GLOBAL
Equity Risk Model

IDENTIFY
ANALYZE
QUANTIFY

NORTHFIELD
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Global Equity Risk Model

### Introduction

The Northfield Global Equity Risk Model and the closely related Northfield Single Market Risk Models are tools to forecast 1 year volatility and understand and manage sources of risk in diversified global (or single market) portfolios. Additionally, the models can be paired with a portfolio optimizer, such as the Northfield Open Optimizer, to build risk/return optimized portfolios.

The model is structured to achieve accuracy and clarity in analyzing diversified portfolios. Within the structure, accuracy at the individual security level is a priority, one reason being that portfolio optimization weights securities based on their forecasts.

Global coverage demands balancing granularity and ubiquity. Factors that capture the specialized behavior of one industry or market fail on another. One might consider joining many specialized models. However, accuracy in the linkages is poor, and, accuracy aside, interpreting exposures to a large set of redundant factors is confusing. Separately, an overly rich set of factors has high in-sample explanatory power but, with false precision and sense of security, fumbles on the dynamic future.

The Northfield Global Equity Risk Model is built to capture risks affecting diversified global portfolios. *Portfolios invested in a single market are best served by a model covering solely that market*.  

### Coverage & Data

Coverage includes country and bond indices, currencies, and over 60,000 companies in 80 countries. Returns, capitalizations, and other data are obtained from Thomson Reuters. Avoiding detailed financial statement numbers, the model is unaffected by reporting lag and the vagaries of accounting standards. Data required to model a security – sector membership and returns – are readily available even for emerging markets. The model is updated monthly.

### Additions

Securities are covered within one month. Bayesian estimation (described below) eliminates the need for history. Securities without return history are assumed to have the median exposure and 75th percentile stock-specific risk of similar securities. As information becomes available, the estimate balances the prior and the information based on the quantity and quality of information, just as it does for securities having a complete return history.

### Model Overview

Each security’s local currency return is explained by 13 factors:

- Market
- Its Sector and Region
- Bonds and Oil
- Market Development, Size, and Value/Growth
- 5 Statistical Factors

Adding currency appreciation against base currency converts the local return to base currency return. The model is available in the following base currencies: AUD, CAD, CHF, CNY, EUR, GBP, HKD, INR, JPY, KRW, SEK, SGD, TWD, USD.

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1 e.g. one of the [Northfield Single Market Models](https://www.northinfo.com) or the [Northfield US Fundamental Model](https://www.northinfo.com)
Global Equity Risk Model

The global model has 107 factors: market, 7 sectors, 8 regions, 5 economic variables, 5 statistical factors, and 81 currencies. Fourteen apply to any particular security (the local return’s 13 + local currency).

The reason for a factor’s inclusion is for the most part apparent. Perhaps less obvious are market development and the statistical factors. Market development, a spread between developed and emerging markets, measures a stock’s response to the level of investor confidence in the market, e.g. what happens when there is a flight to quality. Statistical factors are not pre-specified and come directly from the returns unexplained by the other factors. They pick up pervasive risks that are transient, hence falling outside of any fixed factor set, and automatically adapt the model to dynamic market phenomena. Since statistical factors are dynamic, they are not easily labeled. A statistical factor in one market or period doesn’t necessarily correspond to the same in another.

The Factors

<table>
<thead>
<tr>
<th>Market</th>
<th>The average return(^2) of all securities under coverage(^3).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sector</td>
<td>The average return of all securities in a sector. A security is mapped by industry code to one of seven sectors: Industrial, Consumer, Technology, Health, Interest Rate Sensitive, Non-Energy Minerals, and Energy Minerals.</td>
</tr>
<tr>
<td>Region</td>
<td>The average return of all securities in a region. A security is mapped by country to one of eight regions: USA/Canada, Latin America/Caribbean, Developed Europe, Emerging Europe, Middle East/Africa, Japan, Developed Asia/Asia Pacific, and Emerging Asia/Asia Pacific.</td>
</tr>
<tr>
<td>Bonds</td>
<td>The USD bond market return.</td>
</tr>
<tr>
<td>Oil</td>
<td>The % increase in the USD price of oil.</td>
</tr>
<tr>
<td>Market Development</td>
<td>The difference between the average return of developed and emerging markets.</td>
</tr>
<tr>
<td>Size</td>
<td>The difference between the average return of each region’s top and bottom decile companies in market cap, averaged across regions weighting regions by the summed square root of cap of the region’s top decile.</td>
</tr>
<tr>
<td>Value/Growth</td>
<td>A composite measure of value over growth, constructed by subtracting the second of the following from the first:</td>
</tr>
<tr>
<td>Dividend yield spread</td>
<td>The difference between the average return of the top decile in dividend yield and the average return of those paying no dividend. Its time series is shifted and scaled to have mean 0 and monthly standard deviation 1.</td>
</tr>
</tbody>
</table>

\(^2\) Unless otherwise indicated, in the factor definitions, returns are measured in local currency, and averaging is by square root of cap

\(^3\) Excluding securities under $100M market cap, cross-listings, and those with incomplete history
<table>
<thead>
<tr>
<th>Statistical Factors</th>
<th>Idiosyncratic variety</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The cross-sectional spread of alpha (return unexplained by the market effect). Growth stocks tend to outperform when variety is high, value stocks when variety is low. Its time series is shifted and scaled to have mean 0 and monthly standard deviation 1.</td>
</tr>
</tbody>
</table>

| Model Estimation | Security exposures to the factors are estimated via Bayesian regression. Observation weights exponentially decay with age. The decay rate varies by country, with emerging markets decaying faster than developed. Faster decay rates emphasize recent behavior. |

| Bayesian Inference | Bayesian inference combines observations with prior beliefs – e.g. alike securities tend to behave similarly. It raises the accuracy of individual forecasts and, by softening extremes, improves the out-of-sample performance of optimized portfolios. |

| Stepwise Regression | Because factors are collinear even after being stripped of the market effect, regressions are run stepwise to maximize connection to the more tangible factors. Each regression step is run on the unexplained return remaining after the preceding step. Thus, earlier steps explain more variance than later steps. The order: |
|                    | Market, Sector, and Region |
|                    | Bonds and Oil |
|                    | Market Development, Size, and Value/Growth |
|                    | Statistical Factors |

| Factor Covariance | Forecast variance of a factor is estimated as the variance of the past 60 months of factor returns, with observations exponentially decay weighted. The decay rate is the slowest of the decay rates used to infer exposures, i.e. the decay rate of the most developed markets. |

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4 Prior and regression errors are Gaussian. Bayesian median regression (double exponential prior and regression errors) was tried but performed worse in out of sample tests.

5 A security’s prior comes from the finest sufficiently numerous group of similar securities. From fine to coarse: 1) sector/country, 2) sector/region, 3) ½ sector and ½ region
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**Robust Correlation**
To stabilize against outliers, correlation between factors is estimated as the Spearman rank correlation between the factor returns, with observations exponentially decay weighted.

**Parkinson Volatility**
Parkinson\(^6\) estimates volatility from intra-period high and low prices. For securities with the data available, it provides a second estimate. (The first is the standard deviation of the time series of security returns.) Believing it wise to consider flags suggested by intra-period behavior, Northfield conservatively combines the two sources: if the Parkinson is higher, a security’s specific risk is increased to make up the difference.

**Historic Data**
As each expansion or improvement of the model has taken place, history dating back monthly to 1990 - has been rebuilt to embody the change. Historic data for securities from the euro bloc reflect their original currencies until December 1998. Rebuilding the historic files has improved coverage, the aim being to ensure that at least every security in each of the MSCI indices is included.

**Summary**
The Northfield Global Equity Risk Model is a tool to help investment professionals understand and manage the risks in diversified global portfolios. The factors combine comprehensible insight and predictive power. As a final step to capture transient effects which cannot be found by any static model, statistical factors are included. Northfield also offers the closely related Single Market Risk Models to analyze portfolios concentrated in a single market. Northfield is committed to making certain that clients are fully satisfied with our products.

**Appendix A: Identifiers & Special Symbols**
Non-US securities are identified by a seven digit SEDOL. Separate versions of the model are available identifying US securities by SEDOL, CUSIP, or ticker.

**Currencies**
Currencies are identified by a three letter ISO symbol prefixed by an asterisk. e.g. *CAD for the Canadian dollar

**Country Indices**
A cap-weighted portfolio of securities in each country is identified by the country’s two letter ISO symbol prefixed by an asterisk, e.g. *CA for Canada

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## Appendix B: Countries Covered

### USA/Canada
- Canada
- United States

### Latin America/Caribbean
- Argentina
- Brazil
- Chile
- Colombia
- Mexico
- Peru
- Trinidad and Tobago
- Venezuela

### Developed Europe
- Austria
- Belgium
- Denmark
- Finland
- France
- Germany
- Greece
- Iceland
- Ireland
- Italy
- Luxembourg
- Netherlands
- Norway
- Portugal
- Spain
- Sweden
- Switzerland
- United Kingdom

### Middle East/Africa
- Bahrain
- Egypt
- Iran
- Israel
- Jordan
- Kenya
- Kuwait
- Lebanon
- Mauritius
- Morocco
- Nigeria
- Oman
- Qatar
- Saudi Arabia
- South Africa
- Tunisia
- United Arab Emirates

### Japan
- Japan

### Developed Asia/Asia Pacific
- Australia
- Hong Kong
- New Zealand
- Singapore

### Emerging Europe
- Bulgaria
- Croatia
- Cyprus
- Czech Republic
- Estonia
- Hungary
- Latvia
- Lithuania
- Malta
- Poland
- Romania
- Russia
- Serbia

### Emerging Asia/Asia Pacific
- Bangladesh
- China
- India
- Indonesia
- Kazakhstan
- Malaysia
- Pakistan
- Philippines
- South Korea
- Sri Lanka
- Taiwan
- Thailand
- Vietnam
- Taiwan