Deutsche Bank

Global Quantitative Strategy

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QWAFAFEW Presentation

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#1 Ranked Global Quant Strategy Team





research surveys: America #1; Europe #1; Asia #1



FX quant research #2

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Chile Offshore Support		
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Source: gettyimages.com, Deutsche Bank Quantitative Strategy

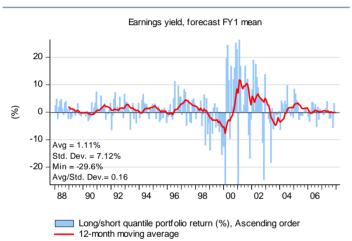
Introduction to quantitative equity investing



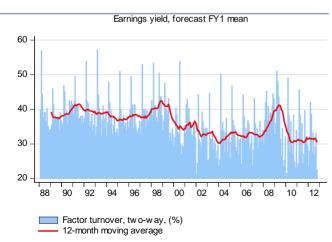
Quants look at factors

A factor is simply a systematic way of ranking (and selecting) stocks. It could be as simple as value (e.g., P/E) or momentum (e.g., past 12-month returns).

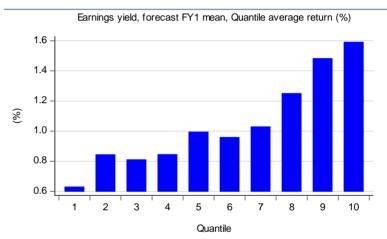
How do we know it's a good factor?



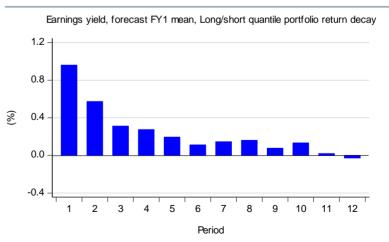
The turnover is not too bad



Cheap stocks are (almost) always good



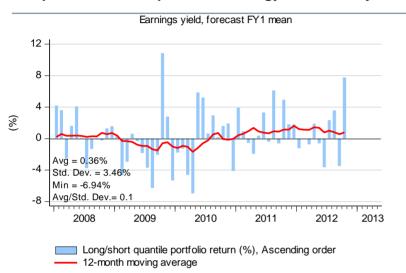
And you don't need to trade it every day



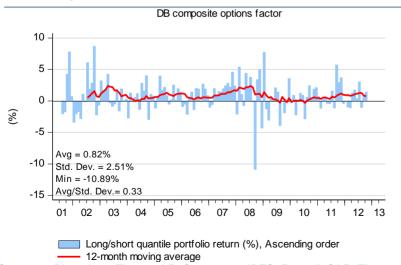
But then the 2008 financial crisis changed everything (maybe forever)



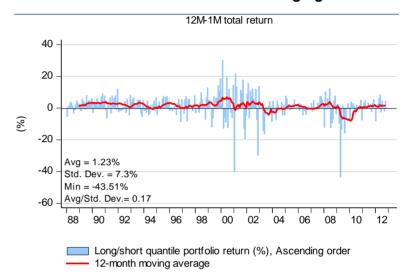
The profit from a simple value strategy has fallen by 2/3



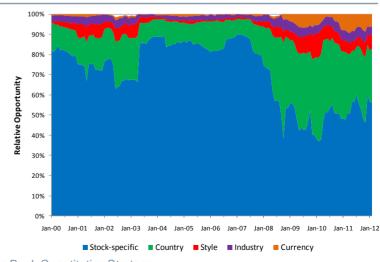
That's why we need new factors



Momentum has been even more challenging



And learn to live in a macro dominated environment



Seven sins of quantitative investing



DB Quant Handbook, Part II

- The rapid rise of computing power and wide availability of off-the-shelf backtesting software provided by many data vendors have given the impression that quant investing is easy, or is it?
- In this paper, we discuss the seven common mistakes investors tend to make when they perform backtesting and build quant models. Some of these may be familiar to our readers, but nonetheless, you may be surprised to see the impact of these biases. The other sins are so commonplace in both academia and practitioner's research that we usually take them for granted.
- There are a few unique features in this research that we have not seen in other places. We deliberate when to and when not to remove outliers: discuss various data normalization techniques; address the intricate issues of signal decay, turnover, and transaction costs; elaborate on the optimal rebalancing frequency; illustrate the asymmetric factor payoff patterns and the impact of short availability on portfolio performance; answer the question of "how many stocks should be held in the portfolio"; and review the tradeoffs of various factor weighting/portfolio construction techniques. Last but not least, we compare traditional active portfolio management via multi-factor models, with the new trend of smart beta/factor portfolio investing.

Deutsche Bank



Quantitative Strategy Signal Processing



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Seven Sins of Quantitative Investing

DB Quant Handbook, Part II

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ands-on tutorial on how to build a multi-factor mod

Lastly, we use a real-life example to show how to avoid the seven sins in building multi-factor models and portfolios.

Seven sins of quant investing

Survivorship bias Look-ahead bias Story telling

Data mining and snooping Signal decay and turnover Outliers and data normalization Asymmetric pattern



Deutsche Bank Securities Inc

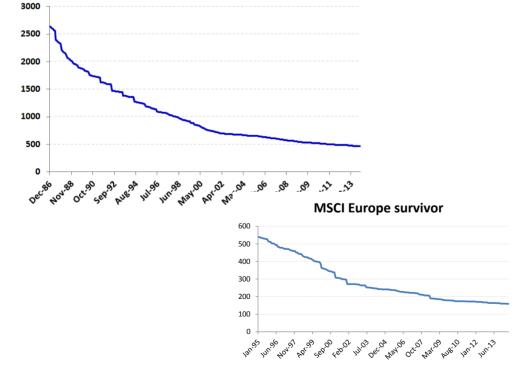
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I. Survivorship bias

Ignoring inactive companies

- Survivorship bias is one of the common mistakes investors tend to make. Most people are aware of the survivorship bias, but few understand its significance.
- Practitioners tend to backtest certain investment strategies using only those companies that are currently in business, meaning stocks that have left the investment universe due to bankruptcy, delisting or being acquired are not included in the backtesting.

of stocks in the US and Europe that have survived until today

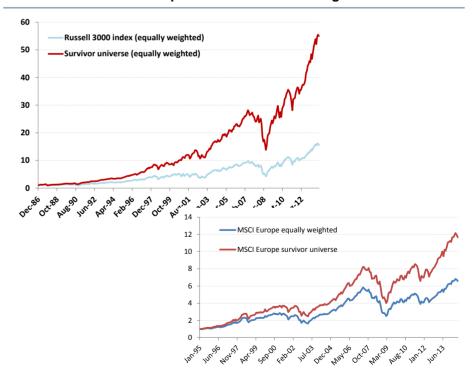


Survivorship bias





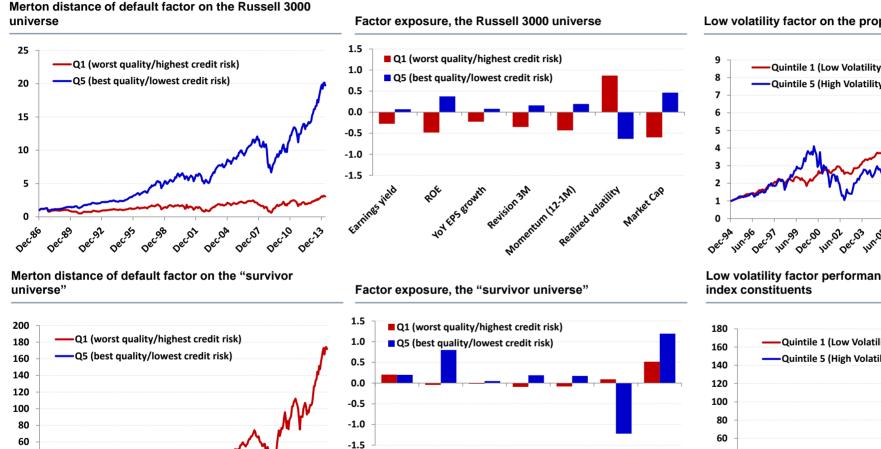
Stocks that have survived perform better than average



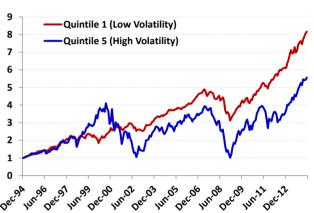
Survivorship bias illustrated



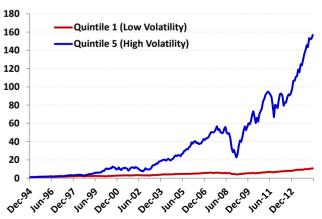
Survivorship bias leads to completely opposite conclusions



Low volatility factor on the proper S&P 500 universe



Low volatility factor performance on the current S&P 500



Source: Bloomberg Finance LLP, Compustat, IBES, Russell, S&P, Thomson Reuters, Deutsche Bank Quantitative Strategy

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The impact of survivorship bias

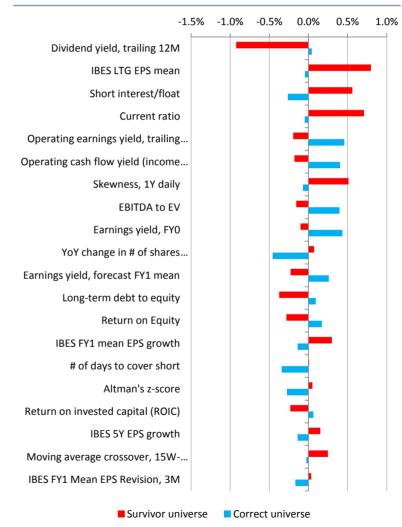


1/3 of factors have the opposite signs with the survivorship-biased universe

Top 20 factors with the largest return differential



Top 20 factors with the opposite signs



II. Look-ahead bias

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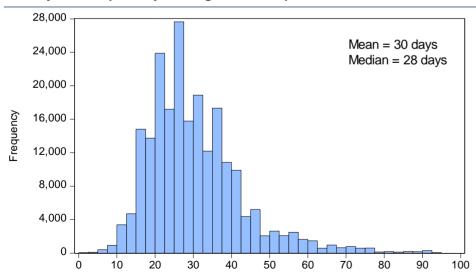
Using data that were unknown

- It is the bias created by using information or data that were unknown or unavailable as of the time when the backtesting was conducted. It is probably the most common bias in the backtesting.
- An obvious example of look-ahead bias lies in companies' financial statement data.
- Ideally, we should use point-in-time data for all backtesting purposes. When PIT data is not available, we need to make reporting lag assumption.

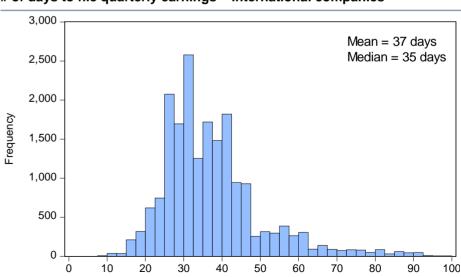
Look-ahead bias



of days to file quarterly earnings - US companies



of days to file quarterly earnings - international companies

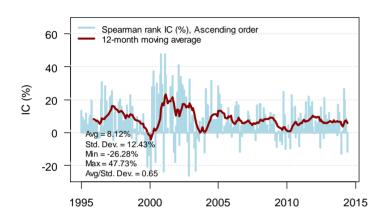


The importance of using PIT data

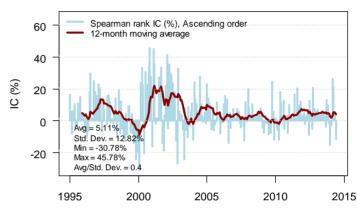


When PIT data is not available, reporting lag assumption is critical

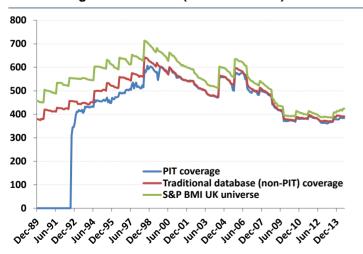
The performance of the earnings yield factor, using non-PIT data



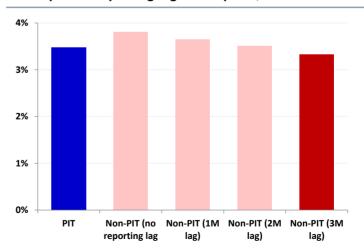
The performance of the earnings yield factor, using PIT data



The coverage of UK stocks (S&P BMI index)



The impact of reporting lag assumption, ROE in UK



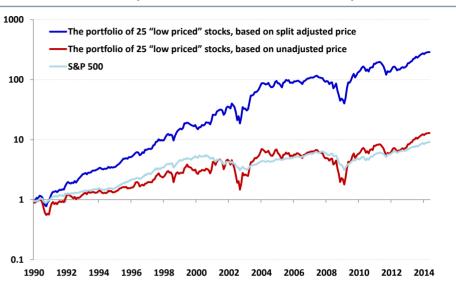
Look-ahead corporate action bias



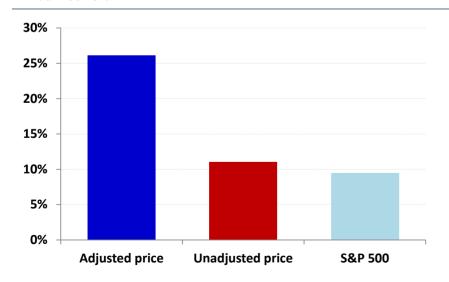
Look-ahead bias can be tricky

For example, split adjustment factors can potentially bring look-ahead bias. From time to time, companies may decide to split their shares (or reverse split), to improve liquidity or attract certain clientele. For most modeling purposes, we want everything to be split adjusted. For example, when we calculate earnings yield, EPS data typically comes from company financial statements with low frequency (quarterly, semi-annually, or annually), while pricing information is from market data available at least daily. We need to make sure both EPS and price are split adjusted at the same time.

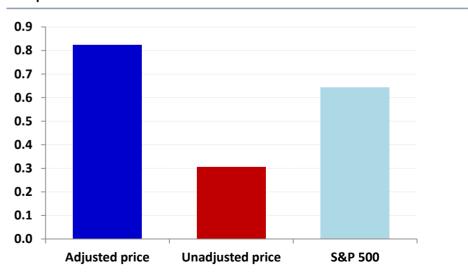
Performance of the top 25 names with the lowest share price



Annualized return



Sharpe ratio

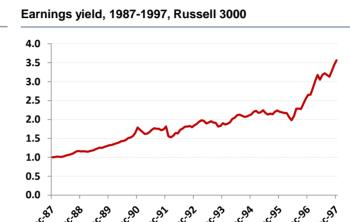


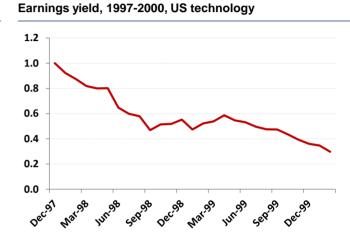
III. The sin of storytelling



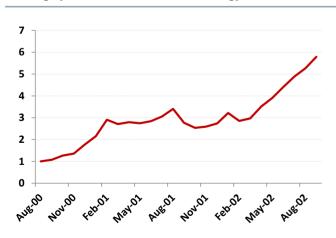
How long is long enough?

Storytelling

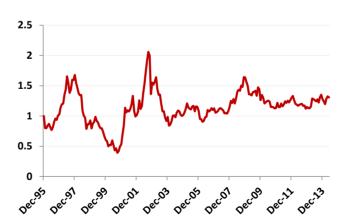




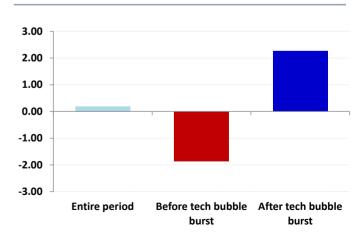
Earnings yield, 2000-2002, US technology



Earnings yield in US technology sector has never been a good factor



Sharpe ratio



IV. Data mining and data snooping



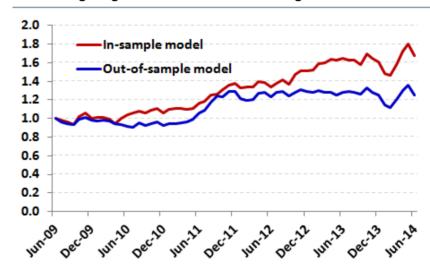
Data mining is almost avoidable

- Universe: S&P 500
- Two factor weighting algorithms
- In-sample model: select the best factor from each of the six style buckets (value, growth, momentum/reversal, sentiment, quality, and exotic) from 2009-2014 and then backtest the same model over the same period.
- Out-of-sample model: from May 31, 2009, at the end of each month, we use rolling 60 months of data to construct our multi-factor model, using data available as of that time.

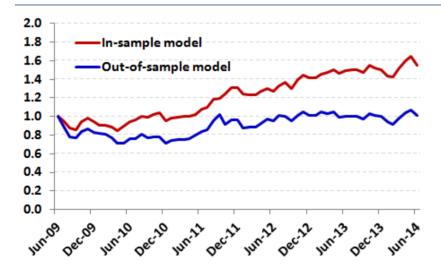
Data mining



Factor weighting - Grinold and Kahn MVO algorithm



Factor weighting - equally weighting algorithm



V. Signal decay, turnover, and transaction cost



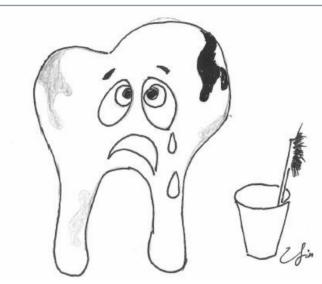
Sharpe ratio of the N-LASR model, with different

turnover constraints

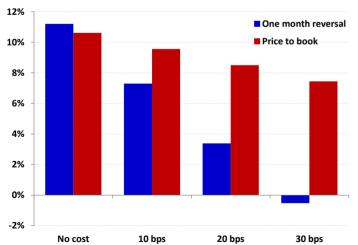
Need to balance among signal decay, transaction cost, and model prediction power

- Different stock-selection factors have different information decay profile. Faster decay signals require higher turnover to capture their benefit. Higher turnover, however, is likely to incur greater transaction costs.
- Adding a turnover constraint at the portfolio construction process is an easy, but not necessarily ideal solution – turnover constraint can either help or hurt our portfolio performance.

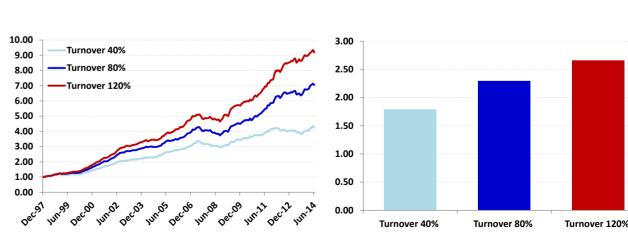
Signal decay



Annualized return with different transaction cost assumptions, Japan dividend-paying stocks



Wealth curve of the N-LASR model, with different turnover constraints



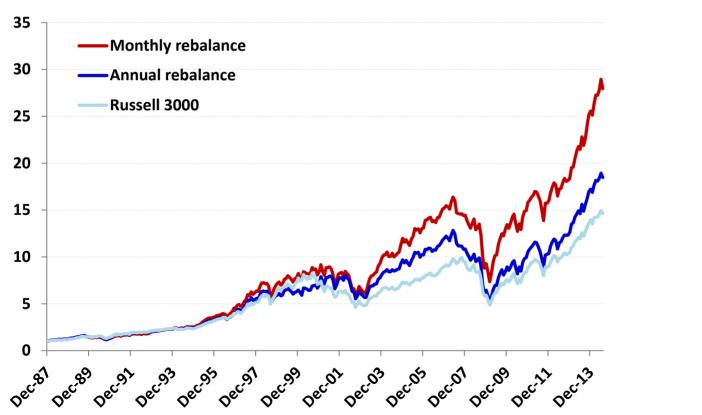
Optimal rebalancing frequency?



Tight turnover constraint ≠ Low rebalancing frequency

— Having a tight turnover constraint, however, does not necessarily mean that we should have a very low rebalance frequency. In many instances, we have heard comments such as "we are long-term value investors; we hold stocks for three to five years; and therefore, we rebalance once a year". New information comes in constantly and we should adjust our models and beliefs accordingly. Even if we have a tight turnover constraint, we may still want to frequently adjust our positions – albeit modestly each time.

Annual versus monthly rebalance for a low turnover value portfolio (36% one-way turnover per year)



Signal decay at the extreme

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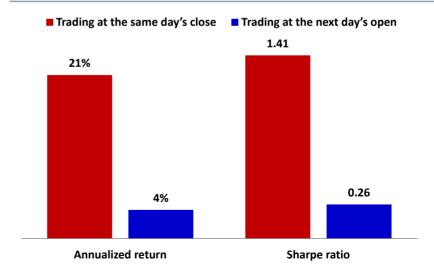
Example: one-day reversal factor

- A simple backtesting of the one-day reversal factor (i.e., buying stocks that have fallen the most on the previous day) seems to suggest that short-term reversal to be a great strategy.
- The only problem is that the factor itself can only be computed after the market closes; therefore, the earliest time we can trade on the signal is at the next day's open.
- If we can calculate the one-day reversal factor and trade on the same day's closing price, we can generate a Sharpe ratio of 1.4x – pretty good for a single factor model. However, in reality, we can only trade at the second day's open, while Sharpe ratio plummets to merely 0.3x (down almost 80%).

Performance of one day reversal



Annualized return and Sharpe ratio



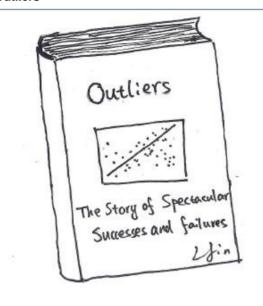
VI. Outliers – spectacular successes and failures



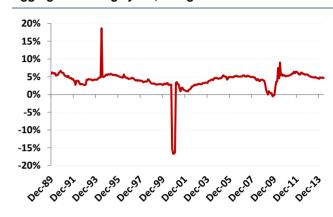
Outlier control and data normalization

- Traditional outlier control techniques include: winsorization (capping data at certain percentiles) and truncation (removing outliers from data sample).
- Data normalization process is closely related to outlier control.
- Outliers could contain useful information, but most of the time, they don't.
- Data normalization techniques can have significant impact on model performance.

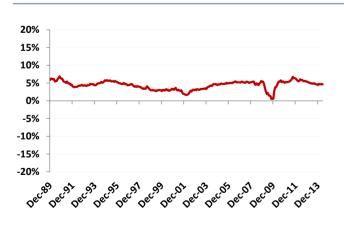
Outliers



Aggregate earnings yield, using raw data



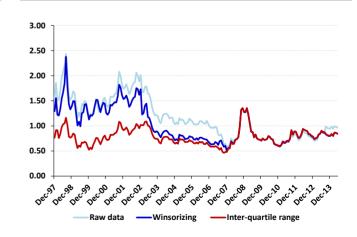
Aggregate earnings yield, using winsorized data



Aggregate earnings yield for the Korean market



Aggregate book-to-market for the Hong Kong market

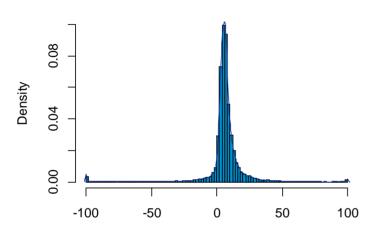


Data transformation

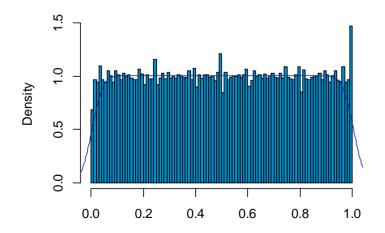


Four alternative data transformation techniques

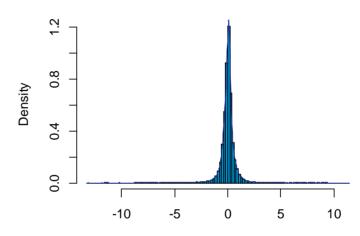
The distribution of Indonesia earnings yield - raw data



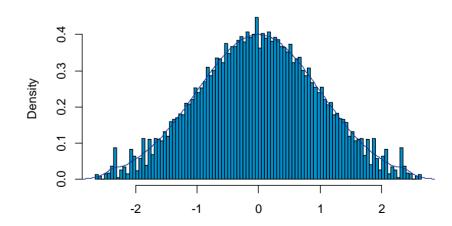
The distribution of Indonesia earnings yield – the ranking transformation



The distribution of Indonesia earnings yield – z-score transformation



The distribution of Indonesia earnings yield – our proprietary transformation



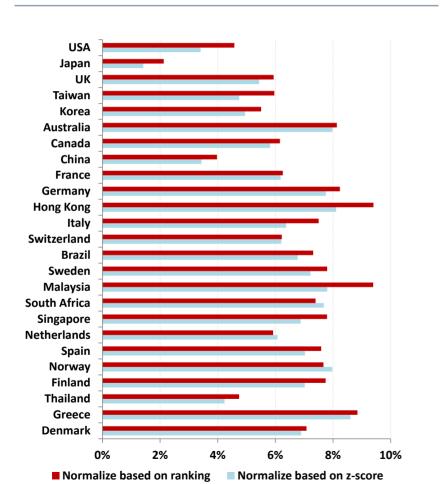
The impact of data normalization techniques



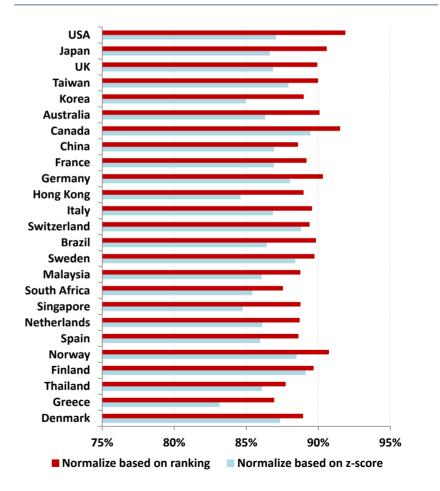
Our proprietary technique can improve model performance by 11% and reduce signal turnover significantly

Example: an equally weighted four-factor model (earnings yield, 12-1M price momentum, three-month earnings revision, and ROE

Average model performance (rank IC), using different data normalization techniques



Average signal serial correlation, using different normalization techniques

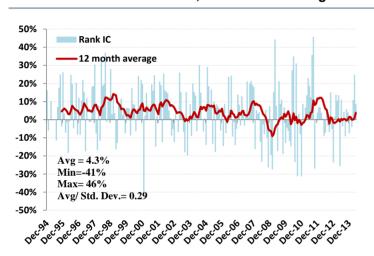


Do outliers contain any useful information?

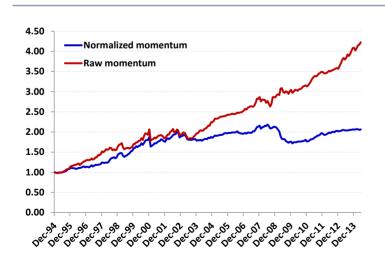


Maybe... at least for the price momentum factor

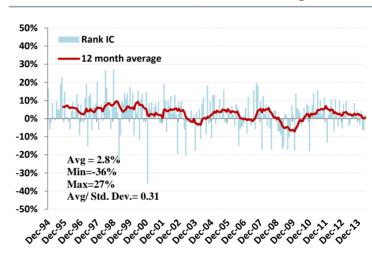
Neutralized momentum factor, without the ranking normalization



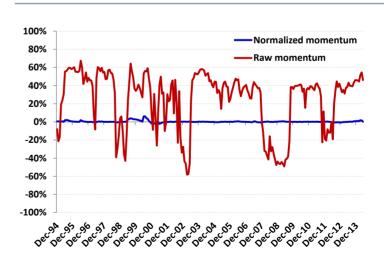
Momentum portfolio performance



Neutralized momentum factor, with the ranking normalization



Aggregate net exposure



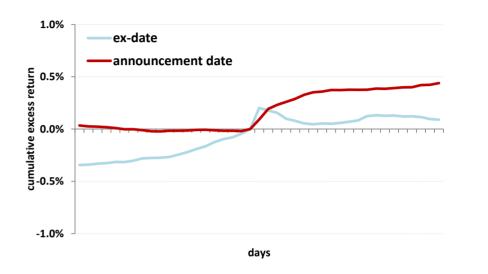
Calculating excess returns in event study



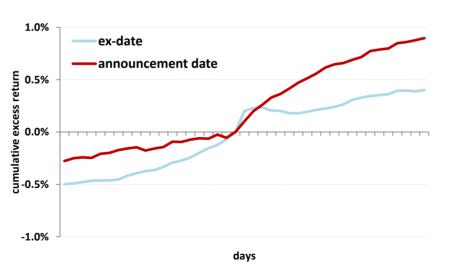
Example: dividend announcement

- When we normalize our data, we have to compute our factors relative to certain universes or benchmarks. Interestingly, the results can also be day-and-night depending on which benchmark we use. We use an event study to show the impact of benchmark selection bias.
- If we normalize each stock's return by subtracting the average return of all dividendpaying stocks on the same day. On average, there is no price movement prior to the event date, i.e., there is probably no leakage of dividend announcement information.
- However, if we choose the wrong benchmark –
 where we use the broad equity market, e.g., the
 S&P 500 index, we see stocks actually tend to
 go up before the dividend announcement.
- The reason is possibly due to the fact that dividend-paying stocks tend to earn higher returns than the broad market. Using the wrong benchmark makes it impossible to tell whether the price drift before dividend announcement is due to the dividend premium or dividend announcement.

Excess return over the equally weighted average of dividend-payi stocks



Excess return over the S&P 500 index



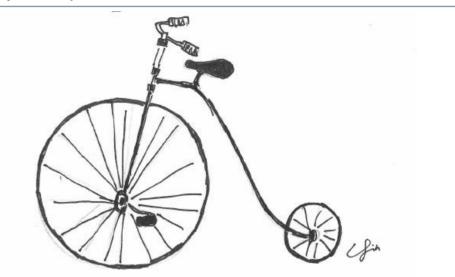
VII. The asymmetric payoff pattern and shorting



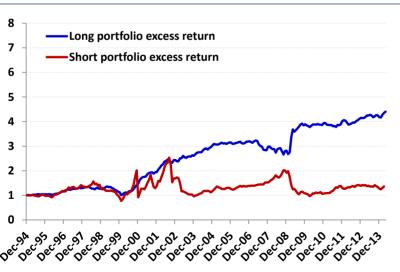
Alpha from the long and the short

- Long portfolio excess return: long the top quartile stocks (equally weighted) against the average (or median) return of our investment universe (which is equivalent to shorting a basket of all stocks in our universe, equally weighted)
- Short portfolio excess return: short the bottom quartile stocks (equally weighted) against the average (or median) return of our investment universe (which is equivalent to using the proceeds from our short positions to fund a long portfolio of all stocks in our universe, equally weighted)

Asymmetric patterns



Earnings yield



Price momentum



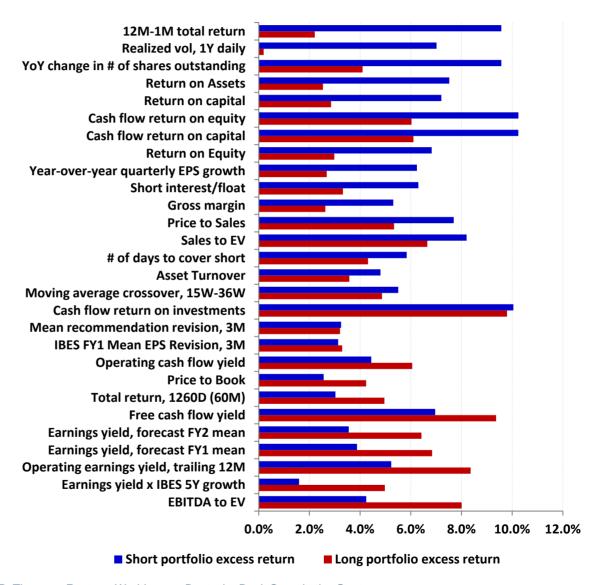
Most factors' payoff patterns are asymmetric



Not all factors are created equally

- These factors are sorted based on the spread between "short excess return" and "long excess return".
- The higher up on the list, the more difficult to capture the alpha, due to heavier demand for shorting and likely higher shorting cost (shorting cost will be discussed in the next section).
- Value factors generally collect their premia from the long side, while price momentum/reversal and quality factors generate more alpha from the short side. Analyst revision factors tend to show more symmetric payoff patterns.

The asymmetric payoff pattern

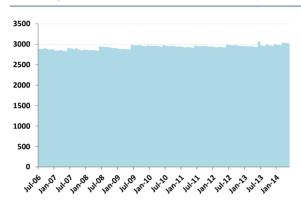


Accounting for short availability

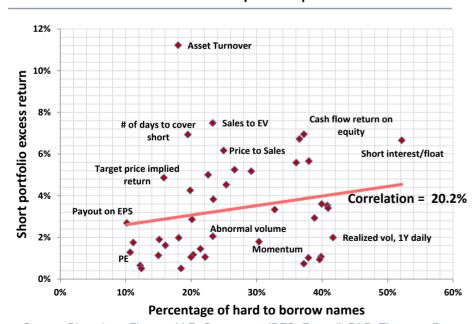


Using DataExplorer's global stock lending database

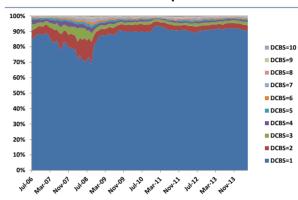
Coverage for the cost of borrow score (DCBS) from DataExplorer



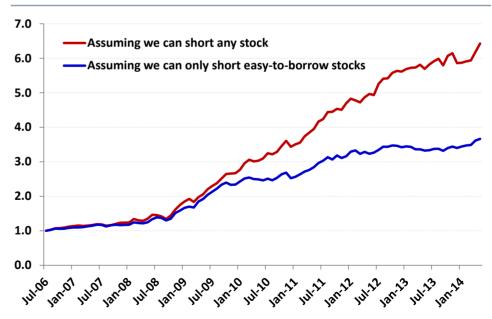
% of hard-to-borrow names vs. short portfolio performance



Cost-of-borrow score composition



Performance with and without short constraints, N-LASR model



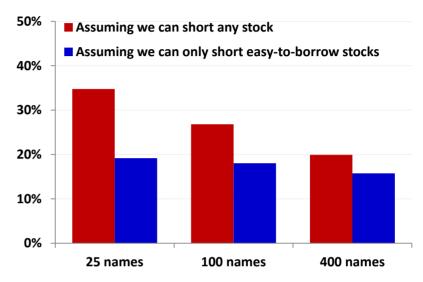
High conviction or diversification



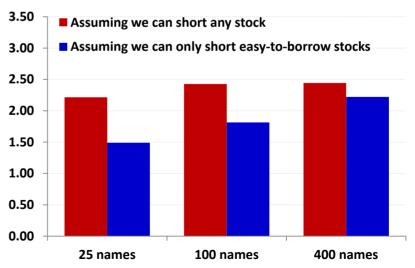
How many stocks do we need to hold

- One popular view in the investment world, especially a view shared by many fundamental investors, is that we should fully take advantage of our "high conviction" ideas; therefore, a more concentrated portfolio is more desirable than a portfolio holding hundreds of stocks. On the other hand, some managers (more likely to be quant) believe in diversification and typically hold fairly diversified portfolios.
- Let's use our N-LASR global stock selection model (which has shown great live performance) as an example.
- Without short constraint, as we hold more and more diversified portfolios, alpha (i.e., active return) goes down.
- With short constraint, as our portfolio becomes more diversified, Sharpe ratio also goes up significantly.

Annualized return, long/short N-LASR portfolios



Sharpe Ratio, long/short N-LASR portfolios



A hands-on tutorial



How to build a realistic model

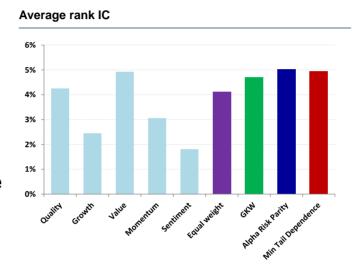
- Five common factors:
 - Value (trailing 12 month earnings yield)
 - Growth (year-over-year quarterly EPS growth)
 - Quality (ROE)
 - Momentum (12-1M total return), and
 - Sentiment (IBES three-month earnings revision)
- How to avoid the seven sins
 - Survivorship bias. We perform our backtesting on the Russell 3000 index universe, using those companies in the index as of a given point in time.
 - Look-ahead bias. We use point-in-time data to calculate all of our factors. Company fundamental data is sourced from Compustat point-in-time database, which reflects whatever was available at each month end.
 - Story telling and data history. We follow the convention for the direction of each factor: buying stocks that are cheaper, that enjoy higher growth, that are more profitable, that have stronger price momentum, and that have more positive analyst sentiment. Our backtesting is conducted over the past 20 years, from 1994 to 2014, covering multiple economic cycles.
 - Data mining and data snooping bias. The four factor weighting algorithms are extensively tested across multiple countries/regions and asset classes.
 - Signal decay and turnover. We avoid fast decay factors in this exercise. Portfolio performance is computed after transaction costs.
 - Outlier control. We use our proprietary data normalization technique to transform each factor to a standard normal distribution, before we combine them together into multi-factor models.
 - The asymmetric payoff pattern and shorting cost. We study the impact of short availability in detail in this section.

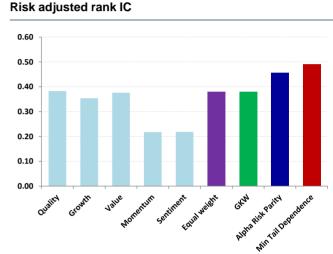
Comparing factor weighting algorithms



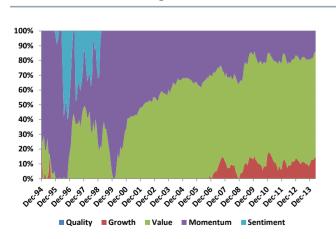
... and the winner is - our proprietary minimum tail dependence model

- Equally weighting
- Grinold & Kahn (i.e., mean-variance optimization)
- Alpha risk parity
- Minimum tail dependence

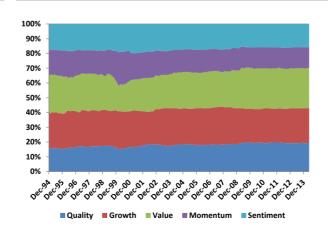




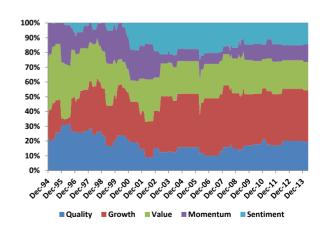
Grinold & Kahn factor weights



Alpha risk parity factor weights



Minimum tail dependence factor weights



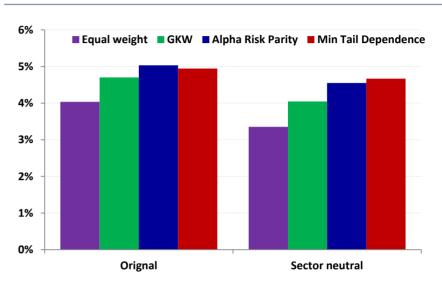
Country and sector neutralization



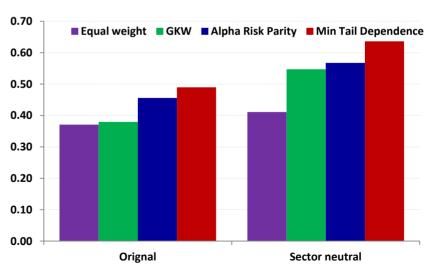
Risk control at the model building stage

- Traditionally, analysts focus on model building, while portfolio managers are responsible for risk control at the portfolio level. In this section, we show the benefit of adding some risk control at the alpha model construction stage.
- Company characteristics (e.g., valuation, growth profile, and profitability) vary greatly from country to country, and from industry to industry. A model that ranks stocks regardless of their country/sector essentially engages in not only stock selection, but also country/sector rotation.
- One way to make our stock selection model more robust and less volatile is to control for country/sector difference via a technique called neutralization.

Average rank IC



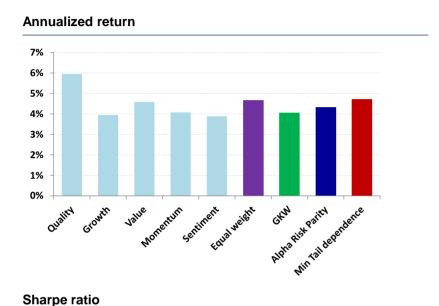
Risk adjusted rank IC

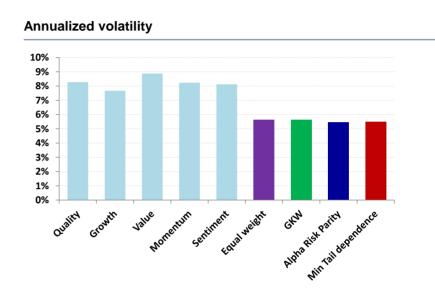


Smart beta investing via factor portfolios

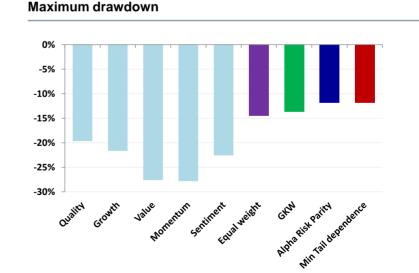


Each factor portfolio is constructed on mean-variance optimization with realistic constraints





1.0 0.9 0.8 0.7 0.6 0.5 0.4 0.3 0.2 0.1 0.0 Chair Growth Growth Walle Servinger Charles of the County of the Coun



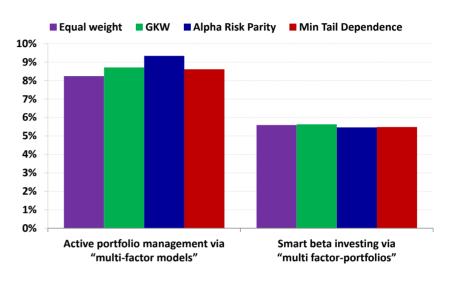
Active portfolio management versus smart beta investing



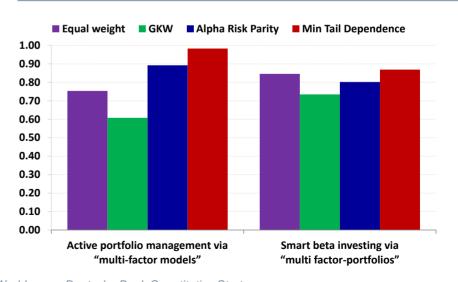
Pros and cons

- Active portfolio management via multi-factor models tend to have higher realized risk than smart beta portfolios. The second stage optimization in multi factor-portfolios further reduces risk.
- Active portfolio management via multi-factor models tend to produce higher Sharpe ratios – especially with more sophisticated portfolio construction techniques like alpha risk parity and minimum tail dependence, as these models are more efficient than multi factor-portfolios.
- The biggest benefit of smart beta via multi factor-portfolios is that it empowers asset owners by providing additional investment instruments to their asset allocation strategies.
- To add value, active managers need to have more unique and proprietary factors in their multi-factor models.

Realized portfolio risk



Sharpe ratio



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The views expressed in this report accurately reflect the personal views of the undersigned lead analyst(s). In addition, the undersigned lead analyst(s) has not and will not receive compensation for providing a specific recommendation or view in this report. [Yin Luo, Miguel-A Alvarez, Javed Jussa, Sheng Wang, Allen Wang]

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