

# Product Workshop

## Northfield Global Equity Risk Models: Alternative Views

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# Product Workshop

- Workshop objective is to demonstration of how the different Northfield global equity models can be used to analyze the same portfolio
  - An apology – there are some interesting results that fall outside the objective and time constraint
  - An offer – free analysis of one developed market equity only portfolio
- Overview:
  - Provide theoretical review of the Northfield global equity models
    - For more in-depth information contact Northfield or me
  - Differentiations in the construction of each equity model
  - Example portfolio and analysis
    - Each model provides a different perspective, but together the models will provide a much better understanding of the example portfolio

# Product Overview – Equity Risk Models

- Two suites of Equity Risk Models
  - Northfield Hybrid (Hybrid or NIS)
    - Single country and regional model
      - Asia Pacific, Australia, Brazil, Canada, China, Europe, Japan, South Africa, Switzerland, United Kingdom, and United States
    - **Global model**
  - Northfield Double Hybrid or Cross Reference Day (Double Hybrid or XRD)
    - Single Country and regional models
      - US, Europe, Japan, Asia ex-Japan, Latin America, and Natural Resources (Canada, Australia, New Zealand, and South Africa)
    - **Global model**
- Each suite has Short Horizon version
  - Adaptive Near Horizon - *“Risk Systems that Read”*
  - XRD5

What makes Northfield models better?

# MODEL CONSTRUCTION

# Background of Risk Model Structures

- Commercially available models fit one of these three theoretical frameworks:
  - Define terms:  $x$  = factor exposures,  $f$  = factor returns,  $\varepsilon$  = residual
- Time-Series (beta)
  - Factor returns defined / exposures estimated :  $\sum \hat{x}_i f + \varepsilon$
- Cross-Sectional
  - Exposures defined / factor returns estimated:  $\sum x_i \hat{f} + \varepsilon$
- Statistical
  - Both exposures and factor returns estimated:  $\sum \hat{x}_i \hat{f} + \varepsilon$
- Hybrid
  - Incorporates more than one of these model structures
  - Method chosen best represents the particular factor block

# Northfield Global Equity Models

- Hybrid model structure is used for the two different suites of global equity models
- Each constructed different and each providing a different view:
  - For a consolidated global investment approach (decisions at a global basis) the Northfield Hybrid Global model uses:
    - Time-series for identifiable factors
    - Statistical on the residuals to measure additional systematic risk
  - For a dispersed investment approach (decisions at country basis) the Northfield Double Hybrid Global model uses:
    - Cross-sectional style factors within individual markets
    - Time-series for the most important risk factors (country and industry)
    - Statistical on the residuals

# Why Northfield Hybrid Models Are Better?

1. Global accounting data cannot be standardized
2. Statistical properties in estimation error
3. Factor Exposures
4. Residual Risk does not equal Specific Risk

1.) Accounting standards vary across countries making it difficult to construct global cross-sectional models

- Difference in the accounting standard globally
  - Treatment for pension liabilities has a profound impact on earnings
- Financial statements in many emerging/frontier markets lack credibility

## 2.) Statistical Properties

- All risk models are built using some form of statistical estimation technique which suffers from estimation error
  - In a time-series model,  $\sum \hat{x}_i f$ , estimation error exist in the exposures,  $x$ . Estimation error of is diversifiable:
    - As the number of assets in a portfolio increases  $n \rightarrow \infty$ , estimation error of the portfolio exposures decreases,  $x \rightarrow 0$
  - Cross-sectional model,  $\sum x_i \hat{f}$ , estimation error exist in the factor returns,  $f$ , irrespective of diversification the portfolio will have the same degree of estimation error:
    - As the number of assets in a portfolio increases  $n \rightarrow \infty$ , estimation error of the factor returns  $f$  is unchanged
  - Statistical models can suffer from estimation error in both exposures and returns



## 3.) Exposures

- Exposures in a time series model are regression coefficients measuring the sensitivity to the factor
- Vendors constructing cross sectional models use binary weights to sector and country factors as exposures

BUT : **Weights  $\neq$  Exposures**

- What is the beta of a bank relative to bank index?
  - Time series model calculates the bank's beta exposure to the index
  - Cross-sectional model assumes the bank has a beta of 1
- If the global financial crisis proved anything, it was that all assets in the same industry are not the same!
- That was particularly evident in the banking industry

## 4.) Residual Risk vs Specific Risk

- Residual risk versus specific risk
  - Many risk vendors make the heroic assumption that their risk model perfectly explain all systematic risk, therefore labeling all residual risk as specific risk
  - Systematic risk may exist in the residual that has either not been identified or is too temporary to include as a permanent factor
    - I.e., a pandemic
  - Northfield hybrid models apply a statistical analysis on the residuals to determine if any unidentified systematic risk exist
  - The statistical analysis allows the Northfield models to instantaneously adapt to unidentified or unexpected market conditions
  - Removing this additional systematic risk the remaining residual risk is uncorrelated becoming a more accurate measurement of asset specific

# MODEL CONSTRUCTION MULTI-STEP REGRESSION

# Why Multi-Step Regression?

- Multicollinearity exist in a multiple regression if factors are correlated
  - Factor based on the log market capitalization and a capitalization weighted industry factor
- Multi-step regression removes the impact of the one factor first
- The order in which the factor are regressed will matter?
  - Hybrid model the factor order is based on importance of risk in the market
    - Market factor
    - Sectors
    - Regions
    - Style
      - Economic
      - Fundamental
  - Double hybrid order is based on which factors we want to have more explanatory power
    - Currency (\*currencies are first to make all assets comparable)
    - Styles factors
    - Industry and country together

# Model Construction – Hybrid (NIS)

1. Regress company returns in local currency on the global market index; process yields betas to market and stock residual returns
2. Regress the residual returns separately on market-adjusted sector and market-adjusted regional factors; process yields exposures to sector & regions and stock residual returns
3. Regress the residual returns in a multiple regression against the economic factors: Citigroup World Government Bond Index, market development, and oil prices; process yields exposures to Bond Index, Market Development, & Oil and stock residual returns
4. Regress the residual returns in a multiple regression against company size and dividend yield factors (apply idiosyncratic variety); process yields exposures to Size, & Growth/Value and stock residual returns
5. Run a principal components analysis on residual returns to capture any residual systematic effect; process yields blind factor returns and exposures
6. Specific risk is the standard deviation of the time series of final residual returns
  - Parkinson adjustment estimates volatility from intra-period high-low prices
  - If Parkinson estimate is higher specific risk is increased to make up the difference

# Global Equity Model Factors - Hybrid

- Factor Blocks
  - Global market factor or regional or country market factor as appropriate
  - Regional factors (8)
  - Super sector factors (7)
  - Macro factors (World Government Bond Index, Market Development and Oil)
  - Style factors (Size and Value/Growth)
  - Blind factors (5)
  - Currency (81)
- Regions
  - USA/Canada
  - Latin America/Caribbean
  - Developed Europe
  - Emerging Europe
  - Middle East/Africa
  - Japan
  - Developed Asia/Asia Pacific
  - Emerging Asia/Asia Pacific

# Model Construction – Double Hybrid (XRD)

1. Convert company returns to model base currency (currency of analysis). Regress company returns in terms on the stock's domicile currency: process yields exposures to domicile currency and stock residual returns
2. Calculate stock exposures to the nine style factor and regress the residual returns in a multiple cross-sectional regression on the set of style factor exposures, one regression per model estimation period: process yields style factor returns for each period and stock residual returns
3. Regress the residual returns in a double regression on each stock's Bayesian priors for industry and country; then run the resulting residual returns in a double step-wise regression on the other industries and countries: process yields exposures to industry & country (secondary betas allowed, albeit with strict statistical checks) and stock residual returns
4. Run a principal components analysis on the residual returns to capture any residual systematic effects: process yields statistical factor returns and betas
5. Specific risk is the standard deviation of the time series of residual returns
6. Cross Reference Day Model: For each model update, four complete models are built using different samples of the estimation window, and then the betas, specific variance, and covariance matrix are averaged to minimise model errors that arise due to sampling
  - i. Four weekly samples creating a **medium** horizon forecast horizon

# Global Equity Model Factors - XRD

- Factor Blocks
  - Currency (31)
  - Regional styles (DY, Value, Growth Trend, Growth Momentum, LT Price Momentum, ST Price Momentum, Liquidity, Leverage, Quality)
  - Regional Country (size effect captured using separate large & small country factors for markets large enough to exhibit a size effect) – (61)
  - Regional Industries (113)
  - Statistical factors (4)
- Regions
  - USA
  - Europe (including Russia and Turkey)
  - Latin America
  - Asia ex-Japan
  - Japan
  - Natural Resources (Canada, Australia, New Zealand, and South Africa)



# Clarifying Two Seeming Contradictions

- How can you have cross sectional style factors if accounting data cannot be compared across countries?
  - Value factor
    - Hybrid global model the value factor is a times series exposure
    - Double hybrid model regional value factor is a cross-sectional factor
      - Cross-sectional style factors are at country or regional level where accounting standards are comparable.
- Why are you using a cross-sectional style exposures if beta is a better exposure?
  - Some factors are not measurable using a regression coefficient
  - Momentum stocks are not momentum stocks for 60 months, in the case regression coefficient cannot keep up with the stocks price momentum

# EXAMPLE PORTFOLIO

# Example Portfolio

- Portfolio: MSCI ACWI ETF versus the British Pound
  - Total risk to explore how each model explains risk of the entire market
  - Active risk introduced another element of complexity
- Two different model will have two different results
- Employ very general categorizations to compare the output
  - Global market, region/sector and country/industry
  - Style
  - Currency
- Variance contribution are used as a common measurement
  - Relative magnitude
  - Variance as percentage of total

# High Level Analysis

- Total risk is 12.4 for the hybrid model vs 17.9 for the double hybrid model
- Global market, region/sector and sector/industry accounts for majority of the risk
- Style and currency has different signs
- Double Hybrid has less risk in statistical factors
- 99% +/- is explained by the factors

	Contribution Portfolio			
	Hybrid		Double Hybrid	
	Variance	Weight (%)	Variance	Weight (%)
Global Market	139.0625	90.41%		
Sector/Industry	-0.0820	-0.05%	194.9176	60.60%
Region/Country	3.0617	1.99%	125.3779	38.98%
Style	3.0207	1.96%	-12.7230	-3.96%
Staticiscal Factors	7.1680	4.66%	1.7419	0.54%
Currency	-0.7763	-0.50%	11.0670	3.44%
Total Factor Variance	151.4544	98.47%	320.3813	99.61%
Stock Specific Variance	2.3503	1.53%	1.2570	0.39%
Total Variance	153.8048	100.00%	321.6383	100.00%
Total Risk	12.4018		17.9343	

# Historical Risk

- Model forecast horizon :
  - Hybrid is long term
  - Double Hybrid is medium term
- According to Morningstar.com as of September 30, 2021
  - Historical risk for 3, 5 and 10 years of the i-share MSCI AWCI are:

Years	Standard Deviation
3	18.2
5	14.65
10	13.48

- Both forecast fall within the range of historical risk associated with their forecast horizon
- Hybrid is closer to the longer-term historical risk, and the Double Hybrid is closer to the medium-term historical risk
- Each model is doing what they are supposed to be doing

# Global Market Factor (Beta)

- In the Hybrid model both sector and region are net of the global market factor impact
  - Beta = 0.99
- Ranked according to % contribution within category
- Largest contributors to regional risk are North America, Japan and Developed Europe
  - Developed Asia is a diversifier
- Largest contributors to sector risk are Consumer, Health and Technology

Factor	Variance Contribution	% Contribution
GLOBAL MARKET	139.0624511	90.41%
USA/CANADA	1.75181938	1.14%
JAPAN	1.146336767	0.75%
DEVELOPED EUROPE	1.078511199	0.70%
EMERGING EUROPE	-0.011713065	-0.01%
MIDDLE EAST/AFRICA	-0.081390725	-0.05%
EMERGING ASIA/ASIA PACIFIC	-0.21621791	-0.14%
LATIN AMERICA/CARIBBEAN	-0.262446874	-0.17%
DEVELOPED ASIA/ASIA PACIFIC	-0.343230184	-0.22%
CONSUMER SECTOR	0.775600954	0.50%
HEALTH SECTOR	0.684884935	0.45%
TECHNOLOGY SECTOR	0.572188779	0.37%
NON-ENERGY MINERALS SECTOR	-0.113360729	-0.07%
ENERGY MINERALS SECTOR	-0.252194421	-0.16%
INDUSTRIAL SECTOR	-0.287621054	-0.19%
INTEREST RATE SENSITIVE SECTOR	-1.461506873	-0.95%
Total Variance	153.8047543	

# Country/Industry

- Double Hybrid model, industry and country are regressed simultaneously and include the impact of any global market factor
- There are 61 country factors and 25 industry factors (truncated view)
- Confirms there is a systematic factor that permeates the global market that is based on the largest markets and industries

Rank By Cont	Factor	Variance Contribution	% Contribution
1	US Large	50.18577163	15.60%
2	US Small	23.63638275	7.35%
3	Hong Kong Large	4.739940009	1.47%
4	India	3.495630226	1.09%
5	Canada Large	3.226199428	1.00%
6	Ireland	3.043834235	0.95%
7	Japan Large	2.604656416	0.81%
8	South Korea Large	2.572116087	0.80%
9	France Large	2.543786935	0.79%
10	United Kingdom Large	2.192886086	0.68%
1	Software & IT Services	34.31805727	10.67%
2	Hardware & Technology	30.24958184	9.40%
3	Consumer Discretionary	16.01079878	4.98%
4	Banking	11.28744317	3.51%
5	Health Care	10.64876268	3.31%
6	Retailers	9.345601278	2.91%
7	Consumer Staples	9.308867384	2.89%
8	Industrials	8.94829242	2.78%
9	Biotechnology & Pharmaceuti	8.172542314	2.54%
10	Materials	8.066905048	2.51%

# Styles

- In the high-level view, style factors had different impacts on the total risk of the portfolio

	Hybrid		Double Hybrid	
	Variance	Weight (%)	Variance	Weight (%)
Style	3.0207	1.96%	-12.7230	-3.96%

- Hybrid model:
  - Styles includes economic variables
  - Largest contributor to style risk is the Value/Growth factor

Factor	Group	Variance Contribution	% Contribution To Total
VALUE/GROWTH	Fundamental	1.7277	1.12%
MARKET DEVELOPMENT	Economic	0.9676	0.63%
OIL	Economic	0.7653	0.50%
SIZE	Fundamental	-0.0918	-0.06%
WORLD GOVT BOND INDEX	Economic	-0.3481	-0.23%
Total Variance		153.8048	



# Value/Growth

- The positive contribution to risk from the Value/Growth impact is consistent with the Double Hybrid
  - Taking a subset of the style factors in the Double Hybrid model which are related to Value/Growth

Style Group	Variance Contribution	% Contribution To Total
Dividend Yield	1.6991	0.5283%
Growth Momentum	-0.2634	-0.0819%
Growth Trend	3.2855	1.0215%
Value	1.9115	0.5943%
Total Growth/Value Factors	6.6327	2.0622%
Total Variance	321.6383	

- Contribution to Variance between the models have different signs

# US Quality Factor

- Contributions to risk from styles in the Double Hybrid model has a different impact, primarily from quality

Style Group	Variance Contribution	% Contribution To Total
Growth Trend	3.2855	1.02%
Value	1.9115	0.59%
Dividend Yield	1.6991	0.53%
Long Term Price Momentum	0.9078	0.28%
Growth Momentum	-0.2634	-0.08%
Leverage	-0.7763	-0.24%
Liquidity	-0.8517	-0.26%
Short Term Price Momentum	-3.3064	-1.03%
Quality	-15.3291	-4.77%
Total Style Factor	-12.7230	-3.96%
Total Variance	321.6383	

- Due to positive exposure to US Quality factor

Factor	Group	Portfolio Exposure	Factor Variance	Variance Contribution
US Quality	Style	0.3090	81.4331	-12.0051

# Currency

- Currency is exogenous from the regression in the Hybrid model and the exposure is the weight
- In the Double Hybrid model currency is the first factor removed and the exposure is a regression coefficient

Hybrid Model			
Top 5 Contributors to Variance			
Factor	Portfolio Exposure	Factor Variance	Variance Contribution
AUSTRALIAN DOLLAR	0.0181	67.932	1.0543
CANADIAN DOLLAR	0.0256	45.116	0.7889
BRAZILIAN REAL	0.0064	229.985	0.3879
SOUTH AFRICAN RAND	0.0045	212.738	0.2888
RUSSIAN ROUBLE	0.0031	166.422	0.2500
Bottom 5 Contributors to Variance			
HONG KONG DOLLAR	0.0358	64.055	-0.0540
EURO	0.0862	34.738	-0.0707
SWISS FRANC	0.0256	60.38	-0.2144
JAPANESE YEN	0.0571	88.523	-1.3183
US DOLLAR	0.6114	64.184	-2.7081

# US Dollar

- In the Hybrid model, the ETF holds assets with a combined 61% of the total value in the USD which is a diversifying factor with a variance contribution of -2.7081
- How does this compare to the Double Hybrid model?

Double Hybrid Model			
Top 5 Contributors to Variance			
Factor	Portfolio Exposure	Factor Variance	Variance Contribution
US Dollar	-0.1031	86.630588	2.4730
Australian Dollar	0.0255	83.828398	2.2726
Euro	-0.0462	62.607026	1.1078
Canadian Dollar	0.0298	55.120839	1.0627
Brazilian Real	0.0119	364.45593	1.0489
Bottom 5 Contributors to Variance			
Turkish Lira	0.0002	412.70642	0.0017
Philippine Peso	0.0001	83.294126	-0.0015
Taiwanese Dollar	0.0038	71.137071	-0.0396
Chinese Yuan	0.0068	66.641618	-0.0702
Swiss Franc	0.0037	90.279605	-0.1039

# Statistical Factors and Asset Specific Risk

- By definition stock specific risk is orthogonal, meaning no asset should have a specific risk that is correlated with another asset's specific risk
- Residual risk is the risk that cannot be explained by the factor model
- If it is true that residual risk = specific risk, then a statistical analysis of the residual would result in 0 impact
- Both models regardless of the structure have non-zero variance to statistical factor

Model	Factor	Variance Contribution
Hybrid	Statistical	7.1680
Double Hybrid	Statistical	1.7419

- For more information on statistical factors see Northfield's September 2020 newsletter article "Tech Support Tip: The Why of Statistical Factors — Better to Know Than Not to Know" available at <https://www.northinfo.com/Documents/953.pdf>

# Conclusion

- Models are used to analyze portfolios for intended and unintended bets
- We can only manage the risk we know exist, but it is the unmanaged risk we are unaware of that can hurt us the most
  - Value managers know they are exposed to value factors, but there could be risk associated with the exposure to value that are unexpected
- Each model tells us something different about our portfolio
  - Sometimes the models are in synch providing confirmation of our bets
    - In our example both models confirmed risk from markets, sectors and value/growth
  - Other times the models may differ providing an indication of where to focus our attention
    - In our example the models identified a few areas needing more attention such as the Developed Asia Region, US Quality and US Dollar

# Thank You!

- Contact me at [mike@northinfo.com](mailto:mike@northinfo.com)
- Visit our website at [www.northinfo.com](http://www.northinfo.com)
- Join the **Northfield Information Services International Community**
  - On LinkedIn at <https://www.linkedin.com/groups/2228261/>
- Questions?

# APPENDIX



# Model Facts

Factor Group	NIS	XRD
Global Stock Coverage	95,000	65,000
Number of countries	80	80
Periodicity	Monthly (medium-horizon); contemporaneous (short-horizon)	4-weekly (medium-horizon); weekly (short-horizon)
Estimation window	60 months (medium-horizon)	80 4-weekly periods (medium-horizon); 80 weekly periods (short-horizon)
Update frequency	Monthly (medium-horizon); daily (short-horizon)	Weekly (medium-horizon & short-horizon)
History	1990	2004/2005

# Factor Blocks - Definition

Factor Group	NIS	XRD
Market	Model Universe	n/a
Currency	Currency factors	Currency factors
Region/Country	Regions e.g. USA/Canada, Developed Europe etc.	Countries e.g. US Large, US Small, Germany Large, Germany Small
Sector/Industry	Global Sectors e.g. Industrial, Consumer, Technology, Interest Rate Sensitive	Regional Industry (GICS based) e.g. US Banks, EU Banks, JP Banks, Asia-Pacific Banks, NR Banks, LA Banks
Style	Global Style e.g. Size, Value/Growth, Market Development, Bonds, Oil	Regional Styles e.g. US Value, EU Value, JP Value, Asia-Pacific Value, NR Value, LA Value
Blind/Statistical	5 Blind Factors	4 Blind Factors

# Factor Blocks - Exposure Comparison

Factor Group	NIS	XRD
Market	Estimated using time series regression	n/a
Currency	1/0 assignment	Estimated using time series regression
Region/Country	Estimated using time series regression	Estimated using time series regression
Sector/Industry	Estimated using time series regression	Estimated using time series regression
Style	Estimated using time series regression	Calculated using accounting & market data
Blind/Statistical	Principal Component Analysis	Principal Component Analysis

# Factor Blocks - Factor Return Comparison

Factor Group	NIS	XRD
Market	Calculated	n/a
Currency	Calculated	Calculated
Region/Country	Calculated	Calculated
Sector/Industry	Calculated	Calculated
Style	Calculated	Estimated via cross-sectional regression
Blind/Statistical	Principal Component Analysis	Principal Component Analysis