EDHEC-Risk Days 2016

Bringing Research Insights to Institutional Investment Professionals

Diversified or Concentrated Factor Tilts?
What are the Investment Beliefs behind these two Smart Beta Approaches?

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Head of Applied Research, EDHEC-Risk Institute
Research Director, ERI Scientific Beta
Outline

• Introduction

• Conceptual Issues
  – Diversified vs. Concentrated
  – Factor Investing and Expected Return Estimation
  – The Need for Diversification within Factors

• Empirical Results
  – Performance
  – Investability
  – Diversification Effects

• Robustness Tests and Extensions
  – Results for individual factors
  – Results for monotonic variation of concentration
  – Diversified Multi-Strategy weighting scheme
Introduction

• Emergence of Factor Indices
  – Initially, factor indices aimed at alleviating a problem with cap-weighted indices (their unfavourable exposure to long-term rewarded factors)
  – Factor investing has become an opportunity to sell stock picking approaches as systematic strategies

• Factor investing thus poses the problem of estimation of expected returns through factor exposures
  – Assumption behind factor investing: performance is driven by the link between stock returns and stock characteristics
  – Ultimately, return estimation will be sensitive to both the time period and to the selection of factor definitions

• This presentation compares the performance and risks of concentrated and diversified factor-tilted indices
  – We look at the six following factor tilts in both in the long and short term:
    – Size, Value, Momentum, Low Vol, High Profitability, Low Investment

• This presentation draws on Amenc et al. (2016).
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Concentrated vs. Diversified Factor Indices

What are the differences?

**Concentrated Factor Indices**

- Do not consider any diversification objective. Ad hoc weighting schemes such as market cap-weighting or score times market cap-weighting are used.
- Often select a very narrow universe of stocks with the highest exposure.

**Diversified Factor Indices**

- Use an alternative weighting scheme to ensure sufficient diversification.
- Use a reasonably broad universe of stocks that have above average exposure to the relevant factor.
Factor investing builds on the insight that tilting to a factor leads to a reward in terms of higher returns

- It is well known that expected returns are notoriously hard to estimate (see Merton [1980]), and “we need decades of data for accurate estimates of average expected return” (Black [1993]).
- Return estimates at the individual stock level are very noisy (Black [1993]). Therefore studies of factor premia (e.g. Fama and French [1993]) rely on portfolio-sorting approaches.

Belief that factor exposures help identifying differences in returns that hold on average across stocks

- strive to build a well-diversified portfolio for a given tilt

Belief that factor exposures have an exact and deterministic link with stock returns

- strive to build a concentrated portfolio with the “right” stocks
“All we really say in finance is: Hold diversified portfolios along whatever tilt you choose”*

Empirical literature emphasizes need for diversification

- Hou, Xue and Zhang [2015]: “CW portfolio returns can be dominated by a few big stocks”.
- Fama and French [2012]: “we ensure that we have lots of stocks in each [tilted] portfolio”

Studies typically do not use simple CW factors

- Asparouhova et al [2013]: many papers in top journals use EW tilted portfolios
- Fama and French’s (1993, 2015) factors are an EW combination of sub-portfolios for different market cap ranges: this increases the effective number of stocks

Theory makes the case for well-diversified factor tilts

- Cochrane [1999]: portfolios should be constructed so as to be mean-variance efficient at a given level of factor exposure
- Fama [1996]: rewarded factors are multifactor mean-variance-efficient

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Illustration: Performance and Investability

- Narrower stock selection keeps performance ratios constant but increases turnover
- EW increases performance ratios with only marginally higher turnover

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<td>Ann. Returns</td>
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<td>Ann. Volatility</td>
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<td>16.64%</td>
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<tr>
<td>Sharpe Ratio</td>
<td>0.44</td>
<td>0.55</td>
<td>0.66</td>
</tr>
<tr>
<td>Ann. Rel. Returns</td>
<td>-</td>
<td>1.61%</td>
<td>3.75%</td>
</tr>
<tr>
<td>Ann. Tracking Error</td>
<td>-</td>
<td>4.61%</td>
<td>5.74%</td>
</tr>
<tr>
<td>Information Ratio</td>
<td>-</td>
<td>0.33</td>
<td>0.66</td>
</tr>
<tr>
<td>Frequency 3Y Outperf</td>
<td>-</td>
<td>68.12%</td>
<td>76.04%</td>
</tr>
<tr>
<td>Ann. 1-Way Turnover</td>
<td>2.68%</td>
<td>29.25%</td>
<td>32.58%</td>
</tr>
<tr>
<td>Days-to-Trade</td>
<td>0.20</td>
<td>0.82</td>
<td>1.56</td>
</tr>
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Weekly total returns in USD from 31-Dec-1974 to 31-Dec-2014 (40 years). Average figures across six factors – size, momentum, low volatility, value, low investment, and high profitability. All factor tilted portfolios are rebalanced annually on the 3rd Friday of June except that of momentum tilted portfolios which are rebalanced semi-annually. Based on 500 largest USA stocks by total market cap. The market cap weighted index of these 500 stocks is the benchmark. The yield on secondary market US Treasury Bills (3M) is the risk-free rate. All risk and return statistics are annualized and Sharpe ratio and Information ratio are computed using annualized figures. Outperformance probability (3 years) is the probability of getting positive relative returns if one invests in the strategy for a period of 3 years at any point during the history of the strategy. It is computed using a rolling window of length 3 years and step size 1 week. Data Source: CRSP and WRDS. The reported Turnover is Annual 1-Way Turnover and is averaged over 40 annual rebalancings in the period 31-Dec-1974 to 31-Dec-2014. Days to Trade or DTT of a stock is the number of days required to trade total stock position in the portfolio of $1 billion, assuming that 10% of ‘Average Daily Traded Volume (ADTV)’ can be traded every day. For each portfolio, the reported DTT value is the 95th percentile of DTT values across all 10 yearly rebalancings in the period 31-Dec-2004 to 31-Dec-2014 and across all stocks.
Diversification effects

- Irrespective of the weighting scheme, the residual risk is larger in the case of narrow stock selection
- Alpha per unit of residual standard deviation increases with better diversification through EW
- Reduction in volatility with respect to their respective factor benchmark is higher for EW factor-tilted portfolios than for CW factor-tilted portfolios

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<tr>
<td>Residual Std. Deviation</td>
<td>0.51%</td>
<td>0.61%</td>
</tr>
<tr>
<td>Interquartile Range of Residual Returns</td>
<td>0.52%</td>
<td>0.62%</td>
</tr>
<tr>
<td>Ann. Alpha</td>
<td>0.68%</td>
<td>1.42%</td>
</tr>
<tr>
<td>Ann. Alpha / Residual Std. Dev.</td>
<td>1.24</td>
<td>2.34</td>
</tr>
<tr>
<td>Change in Specific Volatility</td>
<td>-1.25%</td>
<td>-2.16%</td>
</tr>
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</table>

Diversification Effects in Cap-Weighted and Equal-Weighted Factor Indices - The time period of analysis is 31-Dec-1974 to 31-Dec-2014 (40 years). All figures reported are average figures across six factors – size, momentum, low volatility, value, low investment, and high profitability. All factor-tilted portfolios are rebalanced annually on the 3rd Friday of June except that of Momentum tilted portfolios which are rebalanced semi-annually. The analysis is done using weekly total returns (dividends reinvested) in USD. The portfolios are constructed using a USA stock universe that contains the 500 largest stocks by total market cap. The market-cap-weighted index of these 500 stocks is the benchmark. The yield on secondary market US Treasury Bills (3M) is the risk-free rate. A Carhart 4-factor model is used for regression. The reported alpha is annualised. Change in Specific Volatility is the difference between volatility of the leveraged factor benchmark and its respective portfolio (as described in equation 3). The market factor is the excess returns of the cap-weighted benchmark over the risk-free rate. The size, value, and momentum factors are obtained from Kenneth French’s data library. Data sources: CRSP and WRDS.
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Detailed analysis for individual factor tilts

• So far, we have focused on average results across six single factor tilts, providing a comparison of diversified versus concentrated tilts in terms of
  – Risk-adjusted performance
  – Implementation aspects
  – Diversification effects
• The key conclusions on benefits of diversified indices compared to concentrated are fairly consistent across the six individual factors
• Below, we provide a detailed analysis for individual factor tilts.
Sharpe Ratio for individual factor tilts

- Diversification improves risk-adjusted performance compared to traditional cap-weighted factor indices. The diversification effect is far greater than the concentration/increase in factor exposure effect.

<table>
<thead>
<tr>
<th>Sharpe Ratio (Dec 1974 – Dec 2014)</th>
<th>50% Stock Selection</th>
<th>20% Stock Selection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cap Weighting</td>
<td>Equal Weighting</td>
</tr>
<tr>
<td>Mid Cap</td>
<td>0.63</td>
<td>0.63</td>
</tr>
<tr>
<td>High Momentum</td>
<td>0.50</td>
<td>0.65</td>
</tr>
<tr>
<td>Low Volatility</td>
<td>0.53</td>
<td>0.69</td>
</tr>
<tr>
<td>Value</td>
<td>0.55</td>
<td>0.68</td>
</tr>
<tr>
<td>Low Investment</td>
<td>0.58</td>
<td>0.65</td>
</tr>
<tr>
<td>High Profitability</td>
<td>0.48</td>
<td>0.64</td>
</tr>
<tr>
<td>Avg. across 6 Factors</td>
<td><strong>0.55</strong></td>
<td><strong>0.66</strong></td>
</tr>
</tbody>
</table>

Sharpe ratios for concentrated and diversified factor indices. The time period of analysis is 31-Dec-1974 to 31-Dec-2014 (40 years). All factor tilted portfolios are rebalanced annually on the 3rd Friday of June except that of momentum tilted portfolios which are rebalanced semi-annually. The analysis is done using weekly total returns (dividends reinvested) in USD. The portfolios are constructed using a US stock universe that contains the 500 largest stocks by total market cap. The market-cap-weighted index of these 500 stocks is the benchmark. The yield on secondary market US Treasury Bills (3M) is the risk-free rate. Sharpe ratio is computed using annualized return and risk figures. Data sources: CRSP and WRDS.
Days to Trade for individual factor tilts

- Consistently across the six factors, improving diversification does not have any serious adverse impact on the investability of portfolios.

### Days-to-Trade & Turnover (Dec 2004 – Dec 2014)

<table>
<thead>
<tr>
<th>Factor</th>
<th>50% Stock Selection</th>
<th>20% Stock Selection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cap Weighting</td>
<td>Equal Weighting</td>
</tr>
<tr>
<td>Mid Cap</td>
<td>1.86</td>
<td>1.98</td>
</tr>
<tr>
<td>High Momentum</td>
<td>0.65</td>
<td>1.46</td>
</tr>
<tr>
<td>Low Volatility</td>
<td>0.57</td>
<td>1.70</td>
</tr>
<tr>
<td>Value</td>
<td>0.77</td>
<td>1.56</td>
</tr>
<tr>
<td>Low Investment</td>
<td>0.66</td>
<td>1.46</td>
</tr>
<tr>
<td>High Profitability</td>
<td>0.44</td>
<td>1.22</td>
</tr>
<tr>
<td>Avg. across 6 Factors</td>
<td><strong>0.82</strong></td>
<td><strong>1.56</strong></td>
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Days-to-Trade for concentrated and diversified factor indices. All factor-tilted portfolios are rebalanced annually on the 3rd Friday of June except that of momentum tilted portfolios which are rebalanced semi-annually. The analysis is done using weekly total returns (dividends reinvested) in USD. The reported Turnover is Annual 1-Way Turnover and is averaged over 40 annual rebalancings in the period 31-Dec-1974 to 31-Dec-2014. Days to Trade or DTT of a stock is the number of days required to trade total stock position in the portfolio of $1 billion, assuming that 10% of 'Average Daily Traded Volume (ADTV)' can be traded every day. For each portfolio, the reported DTT value is the 95th percentile of DTT values across all 10 yearly rebalancings in the period 31-Dec-2004 to 31-Dec-2014 and across all stocks. Data sources: CRSP and WRDS.
Diversification effects for individual tilts

- Consistently across the six factors, the good diversification of the factor index’s unrewarded risks enables it to have the best risk-adjusted performance beyond the reward obtained through the factor exposure and to reduce the specific volatility.

<table>
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<tr>
<th>(Dec 1974 – Dec 2014)</th>
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<td>Cap Weighting</td>
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<tr>
<td><strong>Ann. Alpha / Residual Std. Dev.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mid Cap</td>
<td>1.81</td>
<td>1.69</td>
</tr>
<tr>
<td>High Momentum</td>
<td>-1.27</td>
<td>1.38</td>
</tr>
<tr>
<td>Low Volatility</td>
<td>1.59</td>
<td>3.11</td>
</tr>
<tr>
<td>Value</td>
<td>-0.90</td>
<td>1.62</td>
</tr>
<tr>
<td>Low Investment</td>
<td>1.17</td>
<td>1.44</td>
</tr>
<tr>
<td>High Profitability</td>
<td>5.01</td>
<td>4.80</td>
</tr>
<tr>
<td><strong>Avg. across 6 factors</strong></td>
<td><strong>1.24</strong></td>
<td><strong>2.34</strong></td>
</tr>
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</table>

Change in specific volatility (relative to Carhart factor benchmark with identical avg. return)

|                        |             |             |             |             |
| Mid Cap                | -1.51%      | -1.37%      | -1.00%      | -0.62%      |
| High Momentum          | 1.40%       | -0.77%      | 2.51%       | 1.71%       |
| Low Volatility         | -1.29%      | -3.02%      | -1.42%      | -2.96%      |
| Value                  | 1.18%       | -1.01%      | 1.96%       | -1.54%      |
| Low Investment         | -0.62%      | -0.85%      | -1.86%      | -0.04%      |
| High Profitability     | -6.68%      | -5.93%      | -9.16%      | -7.68%      |
| **Avg. across 6 factors** | **-1.25%** | **-2.16%** | **-1.50%** | **-1.86%** |

The time period of analysis is 31-Dec-1974 to 31-Dec-2014 (40 years). All factor-tilted portfolios are rebalanced annually on the 3rd Friday of June except that of momentum tilted portfolios which are rebalanced semi-annually. The analysis is done using weekly total returns (dividends reinvested) in USD. The portfolios are constructed using a USA stock universe that contains the 500 largest stocks by total market cap. The market-cap-weighted index of these 500 stocks is the benchmark. The yield on secondary market US Treasury Bills (3M) is the risk-free rate. A Carhart 4-factor model is used for regression. The reported alpha is annualised. Change in volatility is the difference between portfolio and the volatility of the leveraged Carhart factor benchmark. The market factor is the excess returns of the cap-weighted benchmark over the risk-free rate. The size, value, and momentum factors are obtained from Kenneth French’s data library. Data sources: CRSP and WRDS.
Smooth variation of stock selection

- We show results when varying stock selection consistently across the stock universe
  - We test a range from selecting 95% of stocks to selecting only 5% of stocks.
- It appears consistently that there is no value to factor tilts that are overly concentrated
  - When reducing the number of stocks below 50%, there are no clear performance benefits but clear implementation challenges appear
  - When becoming extremely concentrated (i.e. holding less than 20% of stocks), risk adjusted performance declines dramatically and implementation challenges become severe
Sharpe Ratio with varying concentration

- Extreme concentration decreases Sharpe Ratios
- Turnover rises exponentially with concentration
- Equal weighting consistently adds value over cap-weighting

The time period of analysis is 31-Dec-1974 to 31-Dec-2014 (40 years). All figures are average figures across six factors – size, momentum, low volatility, value, low investment, and high profitability. All factor-titled portfolios are rebalanced annually on the 3rd Friday of June except that of Momentum titled portfolios which are rebalanced semi-annually. The analysis is done using weekly total returns (dividends reinvested) in USD. The portfolios are constructed using a USA stock universe that contains the 500 largest stocks by total market cap. Sources: CRSP and WRDS.
Information Ratio with varying concentration

• Extreme concentration decreases Information Ratios
• Turnover rises exponentially with concentration
• Equal weighting consistently adds value over cap-weighting

The time period of analysis is 31-Dec-1974 to 31-Dec-2014 (40 years). All figures are average figures across six factors – size, momentum, low volatility, value, low investment, and high profitability. All factor-titled portfolios are rebalanced annually on the 3rd Friday of June except that of Momentum tilted portfolios which are rebalanced semi-annually. The analysis is done using weekly total returns (dividends reinvested) in USD. The portfolios are constructed using a USA stock universe that contains the 500 largest stocks by total market cap. sources: CRSP and WRDS.
Expected Returns with varying concentration

Why does risk-adjusted performance **not** increase with concentration?

- Average returns increase, as expected. But when going to extreme levels of concentration, idiosyncratic noise dominates and return no longer increases.

![Relative Return Graph]

The time period of analysis is 31-Dec-1974 to 31-Dec-2014 (40 years). All figures are average figures across six factors – size, momentum, low volatility, value, low investment, and high profitability. All factor-tilted portfolios are rebalanced annually on the 3rd Friday of June except that of Momentum tilted portfolios which are rebalanced semi-annually. The analysis is done using weekly total returns (dividends reinvested) in USD. The portfolios are constructed using a USA stock universe that contains the 500 largest stocks by total market cap. Sources: CRSP and WRDS.
Risk with varying concentration

Why does risk-adjusted performance not increase with concentration?

- Risk increases exponentially with higher concentration.
- The increase in risk more than compensates the increase in expected returns.

The time period of analysis is 31-Dec-1974 to 31-Dec-2014 (40 years). All figures are average figures across six factors—size, momentum, low volatility, value, low investment, and high profitability. All factor-tilted portfolios are rebalanced annually on the 3rd Friday of June except that of Momentum tilted portfolios which are rebalanced semi-annually. The analysis is done using weekly total returns (dividends reinvested) in USD. The portfolios are constructed using a USA stock universe that contains the 500 largest stocks by total market cap. Data sources: CRSP and WRDS.
From Equal-Weighting to Diversified Multi-Strategy

• Equal weighting is a powerful albeit naive diversification approach: it ignores the risk properties of component stocks
• Amenc et al (2014) introduce smart factor indices based on the Diversified Multi-Strategy weighting scheme:
  – The strategy combines five different weighting schemes:
    • Maximum Deconcentration
    • Maximum Decorrelation
    • Efficient Minimum Volatility
    • Efficient Maximum Sharpe Ratio
    • Diversified Risk Weighted
  – Smart Factor indices are based on a broad stock selection (50%)
  – We use indices from Scientific Beta which also incorporate liquidity and turnover control rules to ensure investability
Smart Factor Indices: Performance & Investability

- **Diversified Multi-Strategy improves performance over EW**
  - higher Sharpe Ratio and Information Ratio
  - volatility is notably reduced
  - higher outperformance probability

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Smart Factor Indices: Diversification effects

- Diversified Multi-Strategy indices show even stronger diversification effects than equal-weighted factor indices

### Top 50% Stocks Selected by Factor Score

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<th>Equal Weighted</th>
<th>Div. Multi-Strategy</th>
</tr>
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<tr>
<td>Residual Std. Deviation</td>
<td>0.51%</td>
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</tr>
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<td>Interquartile Range of Residual Returns</td>
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</tbody>
</table>

Diversification Effects in Cap-Weighted and Equal-Weighted Factor Indices - The time period of analysis is 31-Dec-1974 to 31-Dec-2014 (40 years). All figures reported are average figures across six factors – size, momentum, low volatility, value, low investment, and high profitability. All factor-tilted portfolios are rebalanced annually on the 3rd Friday of June except that of Momentum tilted portfolios which are rebalanced semi-annually. Scientific Beta Diversified Multi Strategy Index is based on the same stock universe with 50% stocks included based on the factor score and the Diversified Multi-Strategy weighting scheme is applied. Diversified Multi-Strategy is an equal weighted combination of Maximum Deconcentration, Maximum Decorrelation, Efficient Minimum Volatility, Efficient Maximum Sharpe Ratio and Diversified Risk Weighted weighting schemes. The analysis is done using weekly total returns (dividends reinvested) in USD. The portfolios are constructed using a USA stock universe that contains the 500 largest stocks by total market cap. The market-cap-weighted index of these 500 stocks is the benchmark. The yield on secondary market US Treasury Bills (3M) is the risk-free rate. A Carhart 4-factor model is used for regression. The reported alpha is annualised. Change in Specific Volatility is the difference between volatility of the leveraged factor benchmark and its respective portfolio (as described in equation 3). The market factor is the excess returns of the cap-weighted benchmark over the risk-free rate. The size, value, and momentum factors are obtained from Kenneth French's data library. Data sources: CRSP and WRDS.
Conclusions (I): Problems with Concentration

• Conceptual limits of highly concentrated portfolios
  – Concentration reflects high confidence in the precision of the link between expected returns and factor exposure. But expected returns are notoriously difficult to estimate with precision.

• Empirically, there are no benefits of concentration
  – Selecting fewer stocks that are most strongly tilted to the factor does not have any effect on the risk-adjusted performance.
  – Narrow stock selections increase unrewarded idiosyncratic risks.

• Concentration leads to implementation problems
  – Factor-tilted portfolios on narrow stock selections lead to higher turnover: almost 50% annual turnover for 20% stock selections.
Conclusions (II): Benefits of Diversification

• Deconcentrating portfolios by equal-weighting leads to clear benefits
  – Better Sharpe ratios and information ratios
  – EW portfolios do not pose severe implementation problems

• Equal-weighting is a starting point for more sophisticated diversification strategies
  – Risk-based diversification strategies may generate additional benefits
  – Example: the Diversified Multi Strategy weighting scheme
References