



May 2005

# Northfield News

Quarterly Newsletter for the Friends and Clients of Northfield Information Services

## Special Points of Interest:

- ▶ In Depth Article - Optimization of Multiple Related Accounts
- ▶ Northfield Annual Conference Agenda
- ▶ In Depth Article - Stress Testing of Risk Estimates
- ▶ Technical Support Tip: Industry and Sector Mapping

## Optimization of Multiple Related Accounts

By Dan diBartolomeo

Multiple accounts held by various members of the same family represent a very special challenge to wealth management organizations. For example, a single family could have accounts that are held in the name of the father, mother, various children, plus trust funds. Some of these accounts will be taxable, with a variety of tax circumstances. Other accounts within the set are likely to be tax-deferred retirement accounts. Even a single individual with a tax deferred account must make the interconnected choice of *asset allocation* and *asset location*. In addition, each of the accounts may have a different level of risk tolerance.

One financial service gaining popularity with individuals is what I'll call the "Multiple-Disciplinary Account" (MDA). This is an account where multiple managers provide model portfolios in different market segments (large cap, small cap, value, growth, international, etc.) Each model portfolio has its own benchmark. The selection universe for the model portfolios may or may not be overlapping. The client's actual portfolio is traded as a single central account. The individual manager portfolios are just model port-

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## Stress Testing of Risk Estimates

By Dan diBartolomeo

At Northfield we are often asked about how one could go about "stress testing" the risk values that arise from our risk models. Investors are concerned about the potential "worst case scenario" that might arise as a return realization given a particular level of forecast risk.

If our risk forecasts were perfect, one could easily compute the likelihood of any particular level of return directly from the normal cumulative density function. To the extent that our forecasts are imperfect, we need to do more in some circumstances.

### Traditional Stress Testing Concepts

Before going into the particulars of stress testing, we should review some of the basic reasoning around "stress testing" as a concept. This sort of testing has largely arisen from the risk management practices of banks, trading desks, and hedge funds where portfolio circumstances are generally very different from that of a typical investor's portfolio within a traditional asset management environment. First, trading desk positions can be very undiversified because the transactions that the desk undertakes are based on the profits that can be obtained by providing liquidity to accommodate the transactions of others. With poor diversification, the Central Limit Theorem is likely to be less of a force

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## Recent and Upcoming Events

### Northfield User Seminars Wrap-up

Northfield's Boston Office • March 8 and March 10, 2005

The Northfield user seminars were held on March 8th and 10th in our Boston office. These first of their kind seminars are part of a new effort developed to provide our current clients and prospects with training and a practice based review of common issues associated with everyday usage of Northfield analytical tools.

The early morning featured separate training sessions on Northfield's core offerings: Optimization, Performance Attribution and Asset Allocation. Ample time during these sessions was allotted to answering questions and exploring ad-hoc situations as they arose.

The late morning and afternoon featured advanced presentations which included; "Proxy Holdings for a Hedge Fund," "Rational Long/Short Portfolios," "A Simultaneous Solution for Optimization of Multiple Related Accounts" and "Extracting Useful Information from a Back-Test."

The seminars concluded with a cocktail reception during a semi-final match at the US Open Championships of Court Tennis at the Tennis and Racquet Club of Boston. The presentations will be posted soon to <http://www.northinfo.com>

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### Northfield European Seminars Wrap-up

London, May 17, and Edinburgh, May 19, 2005

Two Northfield seminars were recently held in London and Edinburgh. The purpose of the seminars was to highlight recent advances in portfolio risk management to our growing number of European clients and prospects.

Northfield President Dan diBartolomeo and Northfield's Emilian Belev were the presenters. The topics included; "Equity Risk Modeling: Innovations in Methods & Best Practices," "Extensions to a Risk Model of Everything, Everywhere," "Credit Risk Modeling Using Market Implied Measures, Rational Long/Short Portfolios, and Modeling," "Managing the Market Impact of Large Trades," and "Proxy Holdings for a Hedge Fund."

Each seminar concluded with a well deserved cocktail reception. In addition, the London event offered a unique entertainment demonstration which featured a professional pickpocket, who managed to relieve a number of guests of their wallets and watches in a most entertaining (and temporary) way. Guest feedback was very positive. The seminar proceedings will be posted soon to <http://www.northinfo.com>.

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### 2005 Newport Annual Summer Seminar

Tennis Hall of Fame • Newport, Rhode Island • June 10, 2005

We are pleased to invite you and your colleagues to our annual summer seminar. The purpose of the seminar is to present recent research and technical advances to our clients and friends.

There will be five presentations; "Exploiting Performance Divergence Across Styles," "Equity Risk Modeling: Innovations in Methods & Best Practices," "Optimal Algorithmic Trading," "Active Risk Budgeting with Optimization Tools," and "Active Returns from Passive Management: An Updated Look."

As always, our meeting date has been selected to coincide with the US Professional Championships of Court Tennis. Following the day's presentations, there will be a court tennis demonstration by Northfield President Dan diBartolomeo, and then a semi-final court tennis match. Court Tennis, or "real tennis" is the medieval sport that is the progenitor of all modern racquet sports.

After tennis on Friday evening, an oceanfront dinner party will be held at Johnnie's Atlantic Beach Club and Pavilion in nearby Middletown RI (Purgatory Road).

There is no charge for participation in any aspect of this event, however, we will be accepting donations on behalf of the Pine Street Inn, a Boston homeless shelter. The full seminar agenda and the online registration form has been posted to <http://www.northinfo.com/events.cfm>.

## 2005 Northfield Annual Research Conference

The Fairmont Le Château Montebello • Montebello, Quebec, Canada • July 18-20, 2005

We are pleased to announce our 18th annual research conference at the Fairmont Le Château Montebello, in Montebello, Quebec, Canada. The Château Montebello is an acclaimed resort famed for its rugged luxury and natural Canadian beauty. In addition, it is a family-friendly venue with a broad range of recreational opportunities, including the simple enjoyment of the Canadian outdoors.



Le Château Montebello

The conference will start on Sunday evening, July 17th with an “Unofficial” welcome cocktail party and dinner. As is customary at Northfield events, a complete recreational and social calendar will accompany the working sessions. Monday morning will be reserved for recreational pursuits. We are offering attendees a choice of activities appropriate to our beautiful venue: river rafting, ATV guided tours, canoeing, kayaking, or a trip to a fish hatchery and a chance to catch some trout. Monday evening will feature an elegant “black tie” gala and Tuesday evening will feature a “Camp Northfield” themed event with fun activities, cocktails, Hors D’oeuvres, and dinner.

Northfield is holding a block of rooms for the nights of Sunday, July 17<sup>th</sup> through Tuesday, July 19<sup>th</sup>. The conference room rate is discounted at \$219.00 CDN (approximately \$172.00 US), for a standard room, and is payable directly to the hotel. Deluxe rooms and suites are available at an additional cost. The hotel registration deadline is June 10, 2005.

Please note, 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](mailto:kathy@northinfo.com), 617.208.2020.

### Agenda

The agenda will consist of twelve 1-hour long presentations.

#### **Beyond the Torpedo Effect-An Examination of Factor – Based Portfolio Construction Techniques**

*Robert Hagen, Lord Abbott*

#### **Understanding Momentum**

*Alan Scowcroft, UBS Investments*

#### **Hedge Fund Allocations**

*Mark Kritzman, Windham Capital Management*

#### **Beyond the Fundamental Law: Multiperiod Dynamics of Active Portfolios**

*Leigh Sneddon, Westpeak Global Advisors*

#### **Alpha, the Most Abused Term in Finance!**

*Jason MacQueen, Alpha Strategies & R-Squared Ltd.*

#### **On the Financial Interpretation of Risk Contribution**

*Eddie Qian, Panagora Asset Management*

#### **Honest EPS**

*Doug Coté, ING Investment Management*

#### **Fixed Income Risk Models - Theory and Experience**

*Navin Sharma, Oppenheimer Funds, Inc.*

#### **Uncertainty, Risk, Horizon and Investment Decisions**

*Jonathan Reiss, Analytical Synthesis, LLC.*

#### **Is Alpha-Beta Analysis Useful for Constructing a Fund-of-Hedge Funds Portfolio?**

*Martin Lee, Investcorp*

#### **Return Forecasts and Optimal Portfolio Construction: A Quantile Regression Approach**

*Larry Pohlman, Panagora Asset Management*

#### **Investment Management for High Net Worth Individuals**

*Dan diBartolomeo, Northfield Information Services .*

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folios, and no effort made to make separate trades for "sleeves" (sub-accounts). Our goals in this situation are to do a "global" optimization of the client's portfolio that is both tax efficient across the entire portfolio and captures as much investment performance of the model portfolios as possible.

The easiest way to do this problem is to form a benchmark that is the joint "model" portfolio with each position weighted proportionally to the hypothetical fraction that each model portfolio constitutes of the entire portfolio. So if Manager A is supposed to be 30% of the market value of the MDA, and he has a 4% position in IBM, the benchmark has a 1.2% (.3 \* 4%) position in IBM. You can now run a simple "minimum variance" optimization of the existing positions against this benchmark to do the tax optimization.

Unfortunately, the simple method above is only appropriate when the multiple model accounts have mutually distinct universes of securities. Consider the following example where the positions can overlap:

We have an MDA with two managers with 50% of capital allocated to each. Manager A thinks Exxon is a great stock and overweights it 3%. He has market weighting on the airline sector. Manager B has a big 5% overweight in airlines (which he considers undervalued) and so he overweights Exxon 3% as a hedge against oil prices rising. If we just add the positions together, we will have a 3% overweight in Exxon and a 2.5% overweight in airlines. However, Manager B wanted to overweight Exxon as a hedge against his big airline bet. Since the airline sector is now just overweighted 2.5%, Manager B should want to overweight Exxon just 1.5% as a hedge (to keep the same 5/3 ratio). So our preferred overweight in Exxon should be 3% for Manager A, and 1.5% for Manager B. We get 2.25% overweight in Exxon as the correct "benchmark" (joint model portfolio) weight, not 3%. Similar distortions can occur even if the selections universes are mutually exclusive if one manager is a lot more aggressive than another.

The better way to handle the MDA case is to follow the procedure outlined in my 1999 paper (1992 draft) on running a central portfolio with multiple model portfolios as inputs. This paper can be found at

<http://www.northinfo.com/documents/61.pdf>

Essentially, this process involves making inferences about the "implied" alpha for each stock by each manager. We can then weight the alpha values across managers based on their assigned weight in the overall portfolio. Given the "consensus alphas" we can then optimize the portfolio in

the conventional fashion. This approach has numerous other advantages as enumerated in the paper. The only tricky aspect is handling the impact of the possible "short sale" constraints on the implied alphas if managers running the model portfolios are not allowed to take short positions. We have done additional research since 1999 on this point and have some related suggestions. The Australian division of Vanguard recently started to offer an investment product that they acknowledge is based on the methods outlined in this paper.

Since there is only one account actually being traded, the existing facilities inside the Optimizer for constraints, managing tax costs and wash sales are fine, irrespective of which of the methods is used.

The second and more complex possibility is what I'll call an "overlay management" account. In such an account, there are separate pools of money in various sub-accounts, and funds cannot be moved from one to another. In some cases, the client has multiple managers each actually managing a "sleeve" or distinct sub-account. In other cases, there are sub-accounts for legal reasons (e.g. husband and wife, 401K, trust fund, etc.) There is no central actual account. Each sub-account may have its own benchmark, tax circumstances and risk tolerance. Our goals in this case are to do a "global" optimization of the client's portfolio across all sub-accounts:

- a) in a tax efficient fashion across the entire portfolio
- b) capture as much of the investment performance as possible as would otherwise have occurred in each sub-account
- c) keep each of the sub-accounts meeting any position size constraints that were originally imposed on that sub-account

Our basic approach is to transform the problem we have (multiple heterogeneous sub-accounts) to a mathematically equivalent problem where all the sub-accounts have uniform properties of taxation and risk tolerance. For example, assume we have an individual with both taxable and tax-deferred accounts. To simulate tax deferred positions, we can *pretend* that the cost basis of any position in the tax-deferred account is always equal to the current market price. This removes any influence of capital gain taxes from the optimization on those specific securities.

This method can also handle linear constraints within the sub-accounts such as an income yield requirement, as is usually the case if one of the sub-accounts is a trust. Unfortunately, creating the problem specification is very com-

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plex and involves creating a lot of input files. We expect to have this process automated through the MARS software platform in the future. Here's a step by step run through the procedure:

**1.** Our first step is to make distinct holdings over the same security in different accounts. We can do this by creating "composite asset" synthetic securities. If we have two sub-accounts, we want to create a separate synthetic security such as "IBM\_1" and "IBM\_2" for every stock that could possibly be involved in any separate sub-account (including buy list securities and possibly all members of each sub-account benchmark). Even cash should be created separately for each sub-account (e.g. \*\$\$\$\_1, \*\$\$\$\_2). There can be more than one tax lot of a particular synthetic associated with a sub-account. These can be identified using the serial number function in the Northfield .SHL file format.

**2.** Create the synthetics by using composite assets, rather than adding data records to the database. This is important for two reasons. First, we don't have the issue of incorrectly computing asset specific risk for portfolios since the asset specific risks of IBM\_1 and IBM\_2 would have correlation equal to one, rather than zero as is normally assumed with "separate" stocks. Second, using composite assets, it is easy to handle having different levels of risk tolerance in different accounts. If account #1 is twice as risk tolerant (in variance terms) as account #2, we can just treat a 100 share IBM position in account #1 as a composite asset with an underlying portfolio of 100 shares of IBM. For account #2 that is only half as risk tolerant, we can create the mathematical equivalent by keeping the same risk tolerance coefficient (RAP in Northfield terminology) but representing the underlying portfolio of the composite asset as  $(100 * 2^{0.5})$  shares of IBM, with an offsetting negative position in cash. This composite will have the same dollar value as the 100 shares of IBM in sub-account #1, but will appear riskier so as to reflect the lower risk tolerance of sub-account #2.

**3.** Since every security related to each account is now separate, we can construct min weight and max weight files for a "global" optimization based on the min weight and max weight limits within each sub-account. For example, if the weight limit for "IBM\_1" in sub-account one is 5%, and sub-account one is 25% of the total market value, the "global" max weight for "IBM\_1" is 1.25%. Construct penalty files for each stock that provide for min weight or max weight limits by firm. For example, if we want each stock in the "global" (aggregated) portfolio to be less than 4% of the total, we can build a penalty file that says the weight of

all versions of MSFT must be less than 4%. Do this by simply creating a penalty file where "MSFT\_1", "MSFT\_2"... "MSFT\_n" have a coefficient values of 100 and must sum to less than 4 (constraint max value).

**4.** Now construct a penalty file saying that the weights associated with each sub-account are constrained to remain equal to the appropriate starting fraction of the total market value. For example, if sub-account #2 is 30% of the total market value, then all stocks with the "\_2" suffix must have a penalty coefficient of 100 and must sum to 3. In this way, when we sell a "\_2" security, the corresponding buy must also be a "\_2" security, guaranteeing that the market values of the sub-accounts will stay constant.

**5.** Next lets deal with linear constraints on the sub-accounts. Lets assume that sub-account #3 is a trust with a 4% income yield requirement, and that sub-account #3 is 35% of the total market value. We can construct a penalty file containing only the "\_3" versions of each stock, with their respective income yield as the related value. We can constrain the min value of this penalty to be 1.4% (35% of 4%) for the global portfolio, since all stocks outside the "\_3" group default to a value of zero. We can have as many linear constraints on sub-accounts as needed to handle things like industry min or max weights.

**6.** Because different versions of the same stock, "IBM\_2", "IBM\_3" are now perceived as separate securities, we need to extend the "wash sale" functions of the Optimizer using "no buy" and "no sell" instructions. Find all stocks where any lot has been purchased in the last 30 days and put a "-999" in the global min weight file (a no sell instruction) on all versions of that underlying stock that are held by the same taxpayer entity. Find all stocks where any lot has been sold at a loss in the last 30 days and put a "-999" in the global max weight file (a no buy instruction) for all versions of that underlying stock that are held by the same taxpayer entity.

**7.** Compute the implied alphas for each stock for each sub-account as per the 1999/1992 paper. Since each version of a stock is handled separately, we can have separate alphas for each version. This allows the system to pick up the different opinions of each manager about their own view of a particular stock. Alternatively, we can take a weighted average of the implied alphas (weighted by the fraction of total market value that sub-account represents) and use the same "consensus" alpha for all versions of the same stock.

**8.** If a particular tax lot of a stock is in a non-taxable account (IRA or 401K) set the cost basis of that lot equal to the current price. This will eliminate any tax considera-

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tions for selling that lot.

9. There is only one problem remaining, the potential for illegal substitution trades (selling "IBM\_2" from one sub-account and buying "IBM\_3" into another). This is the most complicated part of the process. We're going to handle the problem by putting more "no buy" and "no sell" instructions into the global min and max weight files.

a) Construct the appropriate benchmark as previously discussed, and set up the global optimization. If the global optimization is not just a minimum variance case, the alpha file we have constructed should be used. If the problem is just minimizing risk, skip the alpha file.

b) Once the problem is assembled, JOIN and do a RUN0. Output the "marginal contribution" report and examine the MUBuy and MUSell columns. Sort the values into descending order and find the median (halfway down). Subtract the median value for the MUBuy column from each MUBuy value. Subtract the median value for MUSell column from each MUSell value. You should now have two columns where the middle value is zero, the upper values are positive and the lower values are negative. Lets call these values "Relative MUBuy" (RMUB) and "Relative MUSell" (RMUS)

c) Now for each different underlying stock (say IBM) find the version of that stock (IBM\_1, IBM\_2) that has the highest RMUB. Now go through the RMUS list and find the version of IBM that has the highest RMUS.

d) The RMUB and RMUS values determine whether the Optimizer will want to be selling or buying a particular stock such as IBM, and which version (IBM\_1, IBM\_2) is likely to be the one traded. Once we've figured this out, we can use "-999" instructions (no buy or no sell) to prevent illegal substitution trades that would violate wash sale rules as follows:

i) if the highest RMUB is positive, and the highest RMUS is negative, we will want to be buying so add a "no sell" (-999) instruction to the global min weight file for all versions of this stock

ii) if the highest RMUB is negative and the highest RMUS is positive, we will want to be selling so add a "no buy" (-999) instruction to the global max weight file for all versions of this stock

iii) if both the highest RMUB and the highest RMUS are negative, we probably don't need to do anything. Imagine a case of a stock with a low alpha (negative RMUB) and an unrealized gain for tax purposes

(negative RMUS). The Optimizer certainly won't want to buy it, but might want to sell it if there are already others losses to offset the gain. Put a "no buy" (-999) order in global max file just in case for all version of this stock.

iv) if both the highest RMUB and the highest RMUS are positive, things get tricky. Imagine a stock with a high alpha (high RMUB) and an unrealized loss for tax purposes (high RMUS). We can help the portfolio by going in either direction with this stock. The Optimizer will naturally move in the direction that has the greater magnitude, but this can be a trap. Imagine that our existing position in the stock (say CSCO\_4) that has the big tax loss is only .001% of the portfolio, while our maximum weight on CSCO is 3% of the portfolio. Even if RMUS is larger than RMUB, we can't get much real improvement to the portfolio by getting the tax benefit of selling this very tiny position. We're better off buying CSCO. To avoid this trap, we should compare (Highest RMUB for any version of CSCO \* the "room to buy" that version of CSCO) to (RMUS for CSCO\_4 \* the amount of CSCO\_4 that can be sold). By considering both the marginal utility values and the amount of room we have to move in a particular direction we can decide if we are better off selling or buying CSCO. Since the second derivatives of the utility function are not zero, this is not an exact solution but is very close. Obviously, if we want to buy, we issue a "no sell" instruction for all versions of CSCO, and if want to sell, we issue a "no buy" order for all versions of CSCO.

You can now run the "global" optimization that has all the properties that we would find desirable. By Using lot serial numbers, it will be easy to track buy and sell orders for processing. The market values of sub-accounts will be maintained, and position weight limits at both the global and sub-account level can be structured. Linear constraints on either the global level or sub-account portfolio properties can be accommodated. Manager implied alphas can be applied to individual sub-accounts or "consensus" alphas can be applied to the global problem. Finally, wash sale rules will be observed including no illegal substitution trades with the sub-accounts held by the same taxpayer.

## Technical Support Tip: Industry and Sector Mapping

By Christine Milne

Northfield provides default industry files for all of its risk models. In the Everything Everywhere, Global and Single Country risk models Northfield uses six broad industrial super-sectors as risk factors. Complete linkage cluster analysis was used to create the groups. In the US Fundamental model a combination of SIC and FactSet industry codes are used.

Any analysis can use Northfield's standard industry and sector classifications for reporting and for imposing constraints. Users may also wish to apply their own industry classification, to override the Northfield standard (found in column three of the monthly risk model data file). Applying user-defined classifications does not change the risk model's industry or sector factors.

### In the Northfield GUI

The Industry Mapping file, under User Input Tables, is a two-column text file listing all security IDs in the project and their new industry code.

The Industries file has six columns:

1. **ID:** first row should be 'N/A' or 'Miscellaneous'. Any securities which are not mapped to an industry correctly will be put into the first row of the industry file.
2. **Name:** description of the industry
3. **Penalty:** A quadratic penalty can be applied to any or all industries and sectors, as in the function below. All industry and sector penalties are benchmark relative.

### Industry and Sector Penalties =

$$\sum_{i=1}^j (W_{\text{portfolio}, i} - W_{\text{benchmark}, i})^2 \times \text{Penalty}_i$$

w = weight of security in portfolio or benchmark if member of industry i

j = number of industries or sectors in the portfolio

**4+5. Min Value/Max Value:** Hard constraints may be applied to industries. Use the scroll boxes to make the constraints absolute, relative to initial or relative to benchmark.

- If using a relative constraint the Minimum Value is assumed to be under the benchmark value, so in most cases a negative sign is not needed.

**6. Sector ID:** Multiple industries may be aggregated into sector groups.

The Sectors file is very similar to the Industries file; constraints and penalties can also be applied at this level.

### Output Report

The Penalties Summary and the Constraint Summary give details of the industry and sector allocation, which constraints have been met, and which penalties have taken effect.

- You can sort any column in the optimiser low to high by clicking on the column heading, or from high to low by clicking while holding Ctrl on the keyboard.

Penalties Summary						
	Industry	BenchWt (%)	InitWt(%)	InitActvWt (%)	OptWt(%)	OptActvWt(%)
1	N/A	0.015	0.000	-0.015	0.000	-0.015
2	INDUSTRIAL	6.944	7.926	0.982	10.071	3.127
3	CONSUMER	23.789	20.405	-3.384	9.791	-13.998
4	TECHNOLOGY	17.505	4.222	-13.283	18.205	0.700
5	INTEREST R	33.948	40.428	6.480	43.759	9.811
6	NON-ENERGY	4.804	6.429	1.626	5.651	0.847
7	ENERGY MIN	12.995	20.590	7.594	12.523	-0.472

### In FactSet

In NPO on FactSet Industries and Sectors – Northfield default or other standard classifications – can be set up in the 'Model Specifications' under the Industry/Sector tab. Custom industries and sectors can also be created, and constraints and penalties applied. Output appears in the 'Industry Constraints', 'Sector Constraints' and 'Industry Summary' reports.

### In NERO

In the Northfield Excel Run0 add-in, user-defined industries can be set up as another column next to portfolio or benchmark holdings, as in the example below:

Symbol	Name	Industry	Weight	Price
0483548	SABMiller	41	0.76	8.120
0916572	Alliance UniChem	48	0.19	8.200
3398649	ITV	54	0.40	1.173
0677608	Pearson	54	0.44	6.475
0237400	Diageo	41	2.01	7.880
0709954	Prudential	84	0.96	4.805
0738992	Old Mutual	84	0.42	1.300
0646233	United Utilities	77	0.31	6.510

The Industry and Sector tables can be specified as separate text files or as spreadsheet areas.

For further inquiries, contact Technical Support in Boston: [support@northinfo.com](mailto:support@northinfo.com) or call 617.208.2080 between the hours of 8am and 6:30pm EST Monday through Friday.

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to insure that the portfolio returns are normally distributed, and therefore appropriately described by parametric statistics.

Second, trading desks and hedge funds often operate with high degrees of leverage. In the presence of gearing, higher moments of portfolio return distributions such as skew and kurtosis can be important, while they are typically of little relevance in traditional asset management situations. This point is well explored in Wilcox (2000) and Cremers, Kritzman and Paige (2004).

Finally, the statistical properties of security returns over very short time horizons can be very different, as described in diBartolomeo (2003). Over such short horizons, many of the underlying assumptions of portfolio theory do not hold very well. As such, our usual ways of looking at portfolio risk such as absolute return volatility and tracking error may be difficult to meaningfully estimate.

Another concept about which we must be clear when we consider stress testing is that when we estimate the tracking error of a portfolio relative to a given benchmark, what we are actually forecasting is the standard deviation of the active return. For a passively managed index fund (from which the terminology tracking error arises), expected return of a fund relative to the index is zero. As such, the standard deviation of active return is always measured around an expected mean of zero. However, in active management our expectation of the mean active return is definitively not zero, and the expected tracking error estimate then becomes the standard deviation around the sample mean. Realizations with large negative sample means are often mistaken for a failure in the risk model. Consider the case of an active manager who underperforms his benchmark by the exact same one hundred basis points each month for a year. The cumulative underperformance is massive, more than 1000 basis points, but the realized tracking error is zero. An excellent presentation on this point can be found in Huber (2001).

### **Possible Solutions**

For Northfield users, there are a number of ways to get a better understanding of the “worst case scenarios” and their likelihood. The simplest is to use the NFA resampling function that is built into our Open Optimizer. This system converts the user’s alpha inputs and the Northfield risk model used into a mathematically equivalent multivariate normal distribution. Part of the output is a description of the expected distribution of the risk statistics such as tracking error. For example, rather than just saying that the tracking error of a given portfolio is 3%, we could see that the central tendency of expected tracking error was 3%,

with a 95% probability that the tracking error will be more than 2.8% and a 95% probability that tracking error will be less than 3.4%. We can now compute the likelihood of a given return event from the normal cumulative density function using the upper bound estimate of tracking error rather than the estimate of the central tendency.

Another approach to testing for a worst case outcome would be to hypothesize a series of scenarios that represent the user’s view of potential market conditions. For example, let’s assume that in the Northfield Global model we estimate that the future volatility of oil prices will be 1225% variance (35% standard deviation). One could easily edit the system’s “.mdl” file with a series of different variance assumptions (500, 800, 1000, 1400, 1800 units of variance, etc.). Similarly, one could observe that in the Northfield US Fundamental Model, the correlation between the E/P factor effect and the log of market cap factor effect is .2. We could easily try different assumptions such as .1 or .3 by editing the “.cor” system file. Once we had hypothesized a different scenario for the state of the risk model, we could repeat our risk analysis. Eventually we would collect a distribution of risk analyses for our particular portfolio.

There are two very important caveats to consider when using a range of scenarios for the various parameters of the risk models. The first is that while it is possible to think up all sorts of strange scenarios, we must also consider the explicit probability of each scenario, or the resulting distribution will be meaningless. For example, the likelihood of a scenario that had oil prices increasing in volatility, while at the same time having decreasing volatility in inflation and interest rates is very small.

The other pitfall of scenario testing is that our modified factor covariance matrix must still have the mathematical property of being positive semi-definite. This means that the factor variances and correlations fit together in a mathematically sensible fashion. If we have a ten factor model and change the correlation between the first and second factor, we are actually describing a change in the relative behaviors of factors one and two. This change in behavior must show up as a change in the correlation between factor one and factors three through ten, or as a change in the correlation of factor two with factors three through ten or both. As those change, they imply further changes in the correlations among all the other factors.

A failure in the positive semi-definite nature of the factor covariance matrix can lead to completely irrational results such as negative risk estimates. Generally, increasing factor variances will not create problems with covariance ma-

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trix properties. Decreasing factor variances or changing correlations amongst factors can easily lead to problems. A simple way to test for the acceptability of a scenario is to invert the factor covariance matrix using the matrix algebra functions in Excel or a statistics package. If the matrix is not invertible, it should not be used. Further, it should be noted that the being invertible does not guarantee that the modified matrix makes economic or statistical sense. This should be explored using the condition statistic of the matrix as a stability measure.

Similar caveats apply to changing assumptions of asset specific risks. If we increase the asset specific risks of particular stocks, we are not likely to cause any problems. However, if we decrease the asset specific risk, it is possible we can create a situation where the factor model looks satisfactory, but the “mathematically equivalent full covariance matrix” is faulty. For a description of factor model equivalent full covariance matrices see diBartolomeo (1998).

Another approach to stress testing is known as “bootstrap resampling.” Essentially what we do here is to take our historical sample of observations for factor returns, and create alternative simulated histories that represent different realizations of the sample distribution. Let us assume we want to consider the possible range of risk outcomes over a 24 month forward horizon.

- 1) Take an N observation history of the factor returns to the risk model. You can think of this as having N numbered balls in a jar.
- 2) Randomly draw a ball from the jar (select a random number between 1 and N). Record this number and put the ball back in the jar. Do this 24 times and keep the list of numbers.
- 3) For each of the numbers drawn, take the factor returns for the corresponding period. So if your first draw was 37, take the 37th observation of factor returns from the sample. You will now have a set of 24 months of factor returns across the factors of the risk model.

The above procedure should be repeated a large number of times (e.g. a 100 or more). You will now have 100 different synthetic samples drawn from the original distribution of factor returns. Since we have put the ball back in the jar each time, we may get the same ball more than once, some balls will not be drawn, and the order will be random compared to the observed history. These random variations create a range of differences between the synthetic samples.

The first thing we can do with these synthetic histories is to

compute the factor variances and factor correlations that are represented by each sample. We could then evaluate the risk of our current portfolio with these alternative versions of the factor covariance matrix. We there can therefore obtain the distribution of the portfolio factor variance, or active factor variance against a benchmark.

Another thing we can do with the bootstrap process would be to simulate the returns of the portfolio. We can then create simulated return histories for our portfolio under the synthetic histories.

- 1) For each of the 24 months, take the vector product of the portfolio factor exposures (or the active exposures if we want a benchmark relative history) and the factor returns as represented in the synthetic history. This will give us a time series of “returns due to factor exposure” for the portfolio.
- 2) For each of the 24 months, take the original asset specific risk of the portfolio in monthly standard deviation units and multiply it by a random value selected from the unit normal distribution (mean zero, standard deviation one). This will give us a time series of “returns due to asset specific events” for the portfolio.
- 3) Sum the two time series together

Once we have the simulated history of the portfolio return (or active return) we can do all sorts of statistics on it. We can calculate the simulated mean return, tracking error, absolute volatility, information ratio, Value-at-Risk, Jensen alpha, worst quarter, maximum cumulative loss, or any other risk measure we might care to consider. If we repeat the process for each of our 100 synthetic histories, we will have a very rich set of simulated data on which to judge the potential for “worst case” events.

It should be noted that the bootstrap process described is still only stress testing the risk model. As noted above, the time series variation in the information coefficient of an active manager’s predictions can cause the sample mean of the return to often become negative. We are not testing the joint worst possible outcome that arises from both the risk driven outcomes (i.e. bad luck) and the time series variation in the effectiveness active management strategies.

If we wanted to simulate the worst case scenario for the joint forecast return and risk process, we could simply incorporate an expected alpha return into our time series simulations. This would require a time series history of the active management information coefficients (for the same time sample as the risk model factor returns) which could

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be converted to an estimated active return. If the manager's active strategy were stock specific in nature, such conversion would require usage of the "Fundamental Law of Active Management" as formulated in Grinold (1989) and the estimation of the Transfer Coefficient as described in Clarke, deSilva and Thorley (2002). If the manager's active strategies were of a "factor timing" nature, or if we believed there were significant serial correlations in the factor returns, we would need to use a more sophisticated bootstrap process that can preserve the correlation structure present in the data.

## Conclusion

It is important to understand that our risk forecasts are estimates of an uncertain future. The level of risk for a portfolio should always be thought of as a distribution rather than a single exact value. To the extent we are interested in the "worst case" tail of that distribution, the methods described should enable our clients to gain a further understanding. However, it should always be kept in mind that the risks in active management include both the random fluctuations of the market conditions measured by the risk model, and the time series variation in the effectiveness of the active strategy. Measuring the likelihood of joint worst case events requires more complex techniques than presented here.

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## Northfield Staff Speaking Engagements

On May 24th, Northfield President Dan diBartolomeo gave a presentation at the Green Mountain Summit on Socially Responsible Investing in Stowe, VT. The topic was on how the investment restrictions imposed by two religious faiths (Catholicism and Islam) impact risk and return.

On May 26th, Northfield's Nick Wade spoke at the Factset Portfolio Analysis conference in Hong Kong. The topic was on Portfolio Theory, Speculation and the Chinese Stock Market.

Northfield's Emilian Belev will be presenting at the FactSet 5th Annual Investment Process Conference in Amsterdam, on June 9th. The topic will be on how Northfield's EE model has been extended to incorporate difficult to model assets such as convertible bonds and real estate.

On June 16th, Dan will be on a panel discussing the pros and cons of different kinds of equity risk models at the FactSet 5th Annual Investment Process Conference in London. Visit [http://www.factset.com/www\\_420.aspx](http://www.factset.com/www_420.aspx) for more information

Dan will be presenting "Empirical Tests of CUSUM procedures for Asset Manager Evaluation and Monitoring," at the R-Squared UBS Conference at Oxford University, England, on September 12th.

## Steve Gaudette Rejoins Northfield

Steve Gaudette, who worked for Northfield in the early 1990s, is back working in our Boston office. Steve will initially be helping improve reporting capabilities and marketing for Northfield's Open Performance Attribution product. After that he will be joining the American region sales team working with all products.

Most recently, Steve managed a team responsible for performance measurement and attribution at State Street Global Advisers. Steve can be reached at [steve@northinfo.com](mailto:steve@northinfo.com).

## Northfield Partner Update

### SoftPak

Northfield recently signed a new agreement with SoftPak Financial, a financial services software company, to become the exclusive distributor of MARS (Managed Accounts Rebalancing System) focusing on the mid to large SMA/high net worth market segment. MARS is a portfolio manufacturing platform that streamlines the investment process utilizing Northfield analytical tools allowing SMA/high net worth managers to achieve higher productivity and profitability without increases in human capital. The new agreement leverages the Northfield brand name within the asset management community and paves the way for continued expansion of the use of Northfield products within this rapidly growing market segment. MARS is targeted toward managers that have both sufficient internal IT resources and experience with quantitative analytical tools to support a portfolio manufacturing platform in house. MARS has gained traction in the market with ten clients in various stages of use. Please contact your Northfield sales representative for details or [MARSales@northinfo.com](mailto:MARSales@northinfo.com).

### InvestEdge

Northfield has signed an agreement with InvestEdge, a financial services software company providing ASP reporting solutions, to imbed Northfield products within their InvestEdge ASP software solution for SMA/high net worth managers. InvestEdge ASP is targeted to smaller managers and regional banks that may not have internal resources to support an in house solution and would prefer an outsourced portfolio manufacturing platform. We believe that this will provide greater access to Northfield tools for clients that are not normally served by our standalone desktop analytical tools. Please contact InvestEdge at [info@investedge.com](mailto:info@investedge.com) for more information.

We consider the MARS and InvestEdge ASP as complementary portfolio manufacturing offerings serving different segments of the SMA/high net worth market yet both providing the benefits of using Northfield products.

### Impact Investing

Northfield and Impact Investing, a financial services software company based in Australia, have signed a letter of cooperation. Impact Investing develops software applications targeted to portfolio managers that seamlessly integrates key portfolio information in both raw and derived form including exposure, risk, optimization, style and performance analysis from databases located on the customer's site in order to improve investment decision making and streamline client reporting. Please contact Impact Investing at [www.impactinvesting.com](http://www.impactinvesting.com) for more information.

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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)**

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