments. Granted there is some level of diversification present, this diversification guards against non-systemic risk only.

However, it is systemic risk that may be the greatest detriment to the preponderance of investors. Therefore, a good measure of diversification should account for it.

It is precisely this type of diversification- diversification against systemic risk-, which drives mean-variance analysis. Without this diversification, MVO delivers an uninspiring array of linearly combined assets and no risk reduction. Diversification provides the essential element of portfolio optimization and analysis. Parsing diversification from the rubric of risk, gives investment managers a new element of control.

The IPC gives that element of control.

The range of values is important in that it measures the range of absolute statistical potential. Naturally, portfolios that are 100% diversified are impractical. Efficient market theorists would argue that a 100% diversified portfolio would have a zero return expectation. This is indeed an accurate assumption in efficient markets.

Perhaps more relevant is that active investors, whether conscience or unconscious of the decision now are able to extract additional Alpha by correctly forecasting that the historical relationship will dismantle. If they are correct, alpha is the reward. If they are wrong, chances are the historical relationships endure, and diversification provides the requisite risk mitigation. Perhaps you know this as arbitrage.

IPC provides a good measure of portfolio diversification for conventional portfolios. In other portfolios that contain both large positive and negative correlations, there is fallibility in that the correlations may net out. This effectively loses the deterministic attributes of the correlation measure. For example, imagine an equally weighted four-asset portfolio. Each assets pair has a perfect positive correlation with one another and a perfect negative correlation with the opposing pair. In such a case, the IPC returns 66.7%. 66.7% diversification implies we have eliminated 66.7% of the systematic risk. However, the correlations in a deterministic sense would suggest that the portfolio has been perfectly hedged.

Turning to Exhibit II, let us look at some examples that may help illuminate the range of IPC values that one may expect:

## **Exhibit II**

<b>Portfolio</b>	<b># of Assets</b>	<b>IPC%</b>
Style Funds	9	7.1
5 Largest US Equity Mutual Funds	5	9.73
5 Largest Bond Funds	5	14.02
National Indices	20	23.69
Sector Funds	9	26.99
5 Largest US Stocks	5	32.73
Dow Jones Utilities	15	32.82
Technology Stocks	20	35.69
Dow Jones Transports	20	37.33
Dow Jones Industrials	30	38.47
5 Smallest Stocks in S&P Smallcap 600	5	40.5
Highest 5-Year Growth Stocks	25	42.24
Lowest Valuation Stocks	25	43.85
Currencies	12	46.81
Commodities	15	47.46
5 Smallest Stocks in S&P 500	5	47.58

We built each portfolio with ten years of monthly return observations ending October 8, 2007. Each portfolio was equally weighted.

The results above are not a comprehensive survey of diversification. Rather, our intent is to illustrate the IPC measure itself.

As you can see the range of IPC values does not often exceed 50% (average correlation =0). Generally, IPC values in excess of 50% require short selling, hedging or special econometric filters (such as semi-correlation).

If you are not measuring portfolio diversification, it might be a good idea. If you have poor diversification, you can work to improve it. This is the essence of investment management. Measuring diversification is every bit as important as measuring risk. The IPC represents a first step into new territory.