Editor's Letter

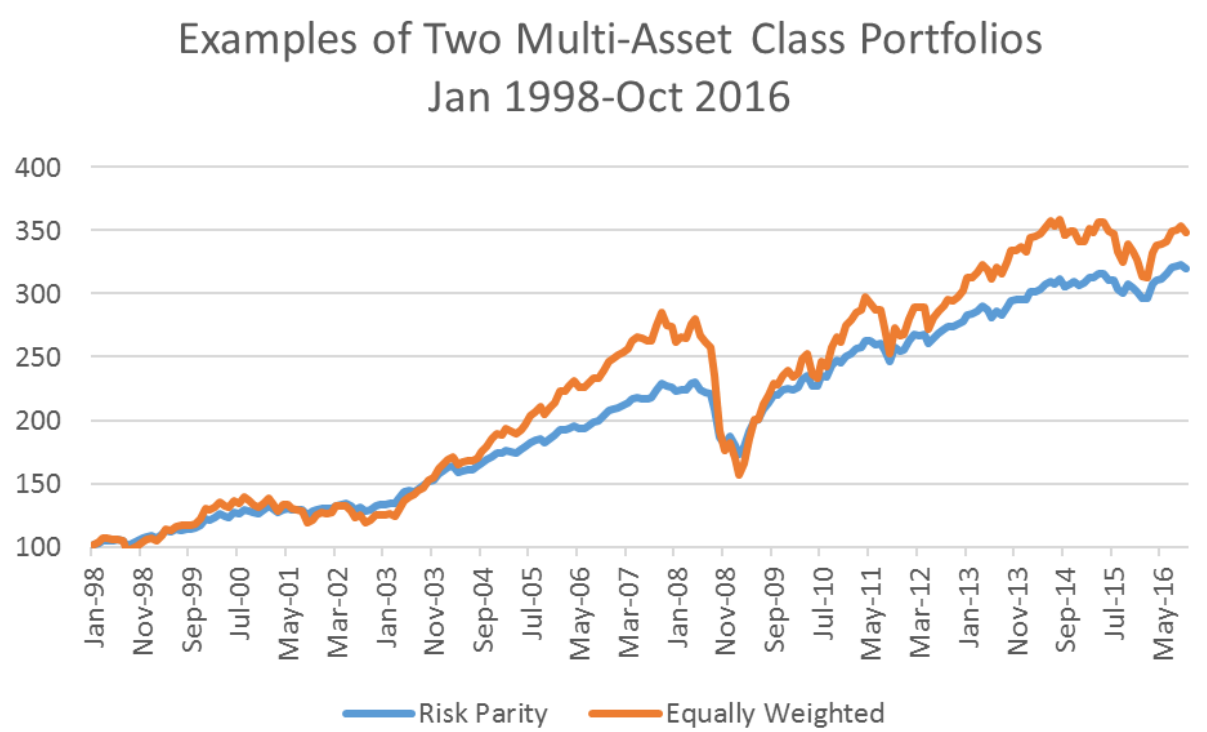
Understanding the Systemic Risk of a Multi-Asset Portfolio

Most investors understand that diversification benefits associated with a multi-asset portfolio could almost disappear during periods of extreme financial stress. The most important case being during the 2008-2009 global financial crisis when the correlations among all risky assets approached one, and only cash and U.S. Treasuries provided some downside protection for such portfolios. These periods of extreme financial distress give rise to systemic risk when financial risks arising from one segment of the market spills over into other segments and very soon the entire global financial market is under stress. While these periods of stress do not arise frequently, their impacts are so great that it pays for investors to be aware of such risks and devise plans to manage and mitigate the effects of this risk. However, before we discuss ways of managing this risk, we need to develop a more precise measure of it.

Suppose an investor is considering a multi-asset class universe of investments to implement an asset allocation program. These asset classes are listed in the following table:

CISDM EW Hedge Fund	Barc US Agg Bond	Barc US Corp High Yield	Barc US Govern	S&P 500	S&P GSCI	MSCI EAFE	MSCI World	MSCI EM	Red Rocks Global Listed Private Equity	DJ Equity All REIT

The asset classes displayed here should allow an investor to create a well-diversified portfolio, providing a steady rate return during the last 25 years. For example, the following chart displays the performances of an equally weighted portfolio and a risk-parity portfolio consisting of these asset classes from January 1998 to October 2016.



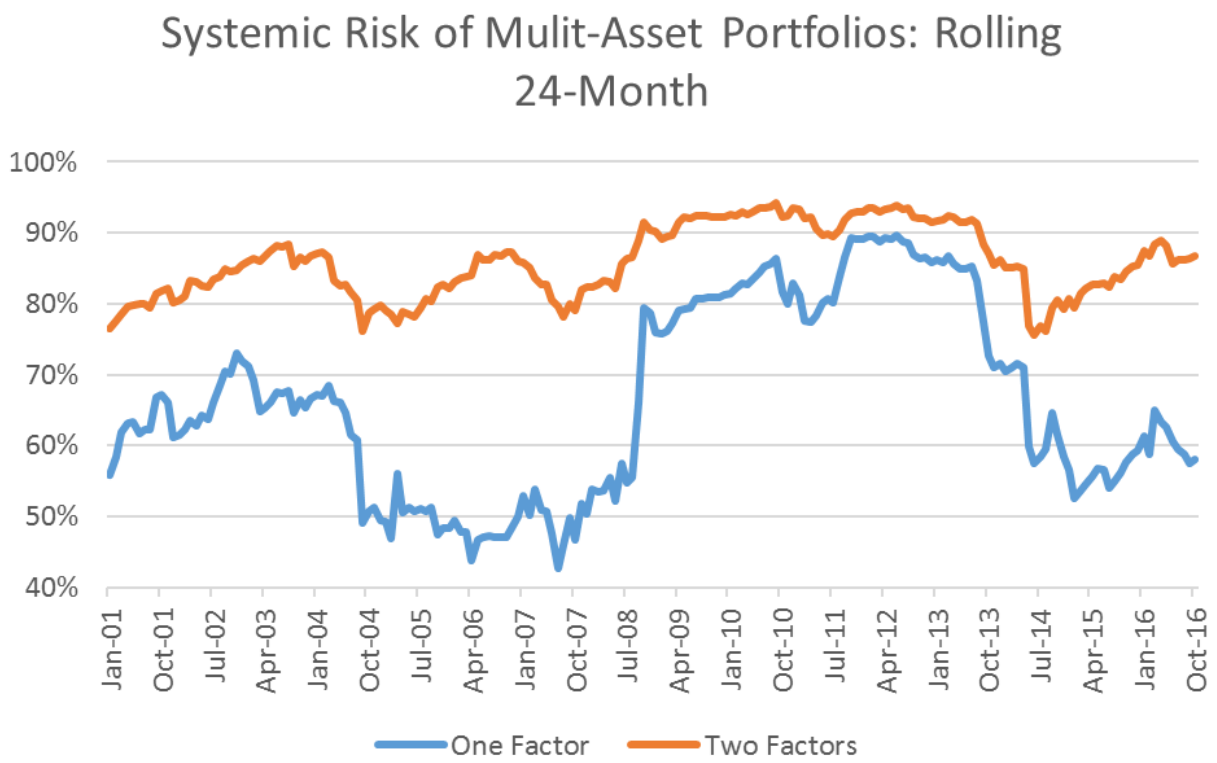
We can see that both portfolios experienced significant declines during 2008-2009 and smaller, but still meaningful declines, during the sovereign debt crisis of 2011 as well as the Chinese slowdown of 2015-2016. What we wish to measure here is the potential diversification benefits offered by these asset classes through time. In other words, we want to identify periods during which one or two common factors begin to drive the returns on all risky asset classes.

Principle Component Analysis (PCA) is a widely used method for extracting information about the common factors that affect the volatility of a set of observations (e.g., returns on assets). Basically, PCA attempts to find the following representation of returns

$$\textbf{Return on Asset k} = \textbf{Weight}_{k1} \times \textbf{PCA}_1 + \textbf{Weight}_{k2} \times \textbf{PCA}_2 + \ldots + \textbf{Weight}_{kN} \times \textbf{PCA}_N$$

That is, asset returns are expressed as linear combinations of a set of common components or factors. More importantly, these factors are independent of each other, and they are determined such that the first factor has the highest explanatory power, then the next factor has the second highest explanatory power and so on. Suppose in 2007 the first factor ends up explaining 50% of the time series variations of these asset classes and then in late 2008 the first factor's explanatory power increases to 90%. This means that there was a substantial decline in the diversification opportunities provided by these asset classes because in late 2008 the major driver of risk asset returns was responsible for 90% of the variation in their returns. The following chart displays the percentage of the time series variation of these asset classes explained the first factor and the first two factors through time.

We can see that the first two factors explain 75% to 95% of the variations of these asset classes through time. The first factor alone explains up to 90% of the variation during periods of financial stress.



Keeping track of these two figures through time will provide investors with early warning signals that diversification benefits are disappearing and appropriate actions must be taken. In addition, investors should track the exposures of their portfolios to these factors through time. For example, in the case of Equally Weighted and Risk Parity portfolios displayed earlier, their overall exposures are given below:

	Exposures to the First Factor: Jan 01-Oct 16	
	Risk Parity	Equally Weighted
Correlation	92%	96%
Beta	0.132	0.242

We can see that the risk parity portfolio has a significantly lower beta with respect to the first factor. In addition, one can calculate rolling betas of these two portfolios with respect to one or two factors to determine if the portfolios exposures to systemic risk is increasing or not. Finally, exposures to systemic risk as measured by these factors can be taken into account when the optimal asset allocations are implemented. In this process, allocations to those asset classes that have the greatest exposure to systemic risk can be reduced.

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