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# Northfield News

*Quarterly Newsletter for the Friends and Clients of Northfield Information Services*

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## Extreme Events, VaR, Parkinson Volatility and Coherence

*By Dan diBartolomeo*

Over the past couple years, an unprecedented number of firms-specific extreme events have occurred in cases such as Enron, Worldcom and Adelphia Communications. It is now common for companies to announce bad news only after trading is closed for the day, in the hope that panic selling will be lessened. Nevertheless, equity investors are facing enormous one-day stock price drops on a very frequent basis.

One way that Northfield has dealt with the issue of extreme outcomes is to redefine the way in which we compute basic information such as the volatility of a stock. We follow the approach of Parkinson (Journal of Business, 1980) and Kunitomo (Journal of Business, 1992). In normal practice, investors define volatility as the standard deviation of periodic security returns measured from the close of trading at one period to close of trading of the next period. However convenient and conventional this approach may be, there is nothing magical about measuring returns from close to close as compared to "open to open" or any other periodic time structure. Parkinson pointed out that what was really important was to look at the extent of the range of security value from its low during any time period to the high achieved during that same time period. What mattered

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## Convertible Bonds in the "Everything Everywhere" Model

*By Nick Wade*

We developed the "Everything Everywhere" (EE) Model in response to the clear need for a straightforward and robust framework in which to analyze and control the risks of a balanced portfolio. The EE model gives managers a tool to monitor and control the risk of global equity, fixed income, and currencies using the same set of risk factors. For those interested in the details of our EE model, please see <http://www.northinfo.com/products/riskmodels/docs/eemodel.pdf>.

Typically, fixed income and equity models contain completely different types of factors, and the unique aspect of the EE model (so useful for balanced portfolios) is that it uses exactly the same set of factors for all securities within all asset classes.

Covering global equities, and global government and corporate coupon and floating rate fixed income securities, the EE model has broad applicability in the area of balanced portfolio management. However, there exists a class of security that contains the risk of both equity and fixed income instruments. In effect, it is a "balanced" security. These securities are convertible bonds. A convertible bond is a coupon paying fixed income instrument that may be converted at the holders' discretion over a set range of dates into

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## 2003 Northfield Annual Research Conference

Topnotch Resort and Spa • Stowe, Vermont • March 16-18, 2003



Topnotch Resort

We are pleased to announce our 16th annual research conference at the Topnotch Resort and Spa, in Stowe, Vermont.

The conference will officially begin with lunch on Sunday, March 16<sup>th</sup> and end with lunch on Tuesday, March 18<sup>th</sup>. As is customary at Northfield events, a complete recreational and social calendar will accompany the working sessions. A Saturday arrival is highly recommended, as our program will unofficially begin on Saturday evening with a themed party, music and additional entertainment which will feature horse drawn sleigh rides.

Sunday morning will be reserved for recreational pursuits. Outings for down hill skiing, snow shoeing and cross county skiing will be offered. To enliven the program, Sunday's evening will feature an elegant "black tie" gala, and Monday evening will feature a unique Vermont experience.

Northfield is holding a block of rooms for the nights of March 15<sup>th</sup> through 17<sup>th</sup>. The conference room rate is discounted at \$230.00 plus applicable taxes and is payable directly to the hotel. Reservations are on a first come basis so it is a good idea to register early. The deadline for all reservations is February 15, 2003.

To register for the conference and make your hotel reservations, contact Kathy Prasad at 617.208.2020, [kathy@northinfo.com](mailto:kathy@northinfo.com). Further program updates will also be posted to <http://www.northinfo.com/events> as they as they become available.

### Agenda

The agenda will consist of 12 hour long presentations.

#### [A Hierarchy of Investment Choice: A Normative Approach](#)

*Mark Kritzman, Windham Capital Management*

#### [Cash Flows, Asset Values, and Investment Returns](#)

*Tony Estep, Bank of America*

#### [Using Statistical Process Control To Monitor Active Managers](#)

*Thomas K. Philips, Paradigm Asset Management*

#### [Tactical Asset Allocation With Pair-wise Strategies](#)

*Edward Qian, Putnam Investments*

#### [Hazards of Accounting Benchmarks](#)

*Diane Garnick, SSGA and Evan Grace, State Street Research*

#### [Is Dead Data Really Dead? Multiple Views of Historical Fundamental Data](#)

*Marcus C. Bogue, III, Charter Oak Investment Systems, Inc.*

#### [Building Sector Specific Models](#)

*Jack Brush, Columbine Capital*

#### [A Foundation for Quantitative Finance: From Randomness Engineering to Financial Engineering](#)

*R. B. Holmes, HIM&R, Inc.*

#### [The Procter & Gamble – Bankers Trust Transaction: A Margrabe Model Analysis](#)

*William Margrabe, Margrabe Group, Inc.*

#### [Differential Market Reactions to Revenue and Expense Surprises](#)

*Yonca Ertimur and Joshua Livnat, New York University*

#### [Monte Carlo Simulations of Performance Fee Structures](#)

*Martin Lee, Alan MacCormack and Dan Bukowski, Citigroup Asset Management*

#### [New Applications of Volatility Metrics](#)

*Dan diBartolomeo, Nick Wade and Sandy Warrick, Northfield*

## 2002 European Seminars Wrap up

Northfield recently hosted two 1 day seminars in Europe on October 14th at the St. Martin's Lane Hotel in London, and on October 16th at the The Grand Amsterdam Hotel in Amsterdam. Both events were well attended and covered a variety of topics currently facing European investors and investors in Europe.

The working sessions addressed both theoretical and operational issues. The agenda featured 5 presentations. Topics included Real Estate - How to Include it in a mixed-asset portfolio, Subtleties of Risk Management for Long/Short Portfolios, Risk Modeling of Convertible Bonds, Equity Style as Described by the Cross-Sectional Volatility of Stock Returns, and the Fallacy of High Frequency Performance Attribution .



The Grand Amsterdam

Presentations were made by Northfield staff members and featured guest speaker Professor Charles Ward of the University of Reading School of Business. Complete Seminar proceedings have been posted to Northfield's website at [www.northinfo.com/papers/european.html](http://www.northinfo.com/papers/european.html)

*(Extreme Events, continued from page 1)*

most to an understanding of volatility were the extremes of outcome.

Portfolio theory normally assumes that stock prices move in geometric Brownian motion. This implies that each price movement is random, there is no serial correlation and that volatility is constant through time. Parkinson observed that if these assumptions were true, there was a direct algebraic transformation from the high-low range of security price during any period and the volatility of that security. Stocks with high volatility should have a wide high-low range, and vice versa. This transformation from the high and low prices observed during a period to the "implied" volatility appears below:

$$\sigma_P = (((\log(H/L))^2 / 4 \log(2)))^{.5} / 1.67$$

Let's assume we compute the volatility of a stock as the standard deviation of the last sixty monthly returns. Alternatively, we could compute the Parkinson volatility for each of the last sixty months and take the average of those sixty values. If our usual assumptions about geometric Brownian motion hold true, the two methods of computing volatility will produce the same values. However, if serial correlation, kurtosis or other imperfections in the assumptions are evident, the two estimates will disagree.

Using Monte Carlo simulation methods, Parkinson found his method about five times as efficient as the traditional calculation for correctly estimating population variance from a limited sample of data. The reason this is true is that when we calculate standard deviation, we compute it

as the square root of the mean squared differences between the observations and the mean of the sample. However, in investing we are observing each event in sequence. As such, we cannot know the mean value from which observed differences are to be measured until the entire time sample has been observed. Using Parkinson, we create independent estimates of the volatility during each observation period from its respective high and low prices. We therefore have a theoretically legitimate estimate of volatility after observing only one period. We get closer to the right answer much sooner.

Northfield has used a form of this methodology in our US Fundamental Model for several years. If the Parkinson implied volatility is larger than the conventional calculation, we adjust asset specific risk upward to reflect our uncertainty about the validity of our basic portfolio theory assumptions. If the conventional estimation of volatility produces a higher value, we err on the side of conservatism by allowing it to remain unchanged. *We are currently in the process of updating our procedures in this area, and will soon be applying the Parkinson methodology to all of our risk models.* It is anticipated that the inclusion of this alternative form of volatility estimation will provide a significant improvement in the predictive power of our models.

In an extension of the Parkinson approach, Garman and Klass (Journal of Business, 1980) created a method for estimating security volatility from the difference between the closing price on one day, and the opening price on the next trading day. Given the current practice of bad news an-

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## New Risk Models Under Development

We are currently testing a new model for Pacific Rim securities. This model will join our existing family of Single-Country & Regional Models, sharing the same factor structure and the same “hybrid” approach. We believe that this approach mixing market, sector, and macro-economic exogenous factors with five principle components provides the most adaptive, intuitive, and parsimonious model possible, capturing the global and local factors that affect this diverse region. In this way, we create a new model that is consistent with our Global Model, and our other Single-Country and Regional Models, allowing managers a clear and consistent view of risks globally.

In the New Year we will also begin development of a range of Fixed Income Models. Our experience with the Northfield EE Model has led to the development of the technical architecture and algorithms to price and handle data required to deal with such a project, together with a detailed understanding of the instrument-specific risks involved with such a diverse asset class. We will be actively seeking client input from the very beginning, following our tradition of producing the best theoretically grounded, most innovative, and most practical risk models available.

Both the PacRim Model and the new family of Fixed Income Models will be compatible with the existing Northfield Open Optimizer. Speak to your Northfield contact for further details.

## Northfield Staff Speaking Engagements

Northfield President Dan diBartolomeo spoke at the second annual Factset PMW User Conference, in Atlanta Georgia, November 6-8. The presentation titled “Total Plan Risk: Integrating Assets into a Consistent Risk Framework has been posted to [www.northinfo.com/papers](http://www.northinfo.com/papers).

Dan will be speaking at the Boston QWAFEFW meeting on January 9th in Boston. The topic will be “Using Volatility State Preferences to Define Value, Growth and Momentum Investing Styles.” Dan will also be speaking at the IIR Performance Attribution Forum on February 26th, in New York. The topic will be “Reconciliation of Monthly and Daily Attribution Methods.”

Northfield’s Russ Hovanec presented "Portfolio Theory, Speculation and the PRC Stock Market" at the Financial

Risk Summit in Shanghai on October 29 and at Alpha Neural's FIT Exchange Conference in Hong Kong on November 1st. The presentation has been posted to [www.northinfo.com/papers](http://www.northinfo.com/papers)

Northfield’s Nick Wade, spoke at the QWAFEFW meeting in London on September 18th. The topic was on convertible bonds and titled "A unified approach to equity risk, credit risk, and convertibility using dual binomial trees.” This presentation has been posted to the Northfield website at [www.northinfo.com/papers](http://www.northinfo.com/papers).

Northfield's' Sandy Warrick spoke at the SRI Summit in Vermont on September 8th, the topic was “Risk Management of Socially Screened Portfolios.” He also spoke at the Investment Management Consultants Association Conference in Chicago, on November 7th. The topic was on the Management of Taxable Accounts. Both have been posted to [www.northinfo.com/papers](http://www.northinfo.com/papers)

## Northfield and FactSet Introduce Real Time Risk Assessment

Firms using the Northfield risk models and optimization via the FactSet delivery system now have the ability to monitor portfolio risk levels updated with real time security prices throughout the day. Northfield summary risk statistics such as tracking error and portfolio beta are now available at no extra charge for Northfield clients that are users of the FactSet Portfolio Analysis application suite.

In addition to the free summary statistics, a new user-friendly form of our risk decomposition reports is available within the FactSet PA environment for a relatively nominal charge. This new system not only provides detailed reporting on up-to-the-minute risk characteristics of portfolios, it can also look back historically so portfolio managers can easily see trends in portfolio risk levels across time. Extensive “drill-down” reporting and graphics have been added as output options, making it easy to communicate the magnitude and nature of portfolio risks to all interested parties. For more information, contact a Northfield or FactSet sales representative.

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**If you have any suggestions of what you would like to see covered in upcoming issues, please e-mail your ideas to [staff@northinfo.com](mailto:staff@northinfo.com)**

*(Bonds is the EE Model, continued from page 1)*

a certain number of shares of stock at a set price. Commonly, convertibles also contain embedded options such as issuer right to call. Many managers of balanced funds, and many fixed income managers in general, hold positions in convertible bonds, and hence it seemed only natural that we should extend our EE model to cover convertibles.

There are several possible approaches to convertibles proposed in textbooks or the academic literature [2], the majority of which involve some quite heroic assumptions that contradict the purpose of the EE model, or are inapplicable in a production environment;

- Interest rates are constant - use Black-Scholes model to value the option part of the convertible security
- There are two constant interest rates (one risky, and one risk-free) - price using a stock price diffusion process modeled by a binomial tree.
- Describe the convertible bond as in the form of a partial differential equation and use Finite-Difference Methods directly on the PDE
- Returns on the underlying stocks are uncorrelated with interest rates
- Returns on the underlying stocks are uncorrelated with each other

Neither of the "constant interest rate" approaches was sensible in a model designed to capture the risks of both equity and fixed income securities. Although the "constant interest rates" assumption is acceptable for short-dated options, many of these convertibles have embedded options spanning ten years or more making this assumption untenable. There are, however, some approaches to combat this. [3][4][5]. Using Finite-Difference methods will produce the right answer subject to some conversion problems, but this is an intractable solution, since it is a complicated job to specify each individual contract in terms of its boundary conditions and dependencies and solve individually given that we need to apply our chosen approach to many thousands of contracts in as automated a way as possible.

Clearly we had to think of a more comprehensive approach containing fewer unpalatable assumptions. Our first approach was to use two orthogonal binomial trees, one for the interest rate process (arbitrage free) and another for the

stock price diffusion process. The two trees recombine with each node branching into four future nodes. One way to think about this is as a different stock price tree for each of many possible interest rate paths. This approach produced very accurate pricing and rational sensitivities to interest rate changes. Clearly therefore, we had with our first approach one that could be applied in a large-scale production environment and that allows us to avoid making the "constant-interest-rates" assumption. This first approach is not perfect, however, because it neglects the correlation between the interest-rate process and the stock price diffusion process.

Another field of research that approaches the issue of correlated processes is that of the pricing of rainbow options [8]. Our second and current approach is to adapt research from that field; two uncorrelated processes can be created from the two original correlated ones and we can thus go on to build the recombining three-dimensional tree free from correlation concerns [7]. Equivalently, one can change the geometry of the tree, or adjust the branching probabilities at the nodes.[9][6] Our second approach provides rational sensitivities to changes in interest rates, a tractable large-scale pricing model, and allows us to avoid both "constant interest rate" assumptions and also to avoid ignoring correlation between our two stochastic processes.

Using this three-dimensional tree structure, we can accurately price these instruments under a range of term-structure scenarios and thus capture sensitivities to interest rate risks.

Turning our attention to credit risk for a moment, the second most important risk with fixed income securities, we began by reviewing the extensive literature on credit risk and default with convertible bonds (for some useful starting points, see [1][9][10]). In our approach, the credit risk component of the convertible securities risks is modeled as sensitivities to the equity factors (we follow the same procedure for risky non-convertible bonds).

The third, and unique, risk attribute of convertible debt stems from its dependence on the dynamics of the underlying equity security. To capture this "equity risk" feature of the convertible we follow the following steps; we determine for each node in our tree whether conversion is optimal, for each converted node, we add a discounted exposure to the underlying equity security. This incorporates:

1. The fact that the security has a future/forward exposure

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*(Bonds is the EE Model, continued from page 5)*

to the equity security risks

2. The time element of that risk. Clearly, if conversion occurs farther in the future, the exposure to the equity risk should be smaller than if conversion occurs tomorrow.

3. The interest rate environment at conversion and the interest rate path taken to arrive at conversion (by discounting the exposures back down this path).

To summarize briefly; our pricing model for convertible bonds captures the dynamics of both the stock and interest rate processes. It also captures the effects of embedded options, the correlation between the underlying equities of multiple convertible bonds within the portfolio.

“Forced” conversion effects are also addressed within the model. Forced conversion occurs when convertible bondholders are forced to exercise the warrant converting their position to simple equity, rather than have the bond called by the issuer. Often when a firm’s shares are selling at a very high price, the firm can sell new shares and use the cash to redeem its convertible bonds. In this situation, convertible bondholders are immediately forced to convert to a simple share position, and are thus deprived of the time value of equity warrant.

A different form of forced conversion can sometimes occur when a firm is in crisis. Such a firm can get debt off its balance sheet by calling convertible bonds knowing that it can’t pay the debts off, precipitating a bankruptcy. Rather than own defaulted convertible bonds, holders have no choice but convert their position to a fixed number stock of the firm at precisely the moment when share prices are apt to be most depressed. Forced conversion also sometimes occurs in corporate acquisitions made for cash.

Our EE model provides an intuitive, parsimonious, and robust approach to measuring the risks of multiple asset classes with respect to the same set of core risk factors. Whilst providing an accurate model for the risks of equity, and diverse fixed income instruments, it also provides a transparent view of global bets across instruments, asset classes, and regions. Our approach to convertible bonds continues this philosophy by providing a model that simultaneously accounts for the dynamics of the equity and interest rate dependent pieces of the instrument without resorting to heroic assumptions. We feel this approach in particular, and EE in general, is a significant advance in the field of risk modeling.

## References

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nouncements coming outside trading hours, “gap down” openings are a frequent occurrence. Northfield is currently researching how to update our Short-Term Risk model shortly after the opening of trading day rather than during the non-trading overnight hours, so as to incorporate the additional information contained in the price changes between the opening and prior closing.

Some investors relate the ideas about extreme values to single tailed risk measures such as Value at Risk (VaR). It should be noted that the concept of VaR can be expressed in two ways that are mathematically equivalent but very intuitively different. For any selected value of P, we can compute X based on the expected distribution of outcomes:

- VaR is the value X such that in P% of observations your loss should be X or less
- VaR is the value X such that in (100-P)% of observations your loss should be X or greater

**If we assume that the distribution of security returns is normal, then there exists a simple algebraic transformation from any volatility measure to VaR and back again.**

$$\text{VaR}(P) = S * Z(P) * V / (n)^{.5}$$

- S = annual percentage volatility of the asset
- Z(P) = the number of standard deviations from the mean to be inclusive of P% fraction in the normal cumulative density function
- V = the market value of the portfolio
- n = the number of VaR measurement periods in a year (e.g. 250 trading days in a year)

**If we do not assume normality in the return distribution, then the VaR measure can break down into non-sensical answers. Let us consider an example from Albanese (University of Toronto Working Paper, 1997): What are the 95% confidence level VaR values of two alternative investments:**

- a single \$1,000,000 bond with 2% yield, and 1% probability of default?
- a \$1,000,000 bond portfolio of 1,000 independent issuers, each \$1000 bond having a 2% yield and 1% default probability

The P=95 VaR for the first case is zero, while for the

second case it is substantially positive. As such, it appears that a single bond is less risky than owning a broadly diversified portfolio of equivalently risky bonds. Artzner, Debaen, Eber and Heath (Mathematical Finance, 1999) refer to this logical breakdown in the behavior of VaR as a failure in coherence.

To be fair to VaR advocates, Artzner, et al. also criticize conventional volatility measures as being incoherent with respect to highly skewed distributions. For example, what’s the risk of a lottery ticket you receive as a gift? The standard deviation of expected outcome is enormous but you have nothing to lose. It should be noted that highly skewed distributions of this kind are rarely a practical concern in investment management, as the Central Limit Theorem of statistics guarantees that the expected return distribution for a well-diversified portfolio will be normal, even if the individual assets are highly skewed. See Hwlatschka & Stern for a clever proof this issue for portfolios of options. (Working Paper 1995).

## Northfield Technical Support

Northfield’s primary technical support desk is in Boston, the hours are 8:00-6:00 EST. If you need Technical Support, or would like to schedule an online training session, call 617-208-2080 or e-mail to [support@northinfo.com](mailto:support@northinfo.com).

European clients who need technical support assistance when the Boston office is closed can call the London office, at +44-(0)-20-7801-6260, or e-mail to Rupert Goodwin, [rupert@northinfo.com](mailto:rupert@northinfo.com).

## Northfield Annual Holiday Party

Friends and clients of Northfield Information Services are cordially invited to attend our annual holiday party. The party will be held in Northfield’s Boston offices on Monday, December 16th. From 5:30 to 9:30.

Complimentary cocktails and and Hors d’oeuvres will be served and the evenings entertainment will be provided by The Random Chance, a local acappella singing group.

Guests are welcomed to this informal gathering. If you would like to attend, please RSVP to Kathy Prasad, [kathy@northinfo.com](mailto:kathy@northinfo.com), 617.208.2020.

## Northfield's Activities in the People's Republic of China

As you may know from earlier newsletters Dan diBartolomeo and Russ Hovanec from Northfield visited the PRC for the first time in May of this year when they met with some 20 organizations; brokers, mutual funds and regulators. What you may not know is that Northfield's interest in the PRC came about more or less by chance just about a year ago when our now current sales representative in China, aEcho Communications Ltd., made several persuasive arguments that piqued our interest. Their points went something like this.

- Only 0.25% of the public invests in the capital markets (that's still ~ 6-8MM people)
- Mutual fund investing began in 1998 with closed end funds
- PRC accepted into WTO in fall 2001
- Open end mutual funds offered in fall 2001 with about 18 fund managers total

### Since last fall

- Joint ventures with large outside players started funds with the local PRC funds (Soc Gen, Allianz, Invesco)
- Non-PRC investors were only allowed to buy B shares which are a small part of the securities offered. Local investors could only invest in A shares. Last week the PRC government began allowing outside investors to petition for the right to trade in A shares. Notably this announcement occurred during the National Party Congress which occurs every five years when the new leaders are chosen. Some of this resistance to outsiders was for their own good, since the quality of shares and the lack of financial reporting standards could surprise unknowing investors.
- With all this activity, there are now 28 fund managers and rising fast.

However, despite the grand welcome and obvious interest in Northfield products, our first visit produced some concerns regarding the marketing of our products.

- There is a lack of expertise in modern portfolio theory and quantitative methods at the funds. The funds are partly owned by banks. Consequently they're staffed with folks from the banks whose risk expertise is more VaR oriented as one would expect to find in banking. This means that there is an educating process that needs to occur over time to get modern portfolio theory immersed in the fund management culture making the acceptance and support of Northfield products easier.
- PRC investors have a trading mentality like that of day traders during the heading days of the internet here in the US. This may have been engrained because of the short life cycle of listed stocks and the PRC limits the accumulation of wealth via stock ownership. The upshot is that this involves more educating on our part as both Dan and Russ have frequently repeated the same message over and over again to PRC prospects.

We have addressed some of these concerns via frequent e-mail questions and answers and by engaging Rebecca Pearson from Alpha Group Consulting in Hong Kong, formerly a quant at Putnam, to become a Northfield partner to help support implementations there. We think it will make a difference vs. the competition and help provide the education needed so new PRC clients get the most benefit out of Northfield products.

On the trip in late October Russ visited some of the Northfield trial prospects in Shenzhen, gave a talk on risk in the PRC at the Financial Risk Summit organized by EFG and visited three new funds in Shanghai, met with five Factset clients in Hong Kong that had an interest in Northfield products, gave the same risk talk as well as a talk on enterprise risk implementation at a conference organized by Alpha Neural that we sponsored in Hong Kong and met with several prospective business partners there. It is exciting for Northfield to watch the PRC funds management industry quickly evolve as well as playing a role in the process.



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