Northfield News

March 2008

A Newsletter for the Friends and Clients of Northfield Information Services

Fat Tails, Liquidity Limits and IID Assumptions
By Dan diBartolomeo

Over the past six months, equity markets have exhibited some very volatile returns over short periods. Beginning with the "sub-prime" meltdown in August, many fund managers, particularly those with a quantitative approach have experienced substantially negative returns.

The financial press has brought forward numerous, sometimes conflicting explanations of the causes. Some articles have suggested that extremely rare events (e.g. seven to ten standard deviations) have been observed on several occasions between August and today in various markets. This explanation is paradoxical because it simultaneously asserts that these large return events are very, very rare and yet have occurred frequently in last six months.

Clearly, something is wrong with this explanation. The failure is simple. When we talk about "ten standard deviation" events, we are implicitly assuming that the distribution about which we are speaking is such that standard deviation is an appropriate measure of dispersion. For stock returns measured over periods of less than one month, the vast predominance of empirical data suggests that normality cannot be assumed, nor can the related assumption of independent and identical distribution (IID).

At its simplest, this means that we cannot take a risk forecast such as an annual tracking error and convert it to daily equivalent units by the usual approach (i.e. scaling by the square root of time). Once we're down to daily measurement periods, the frequency of large magnitude events can be expected to be much, much greater than would be expected under a normal distribution.

If the distribution of returns is not normal, what is it? If we have no information about the shape of the distribution, we can evaluate the likelihood of extreme events based on Chebyshev's inequality **(http://en.wikipedia.org/ wiki/Chebyshev's inequality)**. An important issue is that distributions don't have to be very "fat tailed" looking to be sufficiently different from normal to greatly impact the probability of large events. Some recent research by Northfield's Anish Shah provides the following table at the top of the next page.

The above table represents the probability of an event in either the upper or lower tail of a distribution. The second and third rows of the table illustrate that even if we construct random variables with the same kurtosis as a normal distribution, it is still possible to get tail probabilities that are much closer to the "we don't know anything" values seen in the top row than those in the bottom row. When we make normal distribution assumption, we are also assuming that the distribution is symmetric about the mean, so the likelihood of a "worse than six standard deviation" event under the normal distribution assumption

Recent and Upcoming Events

2008 Northfield Annual Research Conference
Resort at Squaw Creek ● Olympic Village, CA ● March 25-28, 2008

We are pleased to announce our 21st annual research conference at the Resort at Squaw Creek, in Olympic Village, California.

The Resort at Squaw Creek is a full-service, luxury resort in an idyllic mountain setting. It rests at the base of Squaw Valley USA, site of the 1960 winter Olympics, and is just minutes from California's North Lake Tahoe. Often named as one top ski resorts in the world by leading ski and travel publications, the hotel offers luxurious accommodations, breathtaking views of the Sierra Nevada Mountains, and the convenience of ski-in, ski account access to Squaw Valley alpine slopes.

Resort at Squaw Creek

The conference will start on Tuesday evening with the "Unofficial" welcome cocktail party and dinner. As is customary at Northfield events, a complete recreational and social calendar will accompany the working sessions. Wednesday morning will be reserved for recreational pursuits. Attendees will have a choice of alpine skiing, cross country skiing, snowshoeing, dog sledding, snowmobiling or tubing. Wednesday evening will feature an elegant "black tie" gala and Thursday evening will feature a family themed "Olympic Night at High Camp" adventure.

Northfield is holding a block of rooms for the nights of Tuesday, March 25th through Thursday, March 28th. Fireplace Suites are all that is currently available and are being offered at a discounted rate of $339, payable directly to the hotel. Registrations are subject to availability.

We are accepting online registrations only. To complete your online registration, hotel requirements, and to view the detailed conference agenda, visit **http://www.northinfo.com/events.cfm**. Contact Kathy Prasad if you have any difficulties registering, **kathy@northinfo.com**, 617.208.2020.

Agenda
The agenda will consist of eleven 1-hour long presentations.

Active Management of Legacy Portfolios
Sandy Warrick, Placemark

Measuring and Targeting Efficiency to Optimize the Use of Turnover
Ganesh Suntharam, Perpetual Asset Management

Robust Optimization: What Works and What Does Not?
Dong Shaw, Paradigm Asset Management

Active Equity Portfolio Allocation Sensitivity and Modern Robust Risk Models
Steven J. Kusiak, Ph.D., New Frontier

From Decisions to Results: Connecting the Dots
Gary Nan Tie, Travelers

The Polyphemus Perspective, or a Few Words in Defense of Single Factor Models
Jason MacQueen, Alpha Strategies

The Origins of Value
Ed Fishwick, Blackrock and Steve Satchell, Trinity College, Cambridge

How High are Hedge Fund Fees?
Ludger Hentschel, New York Life

Volatility Based Asset Allocations: Why Static Allocations are Incorrect
Scott Lummer, Atlantic Asset Management

Making Global Equity Indexes More Global
Barry Feldman, Frank Russell

Classical Economics, The Non-Rival Good and Stock Returns
Dan diBartolomeo, Northfield

Northfield European Seminar
London ● April 24, 2008

Northfield will be hosting a one day seminar on April 24, 2008 at the Institute of Directors Business Centre located in the heart of London's West End. The purpose of the seminar is to showcase research on various topics in investment and risk management to our European clients.

Further details will be posted to **http://northinfo.com/events.cfm** as the agenda becomes finalized. Contact Northfield's London office for further details, +44-(0)-20-7801-6260, **rupert@northinfo-europe.com**, **david@northinfo-europe.com** or **george@northinfo-europe.com**.

Institute of Directors Centre

CARISMA Center Events
Brunel University ● West London

Northfield President Dan diBartolomeo is a Visiting Professor at the Center for the Analysis of Risk and Optimization Modeling Applications (CARISMA) at Brunel University in West London. The mission of the center is to be a center of excellence recognized for its research and scholarship in the analysis of risk, optimization modeling, and the combined paradigm of risk and return quantification.

The fourth annual CARISMA Seminar on "Risk Control Strategies for Hedge Funds and Program Trading" will be held in London, on June 30-July 3, 2008. Visit **http://www.optirisk-systems.com/newsandevents/carisma2008.asp** for more information.

Northfield High Net Worth Seminar Wrap-up
The Naples Grande ● Naples, FL ● January 24-25, 2008

Northfield held a one and one half day high net worth seminar at the Naples Grande in Naples, Florida. The purpose of the seminar was to highlight the best practices for managing high net worth clients and to discuss a number of complex issues that the management of private, taxable wealth presents.

The presenters included Dan diBartolomeo, Mike Knezevich, and Anish Shah of Northfield, and Jarrod Wilcox of Wilcox Investment, Inc. The topics included; "Risk Containment for Hedge Funds," "The Uncertainty of Death and Taxes," "The Beginners Guide to Tax Optimization," "Multiple Managers and Multiple Accounts," and "The Variety of Security Returns and the Tradeoffs Between Capital Growth, Risk and Taxes."

The seminar proceedings have been posted to **http://www.northinfo.com/papersearch.cfm.**

Asia Seminars Wrap-up
Tokyo, Hong Kong and Sydney ● November and December 2007

Northfield hosted our annual Asia Seminar Series with three highly successful events in Tokyo, Sydney and Hong Kong. The seminars showcased our research on key topics in investment and risk management to our growing family of Australian and Far Eastern clients and prospects and broadened awareness of the range and depth of Northfield products, services, and research.

The presentations were given by Dan diBartolomeo, Nick Wade, and Ganesh Suntharam of Perpetual. Topics included: "Distinguishing Between Being Unlucky and Unskillful," "A Market Impact Model that Works," "Risk Containment for Hedge Funds" "Measuring and Targeting Efficiency to Optimize the use of Turnover," "Improving Returns-Based Style Analysis," and "Alpha Scaling Revisited."

Complete seminar proceedings have been posted at **http://www.northinfo.com/papersearch.cfm.**

Technical Support Tip: Transitioning to NisOpt 2008: Working with Existing Project files
By Mike Knezevich

Currently the GUI transition from NisOpt32 to NisOpt2008 has been relatively smooth and we are on schedule to discontinue the NISOP32 Optimizer version by the end of March. We want to thank those clients who have been early adaptors to the products; your feedback has been invaluable to our software development team. For those clients who need to extend their transition period an optional extension period may be provided for up to two months (maximum extension May 2008). Clients must provide advanced notification to their account manager on a monthly basis for each additional month (prior the end of March for the 20080331 update and end of May for the 20080530 update). All other clients will only receive the NisOpt2008 version and the NisOpt32 version will be removed with the March download. The newest release is slated for some exciting new analytical improvements and functionality in the coming months.

### Working with Existing Project files

A different project file format was necessary to accommodate the changes of the new Optimizer GUI. This new format is not backward compatible to the previous version and project files in the previous format must be converted to the new format. Additional functionality is incorporated into our programs for easier conversion.

Northfield Optimizer
Functionality has been added to the file menu of the optimizer.

Import
Located in the file menu, import is similar to open function except it converts the older project file format into the new format. Saving the project file after importing will save it in the new format. a good exercise is to compare old and new formats for those so inclined to do so, but not recommend for all. When saving, the project file retains the new format.
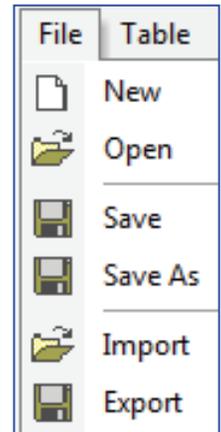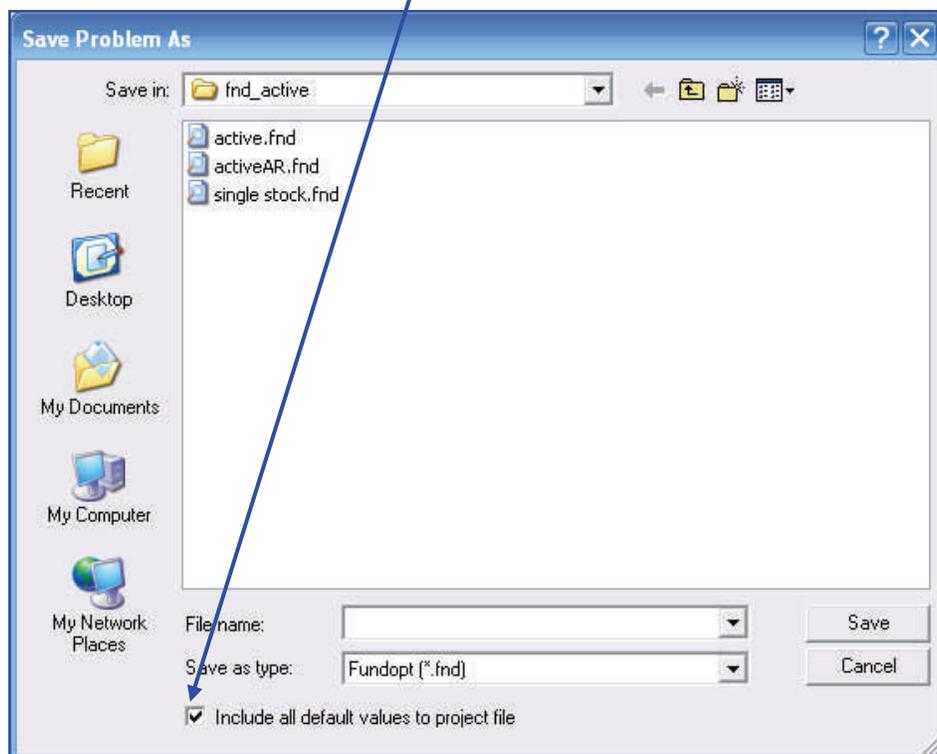
Export
Located in the file menu, export saves a projected created in NISOPT2008 to the NISOPT32 project file format.

Save As
Default settings are not saved in the project file unless specified by selecting this option.

NOTE Project files saved in the Optimizer 2008 will be in the latest format.

Nisbatch 2008

This portion of the article specifically addresses those users of Northfield's batch software (NisBatch) which is a separate software program from the Optimizer. An additional subscription is necessary for those clients interested in learning more about the NisBatch product contact your account manager for details.

Nisbatch2008 is the latest version of the Northfield batching software. This release corresponds with the latest incarnation of the Portfolio Optimizer. With changes made to the project file additional commands were necessary to provide user with the ability to work with those processes created in the previous version.

Currently when attempting to run a batch file which is linked to files created in the previous NisOpt32 version, Nisbatch2008 generally generates an error. If the batch file (.nbt) had run correctly in the previous version this error is most likely due to the incompatibility of the project and/or upd files.

The functionality allows the user to import files in different formats as well as convert those created in the previous version into the new format.

Format Old

this command will allow the user to run the batch process for those project and upd files which have been created in the previous format. This function is useful for comparing output from the old and new batch processors using the same batch file.
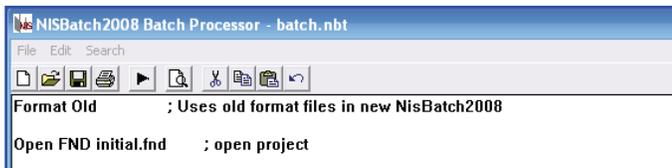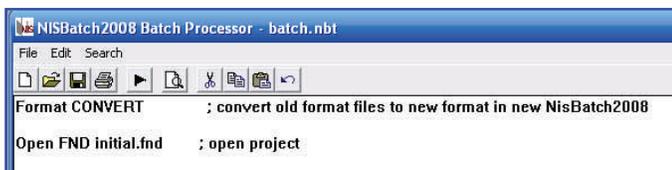

Format New

This is the new default setting for the batch processor, but can be an indicator for nbt files that use input files in the new format.
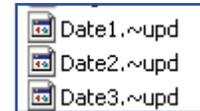
Format Convert:

Converts the existing project and upd files from the NisOpt32 format to the NisOpt2008 format (additional adjustments maybe necessary).

This function over-writes existing files with the current names in the new format;
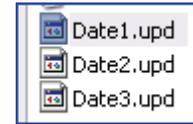
These files are backed in the previous format and are denoted by a tilde in the extension.

The example used above is available for perusing in the \NorthInfo\nisopt2008\samples2008\batch_backtest directory.

Run02008, runlib2008, runlibnet2008

This portion of the article specifically addresses those users of Northfield's Optimizer library which is a separate software program from the Optimizer. An additional subscription is necessary for those clients interested in learning more about the library product contact your account manager for details.

For this functionality it is particularly important that the only true change at the moment is that of the project and the upd files. Additional command line switches have been added to the Optimizer library to import or convert these project and upd files.

Import

-i import an old formatted project or an .nbt file.

Convert

-c import an old formatted project or an .nbt file, converts the project file or all project files specified in the .nbt file to the new format and saves project files in the new format.

For further inquiries, contact Technical Support in Boston: **support@northinfo.com** or call 617.208.2080. European clients can contact: **support@northinfo-europe.com** or call +44-(0)-20-7801-6260. In Asia, contact James Williams, **james@northinfo.com**.

(Fat Tails, Continued from page 1)

is about one in one bil-
lion (bottom row),
while the likelihood is
about one in seventy-
two if we limit our-
selves to distributions
which are symmetric
but otherwise of un-
known shape, and one
in thirty-six for a completely arbitrary distribution.

Probability of a realization > n standard deviations away from mean					
	n=2	3	4	5	6
Chebyshev	1/4	1/9	1/16	1/25	1/36
Bound Same K	1/5	1/27	1/85	1/208	1/432
RV with Same K	1/6	1/33	1/114	1/289	1/614
Normal Dist	1/22	1/370	1/16000	1/1.75 MIL	1/500 MIL

The table illustrates the way out of our paradox. Even for relatively small imperfections in our usual assumptions, the likelihood of extreme events rises to a level where the events of the last six months seem rather ordinary. While imperfections in our assumptions can come from a variety of causes, it is certainly reasonable to believe they will arise from extreme market conditions that occur from time to time. The unusual events of August combined the rapid arrival of new information to the market (i.e. the sub-prime crisis) and high gearing among hedge funds created the need for some funds to liquidate positions irrespective of their perception of investment value of the position. Like 1987 and 1929, once investor's are forced to act, rather than act by considered choice, market liquidity will be insufficient for activity to be routine.

To give more background on the underlying processes and the implications for investor's response to the phenomena of "fat tails", the balance of this article is excerpted from Fat Tails, Tall Tails, Puppy Dog Tails, by Dan diBartolomeo, published in the August 2007 issue of *Professional Investor* magazine.

The Problem
While traditional portfolio theory assumes that returns for equity securities and market are normally distributed, there is a vast amount of empirical evidence that the frequency of large magnitude events *seems much greater than is predicted by the normal distribution with observed sample variance parameters*. There have been three broad schools of thought with respect to this phenomenon:

- Equity returns have stable distributions of infinite variance.
- Equity returns have specific, identifiable distributions that have significant kurtosis (fat tails) relative to the normal distribution (e.g. a gamma distribution).
- Distributions of equity returns are normal at each instant of time, but look fat tailed due to time series fluctuations in the variance.

One of the first influential studies on this issue is from the mathematician Mandelbrot (1963) who argues that extreme events are far too frequent in financial data series for the normal distribution to hold. He argues for a *stable Paretian* model, which has the uncomfortable statistical property of infinite variance. Essentially, under this theory anything can happen at any time in terms of security returns. Later, Mandelbrot (1969) provided a compromise, allowing for "locally Gaussian processes" that are normally distributed a portion of the time. An empirical study by Fama (1965) provides tests of Mandelbrot's idea on daily US stock returns. He found evidence of "fat tails" but also found evidence of volatility clustering, wherein observed volatility had positive serial correlation. A much later empirical study, Lau, Lau and Wingender (1990) rejects the stable distribution hypothesis.

General stable distributions are described by four parameters: Location (replaces mean), Scale (replaces standard deviation), Skew and Tail Fatness. Some moments of this distribution, such as variance are infinite. Except for some special cases (e.g. normal) there are no analytical expressions for the likelihood functions. For example, we can easily calculate that in a normal distribution the likelihood of an event more than three standard deviations negative is close to one in two hundred. No formulae exist for such likelihoods for most stable distributions. Another issue that makes the stable distribution assumption somewhat problematic in practices is that the estimation of the parameters is very fragile. Many, many different combinations of the four parameters can fit sets of data equally well. Stable distributions do have time scaling properties, so we should be able to scale the magnitude of measured values across different frequencies, in the same way that we know that under the normal distribution assumption, the standard deviation of a distribution increases with the square root of time. For more information on the mathematical details of stable distributions, see Rachev (2000, 2003).

One alternative view is to believe that the distribution of stock returns has a specific shape that just happens to have "fat tails," as compared to the normal distribution. Gulko (1999) argues that an efficient market corresponds to a state where the informational entropy of the system is maximized. He then finds the risk-neutral probabilities that maximize entropy. It turns out that the entropy maxi-

mizing risk neutral probabilities are equivalent to returns having the Gamma distribution. The Gamma has fat tails but only two parameters and finite moments. It also has a finite lower bound which fits nicely with the lower bound on returns (i.e. -100%). Using these assumptions, Gulko derives and tests an option pricing model of which Black-Scholes model is a special case

The alternative to stable fat-tailed distributions is a belief that returns are normally distributed at each moment in time, but with time varying volatility, giving the illusion of fat tails when a long time period is examined. This view is first articulated in an unpublished paper, Rosenberg (1974). This paper provides a detailed mathematical model of time-varying volatility in which long run kurtosis arises from two sources: the kurtosis of a population is an accumulation of the kurtosis across each sample sub-period and secondly that time varying volatility and serial correlation can induce the appearance of kurtosis when the distribution at any one moment in time is normal. An important prediction from this model is that kurtosis should appear greater as we increase the frequency of observations. An empirical test on 100 years of monthly US stock index returns shows an R-squared of .86, which is an extremely good fit to the data. The major conclusion is that most kurtosis in financial time series can be explained by *predictable* time series variation in the volatility of a normal distribution

Predictable variation in volatility across time is the essence of the family of ARCH and GARCH (Generalized AutoRegressive Conditional Heteroscedasticity) models, first put forward by Engle (1982) for ARCH, and by Bollerslev (1986) for GARCH. These models present a mathematical form for the clustering of volatility, as first noted in the Fama study. There is a huge literature of over 250 academic research papers applying ARCH/GARCH to financial data.

The financial literature on the fat tailed nature of returns is also vast. It papers showing the fat tailed nature of stock returns across multiple countries (US, Japan, France), across a wide range of financial instruments, and observation frequencies. Almost all empirical work shows that fat tails are more prevalent with high frequency (i.e. daily rather than monthly) return observations. The lack of fat tails in low frequency data is problem for proponents of stable distributions, as the tail properties should time scale. It has been argued we just don't have enough observations when we use lower frequency data for apparent kurtosis to be statistically significant. Lau and Wingender (1989) argue that the differences in kurtosis across observation frequencies could be a mathematical artifact of the way returns are being calculated.

A notable recent paper, Lebaron, Samanta and Cecchetti (2006) conducts exhaustive Monte-Carlo bootstrap tests of various fat tailed distributions to daily Dow Jones Index data using robust estimators. An interesting outcome of the paper is a novel adjustment for time scaling volatilities to account for kurtosis, in order to use daily data to forecast monthly volatility. It finds strong support for time varying volatility, but very weak evidence of actual kurtosis. Another important paper is Andersen, Bollerslev, Diebold and Labys (2000) where they conclude exchange rate returns are Gaussian (normal). This is of particular interest because market participants often assume that exchange rate returns would not be normal due to market interventions by central banks.

In addition to concerns about kurtosis, financial market participants are also concerned with potential skew in the distribution of asset returns. A substantial amount of research literature indicates a consistent prevalence of negative skew in financial data time series. Put simply, markets crash more frequently than they have huge, rapid upswings. Harvey and Siddique (1999) find that skew can be predicted using an autoregressive scheme similar to GARCH.

When we think about "fat tails" we are usually thinking about time series observations of returns. For active managers, the cross-sectional distribution of returns (often called "variety" as distinct from volatility) may be even more important, as it defines the magnitude of the opportunity set. DeSilva, Sapra and Thorley (2001) show that if asset specific risk varies across stocks, the cross-section should be expected to have a unimodal, fat-tailed distribution. Almgren and Chriss (2004) provides a substitute for forming return expectations by sorting stocks by attractiveness criteria, then mapping the sorted values into a fat-tailed multivariate distribution using copula methods

The Reasons

It is interesting to consider the underlying economic causes from which the fat tails and skew in return distributions may arise. Financial markets are driven by the arrival of information in the form of "news" (truly unanticipated) and the form of "announcements" that are anticipated with respect to time (e.g. a company earnings release) but not with respect to content. Several papers have examined the relative market response to "news" and "announcements" such as Ederington and Lee (1996), Kwag, Shrieves and Wansley (2000), and Abraham and Taylor (1993).

The key distinction between the two is that for announcements, investors can think about the "what-ifs" of the situation and plan their actions, conditional on the revealed con-

tent. This allows investors to act quickly and market prices to move relatively smoothly subsequent to announcements. On the other hand, the time intervals it takes markets to absorb and adjust to completely new information ranges from minutes to days. This interval is generally much smaller than a month, but up to and often larger than a day. That's why US markets were sensibly closed for a week after September 11th. Market prices can move violently, generating fat tail return events whenever the flow of trading is interrupted by investors taking the time to ponder the revealed news.

An intuitive rational for skew in return distributions can be found in Brown, Harlow and Tinic (1988). They make the simple argument that investors value investment as the discount present value of future cash flows, and that the discount rate is a function of the risk of the investment, and the investor's confidence in their own understanding of the security. This second contributor to setting the discount rate provides a framework for asymmetrical response to "good" and "bad" news. Good news increases expected cash flows, while bad news causes a decrease in expected future cash flows. However, all news is a "surprise," decreasing investor's confidence in their understanding of the security, and increasing discount rates. Upward price movements are thereby muted, while downward movements are accentuated.

If investors incorporate preferences skew and/or kurtosis, there are implications for asset pricing. Kraus and Litzenberger (1976) and Harvey and Siddique (2000) find that investors are averse to negative skew. Satchell (2004) illustrates that plausible utility functions will favor positive skew and dislike kurtosis. diBartolomeo (2003) argues that the value/growth relationship in equity returns can be modeled as option payoffs, implying skew in distribution. If the value/growth relationship has skew, then an efficient market will show a value premium. Barro (2005) finds that the large equity risk premium observed in most markets is justified under a "rare disaster" scenario

The issue of fat tails in returns is obviously a great concern in the context of risk management of portfolios. While traditional portfolio theory assumes that the future is a single period, many real world investors may not survive into the indefinite future. Kritzman and Rich (1998) define risk management functions when bankruptcy is possible. Wilcox (2000) shows that the importance of higher moments is an increasing function of investor gearing. Obviously, a highly leveraged fund may run the risk of bankruptcy from a single large negative return event. It is much like a boxing match: if you get hit hard enough, you don't get up again. However, for most institutional investors, leverage

is not an issue. Cremers, Kritzman and Paige (2003) use extensive simulations to measure the loss of utility associated with ignoring higher moments in portfolio construction. They find that the loss of utility is negligible except for the special cases of concentrated portfolios or "kinked" utility functions (i.e. when there is risk of non-survival).

Conclusions

The fat tailed nature of high frequency stock returns is well established. The nature of the process is usually described as being a fat tailed stable distribution or a normal distribution with time varying volatility. The underlying process that creates fat tailed distributions probably has to do with rate at which markets can absorb new information. The existence of fat tails and skew has important implications for asset pricing, but fat tails probably have relatively lesser importance for portfolio formation, unless there are special conditions such as gearing that imply non-standard utility functions.

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Northfield Staff Speaking Engagements

Northfield President Dan diBartolomeo will be speaking at a joint Renmin University and University of Brunel Finance conference in Beijing on May 16-18th. The topic is still to be determined.

On May 19th, Dan will be presenting at the London Quant Group CQA Conference. The topic will be on centralized portfolio management.

Dan will be speaking on May 21st at DePaul University in Chicago on contingent claims analysis.

Dan will be presenting at the CFA Institute "Investment Strategies for Private Clients" seminars in Canada. The seminars start in Ottawa on May 26th, Montreal May 27th and Halifax on May 28th. The topic for all three will be "Asset Allocation for High Net Worth Investors." Visit **http://www.cfainstitute.org/memresources/conferences/calendar.html** for more information.

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Australian clients can now more conveniently reach Northfield in Asia via our new Australian office. The number and address are as follows:

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