Viewpoint

Russell Research

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Correlations have fat tails, too

The investment community is, by now, familiar with the idea of fat tails. The concept moved beyond the domain of actuaries and quant geeks with Nassim Nicholas Taleb's book *The Black Swan* (2007). Taleb drove home the point that volatility does not tell the whole story of the uncertainty associated with asset returns. In particular, extreme outcomes occur more frequently (i.e., tails are fatter) in practice than implied by a normal distribution.

This observation—that the simple risk measure does not capture the full distribution—applies also to the interaction between assets. In other words, correlations have fat tails, too.

Traditional modeling falls short

So not only is the normal distribution a poor model of the returns expected from an investment, the traditional model of asset class interaction also falls short. But this is not widely recognized. Somebody who argues that "strategy X has such-and-such a volatility, so the potential downside is Y" is likely to find themselves challenged because of fat tails. Yet no such challenge is made when correlation is used to describe the relationship between assets.

This matters a great deal in today's investment world. Interaction between investments has grown in importance in recent years for two reasons. First is the growing attention paid to liability hedging, especially for defined benefit pension plans; hedging requires assets that behave like liabilities. Second is the quest to spread risk through diversification, and diversification requires assets that behave unlike other assets.

With so many investment decisions being driven by these considerations, a solid understanding of the interaction between investments has become critical.

A powerful illustration of this is provided by the events of 2008.

Table 1 shows year-by-year performance of the Russell 3000® index and other asset classes that might be diversifiers to the U.S. stock market since 2000. Table 2 shows how the Russell 3000 and the other asset classes performed in the bull and bear markets of the

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same time period, as well as the correlation of monthly returns of each asset class from 2000 through October 2007 with the returns on U.S. equity.

Table 1: Calendar year returns 2000–2010+

%	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010*
US equity	–7.5	–11.5	–21.5	31.1	11.9	6.1	15.7	5.1	–37.3	28.3	4.8
International equity	–12.2	–20.4	–15.4	42.5	22.0	15.6	25.9	12.8	–44.2	37.5	3.4
Emerging market	–35.4	–5.7	–8.7	56.3	24.8	33.2	33.7	41.1	–55.4	84.2	13.0
REITS	26.4	13.9	3.8	37.1	31.6	12.2	35.1	–15.7	–37.7	28.0	19.1
Treasuries	13.2	7.2	11.5	2.4	3.5	2.7	3.5	8.7	12.4	-2.2	8.0
Credit	9.4	10.4	10.5	7.7	5.2	2.0	4.3	5.1	–3.1	16.0	10.5
Emerging debt	15.7	-0.8	14.2	28.8	11.8	11.9	10.5	6.5	–9.7	26.0	14.5
Commodities	31.8	-19.5	25.9	23.9	9.1	21.4	2.1	16.2	–35.6	18.9	0.9

* 2010 figures are through the end of September.
+ The indexes used are as follows:
U.S. equity – Russell 3000 Index
International. equity – Russell Developed ex-U.S. Large Cap
Emerging market – Russell Emerging Market
REITS – NAREIT Index
Treasuries – Barclays Capital Government Bond Index
Credit – Barclays Capital U.S. Credit Bond Index
Emerging debt – JP Morgan Emerging Markets Bond Index
Commodities – Dow Jones-UBS Commodity Index Net

Table 2: Total (non-annualized) returns over various time periods+

%	Bear I	Bull I	Correlation	Bear II	Bull II	Total
US equity	–40.5	115.6	1.00	–51.2	64.0	2.7
International equity	–44.8	225.4	0.86	–56.9	73.1	34.0
Emerging market	–49.0	469.6	0.70	–63.0	135.3	152.8
REITS	48.8	167.9	0.34	–64.8	132.8	226.9
Treasuries	34.4	19.6	–0.34	12.5	8.7	96.6
Credit	29.5	29.2	–0.09	–3.8	30.5	110.1
Emerging debt	14.4	116.8	0.44	–10.5	45.6	223.2
Commodities	28.3	100.1	0.12	–41.0	32.7	100.9

Bear I = January 2000–September 2002
Bull I = October 2000 –October 2007
Bear II = November 2007–February 2009
Bull II = March 2009–September 2010
Total period = January 2000–September 2010
Correlation = Correlation of monthly returns with U.S. equity January 2000–October 2007

Based on the correlations over the period to January 2000−October 2007, one might conclude that a portfolio spread across these various asset classes was well-diversified and hence protected against a market downturn. As we all know, it wasn't. Every asset class except Treasury bonds fell sharply in the Bear II period (the 16 months around 2008) and correlations spiked.

These events serve as a reminder of the complexity of markets. Authers (2010) has described the dynamics behind the crash of 2008 and the impact of institutions' search for diversification on the interaction of asset prices. He concludes, "The crash demonstrated what might be called a new paradox of diversification; the more investors bought in to assets on the assumption they were not correlated, the more they tended to become correlated."

While the mean-variance model of portfolio construction introduced by Markowitz (1959) has proved valuable in the development of investment practice, it can provide an inadequate description of the behavior of markets at times of stress.

This illustrates the unstable patterns and feedback loops that can arise when market participants' behavior adapts over time. If a particular relationship exists (in this case, low correlation) and that relationship causes investors to take certain steps (in this case, to diversify across the various assets), then those actions themselves can destroy the very relationship on which they were based (in this case, the uncorrelated assets became correlated as falling values in one market led to institutional money leaving other markets, leading to falling values there, too.)

Thus, while the mean-variance model of portfolio construction introduced by Markowitz (1959) has proved valuable in the development of investment practice, it can provide an inadequate description of the behavior of markets at times of stress (extreme events). But the view of a market as a complex adaptive system makes modeling challenging, as noted by Lansing (2003): "If the system is sufficiently complex, it may not be practical or perhaps even possible to know the details of each local interaction. Moreover, local interactions can produce nonlinear effects that make even simple systems impossible to solve (as Newton discovered in attempting to solve the three-body problem)."

In the case of the use of correlation, this challenge is compounded by the growth in the importance of asset class interaction. In the mean-variance model, correlation was regarded as the least important of the input assumptions. For example, Chopra and Ziemba (1991) found that "for the typical risk tolerance of 50, errors in the forecasted means are about 11 times more damaging than errors in forecasted variances, and over 20 times as damaging as errors in covariances." But, as noted above, asset class interaction has taken on greater importance as investors have come to focus more on liability-hedging and diversification in their portfolios.

It's not only low correlations that can deceive: High correlations cannot be depended upon to tell the whole story, either.

And it's not only low correlations that can deceive: High correlations cannot be depended upon to tell the whole story, either. Corporate bond yields, for example, are closely linked to Treasury yields. As a result, pension plans, whose liabilities are calculated based on the AA corporate yield, might invest in Treasuries as a hedging strategy. From the start of 2000 through the end of 2006, the yields had a correlation over 97 percent. That strong relationship started breaking down in 2007 and 2008 as Treasury yields fell but corporate yields remained steady and then spiked. Indeed, while the corporate yield hit a high (above 7 percent) in October 2008, the Treasury yield hit a low (below 1.5 percent) barely two months later.

This meant that Treasury bonds outperformed pension-plan liabilities until October 2008, then underperformed. In other words, using Treasuries to hedge corporate-based liabilities proved to be a poor strategy despite the earlier 97-percent correlation (though this approach did generate some nice—but unexpected—profits for plans that were able to opportunistically change hedging strategies when it became clear that the yields had decoupled: a rare example of the breakdown of a relationship leading to a gain rather than a loss).

One response to this, first discussed in the 1990s (e.g., Watada 1997), is to use a range of possible inputs rather than a single estimated value for correlation and other statistics, thus generating a "fuzzy frontier." Xu et al. (2010) found this to be a useful tool for dealing with uncertainty in the context of currency exchange risk. While this approach deals only partially with the challenge of changing relationships during extreme market events, it does explicitly recognize imprecision in the model inputs. This keeps the impact of varying assumptions front of mind and hence is likely to make users more sensitive to tails in the joint distribution of asset returns.

The year 2008 provides an unusually clear example of the dangers of relying on correlation as the only measure of asset class interaction. This article is not, however, intended to be just a history lesson. Simple correlation statistics continue to be used widely in the analysis (and the marketing) of various investment strategies and products, and this practice can lead to incorrect conclusions.

Investors rely too heavily on correlation statistics when making decisions about liability hedging and diversification.

Because understanding the interaction between assets has become so important, greater care needs to be applied in the use of correlations. Correlations are a simple (and often useful) measure of the degree to which assets move in line with one another in typical times, but that's all they are. They do not fully describe the nature of the relationship between two different asset classes or accurately indicate what is likely to happen in extreme events.

Investors rely too heavily on correlation statistics when making decisions about liability hedging and diversification. Because these decisions depend fundamentally on the interactions between asset classes, a deeper understanding of the true nature of the relationships is needed.

REFERENCES:

Authers, John. 2010. *The Fearful Rise of Markets: Global Bubbles, Synchronized Meltdowns, and How To Prevent Them in the Future* (Upper Saddle River, NJ: FT Press).

Chopra, Vijay & William Ziemba. 1991. The Effect of Errors in Means, Variances and Covariances on Optimal Portfolio Choice. *Russell Research Commentary* (November): 1–11.

Lansing, Stephen. 2003. Complex Adaptive Systems. *Annual Review of Anthropology* 32, no.1: 183–204.

Markowitz, Harry M. 1959. *Portfolio Selection: Efficient Diversification of Investments* (New York: John Wiley & Sons, Inc.).

Taleb, Nassim Nicholas. 2007. *The Black Swan: The Impact of the Highly Improbable* (New York: Random House).

Watada, Junzo. 1997. Fuzzy Portfolio Selection and its Application to Decision Making. *Tatra Mountains Mathematical Publications* 13, no. 4 (Slovak Academy of Sciences): 219–248.

Xu, Weijun, Weidong Xu, Hongyi Li, and Weiguo Zhang. 2010. Uncertainty Portfolio Model in Cross Currency Markets. *International Journal of Uncertainty, Fuzziness and Knowledge-Based Systems* 18, no. 6: 759–777.

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