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Global Equity Quantitative Strategy
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The puzzling relationship between risk and return

March 16, 2011

Passion to Perform

QWAFAFEW New York

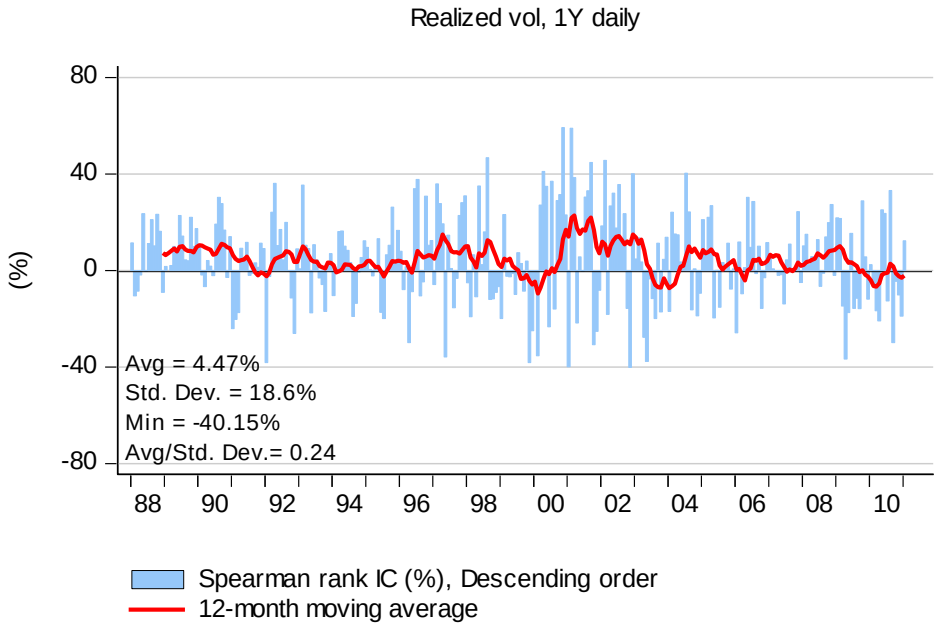
Theory and empirical analysis don't always match

One of the biggest puzzles in finance

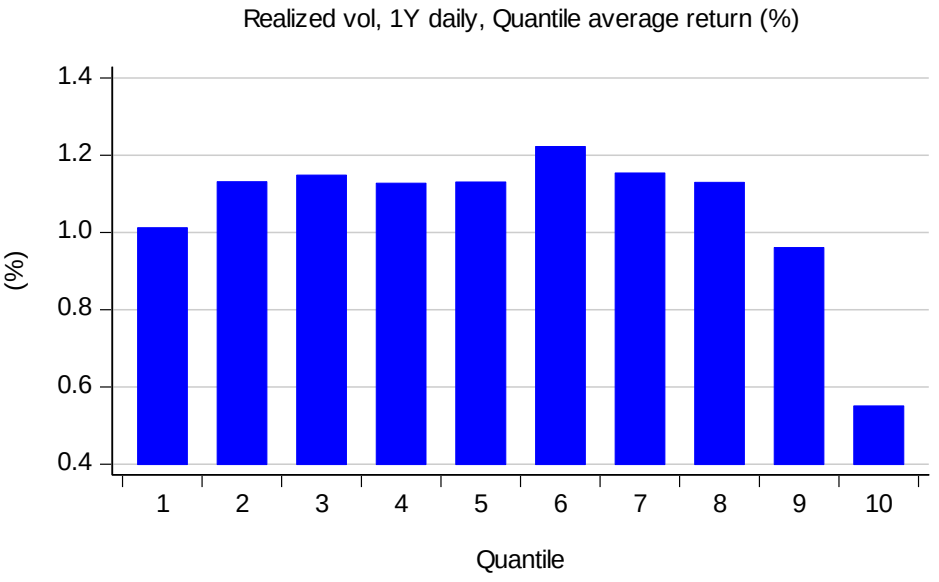
— Finance theory suggests that riskier stocks should have higher returns to compensate investors for taking the extra risk.

— Empirically, riskier stocks tend to deliver lower subsequent realized returns.

Realized volatility, Spearman rank IC



Realized volatility, average decile portfolio returns



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

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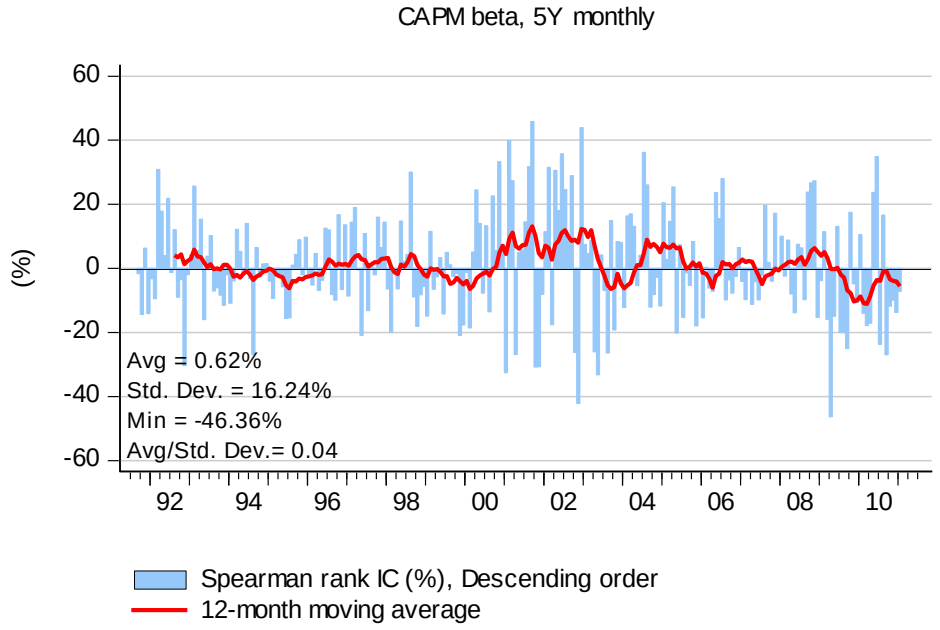
It's not just realized volatility

It works for almost all types of risk measures

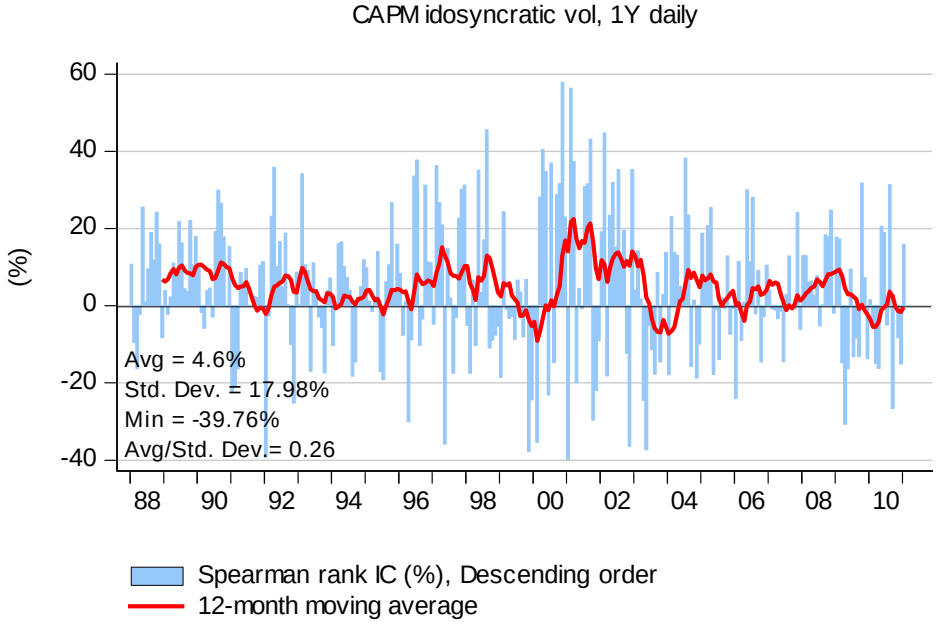
— This risk/return anomaly is not unique to realized volatility.

— If we perform the backtesting using idiosyncratic volatility, beta, options implied volatility, kurtosis, etc., we find the same pattern.

Beta, Spearman rank IC



Idiosyncratic volatility, Spearman rank IC



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

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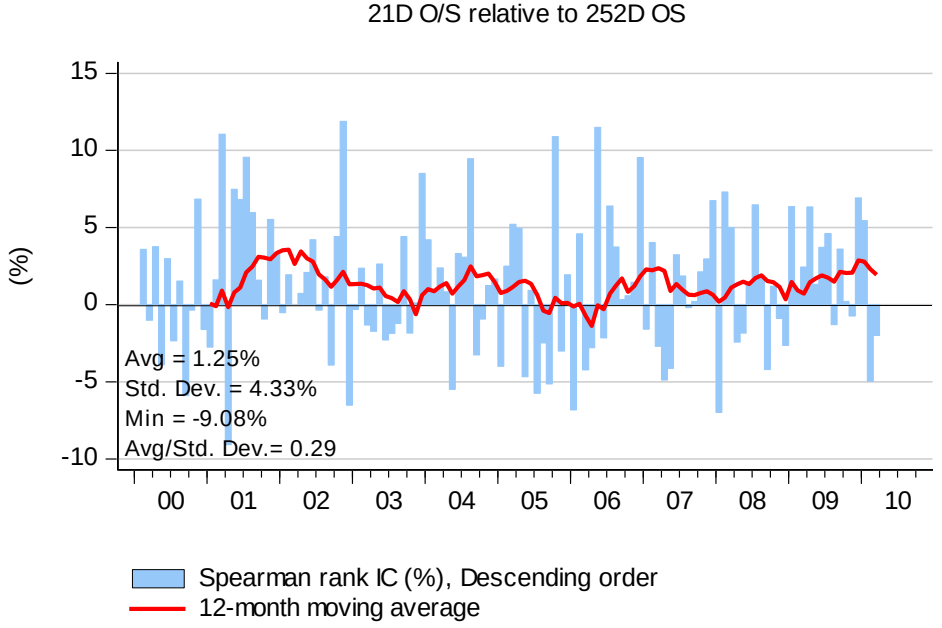
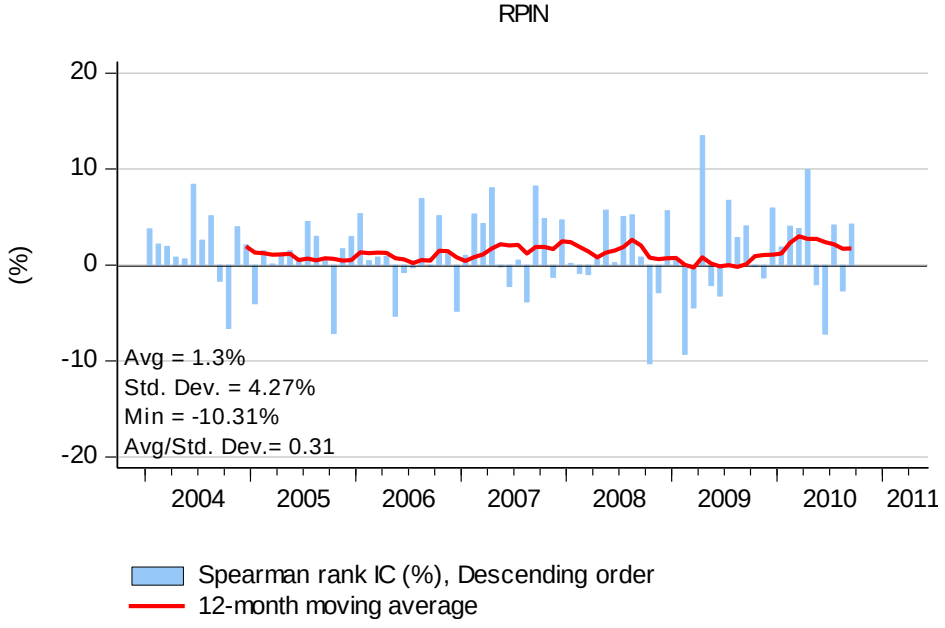
The risk/return anomaly also applies to information risk

- In our research, we measure information risk using two factors.
- O/S ratio. If we assume options traders are better informed, higher options trading relative to the trading volume of the underlying stocks would suggest higher information risk.
- RPIN. Another way to measure information risk is to use tick-by-tick high frequency data to calculate the probability of informed trading. We make further adjustments by removing the volatility, size, and liquidity biases.

O/S ratio, Spearman rank IC



RPIN, Spearman rank IC



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

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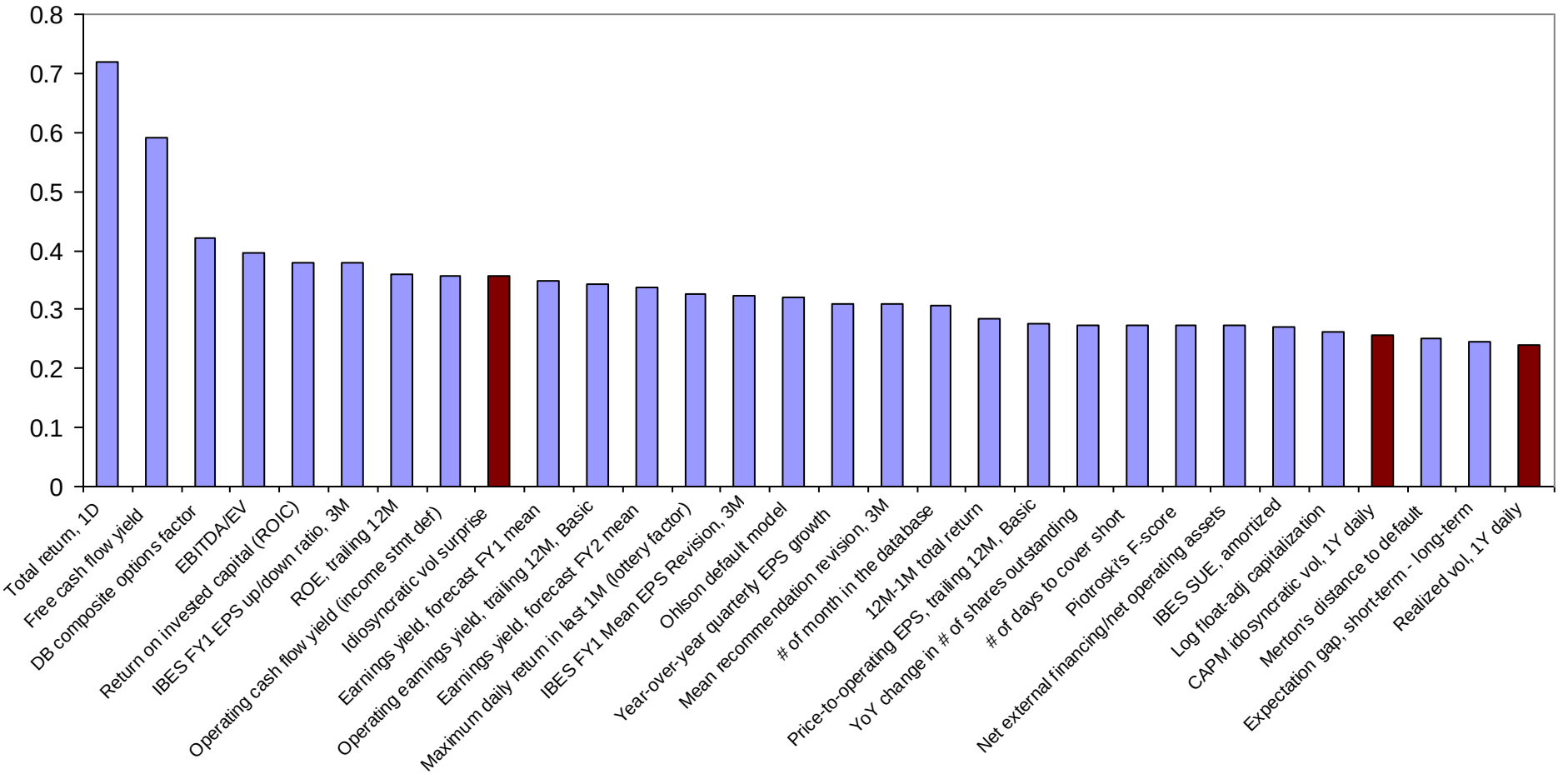
What can explain the risk/return anomaly?

- Baker, Bradley, and Wurgler [2011] gives two interesting explanations.
- The irrational preference for high volatility
  - Preference for lotteries
  - Representativeness
  - Overconfidence
- Benchmarks as limits to arbitrage
  - Portfolios constructed (optimized) against a market-cap weighted benchmark, without using leverage, typically means that managers won't overweight an undervalued low-beta stock until its alpha exceeds a high threshold.

Risk factors are actually good alpha factors

Risk factors rank well compared to traditional “alpha” factors

Factor performance ranking



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

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Enhanced minimum variance as a defensive strategy

Minimum variance portfolios

— Touted as the “magic formula” that produces superior risk-adjusted performance without the need for return forecasts.

Is the strategy what it claims to be?

— We find that far from being passive, the strategy depends on outperformance of stocks with low common factor risk.

— In contrast to most perceptions, it is not a pure low-volatility strategy.

Properties

— We outline its properties both empirically and analytically.

— The strategy is aligned against beta.

— The strategy is uncorrelated with most active strategies.

Constraints do not work

— We show that beta, sector or style constraints will rarely work.

An Enhancement that works

— An enhancement that works.

— Combining the strategy with an alpha model can improve IR.

Quantitative Strategy
North America United States

Deutsche Bank

9 February 2011

Global Markets Research

Portfolios Under Construction

Minimum Variance: Exposing the "magic"

Minimum Variance Portfolios
The minimum variance portfolio has been touted as the "magic" formula that generates superior risk-adjusted returns. We analyze and dissect the strategy to discover its secrets and vulnerabilities and propose an enhancement that works.

The Minimum Variance Portfolio Strategy

The minimum variance portfolio strategy is not a low-risk strategy
The common perception that the minimum variance portfolio strategy is a low-risk strategy is not entirely true. We find and show that the short-side of the portfolio can sometimes turn into a high-risk stock strategy.

Minimum variance portfolios are great diversifiers
We find some fascinating and useful properties about minimum variance portfolios. In particular, we show why they tend to possess very little correlation with traditional quant strategies.

Constraints on beta, styles and industries DO NOT work
Similar to other research, we find that adding constraints or neutralizing the portfolio against beta, style and industries does not work. However, we show why we find this is the case and show that neutralization could only serve to change the nature of the strategy.

An enhancement that works
We propose a slight and simple enhancement to the strategy, which offers protection for one of its vulnerabilities, while not veering the strategy from its intended purpose.

Adding it to an alpha-strategy
We show that adding the minimum variance strategy or our enhancement to an alpha-model can add significant value in terms of risk-adjusted performance. We attribute to the diversification benefit of the strategy.

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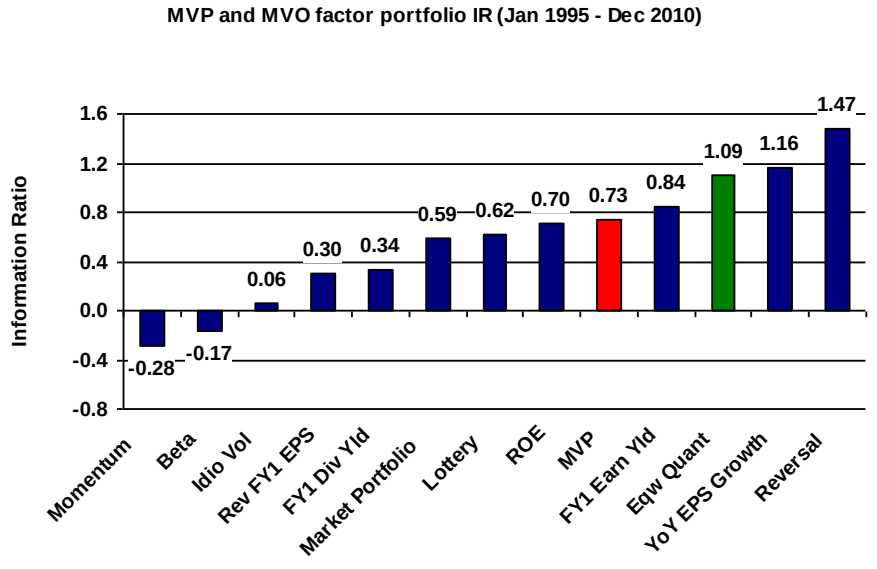
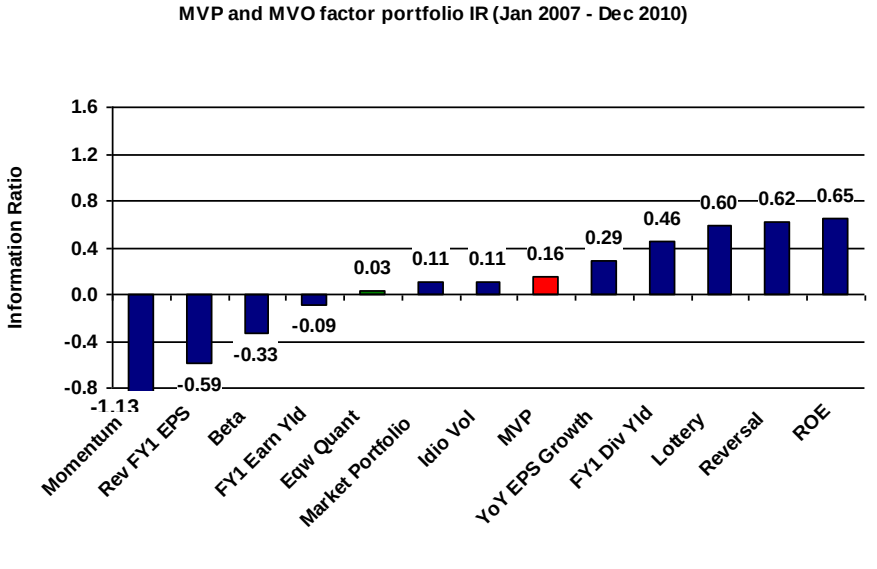
The Minimum Variance Portfolio (MVP) strategy

- The minimum variance strategy is not passive. It is more like an active strategy.
- It makes the implicit assumption that a portfolio with minimum risk will outperform.
- But what does this mean? Is it just like any other low-volatility strategy?
- Not entirely! Minimizing portfolio risk doesn't imply that the strategy will outperform when investors become risk-averse or when low risk stocks outperform higher.

Superior risk-adjusted performance: Jan 1995 – Dec 2010



Less so in the recent period: Jan 2007 – Dec 2010

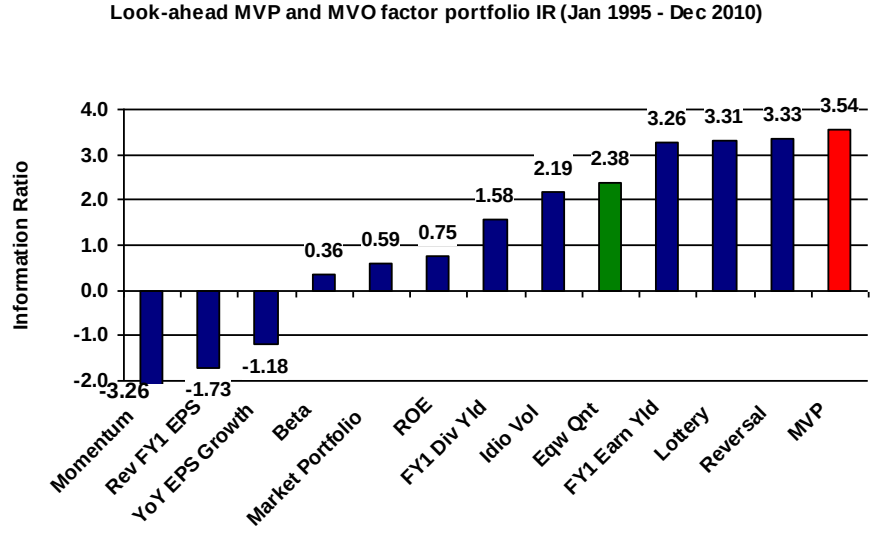


Source: Axioma, Bloomberg Finance LP, Compustat, Haver, IBES, Russell, S&P, Thomson Reuters, Deutsche Bank

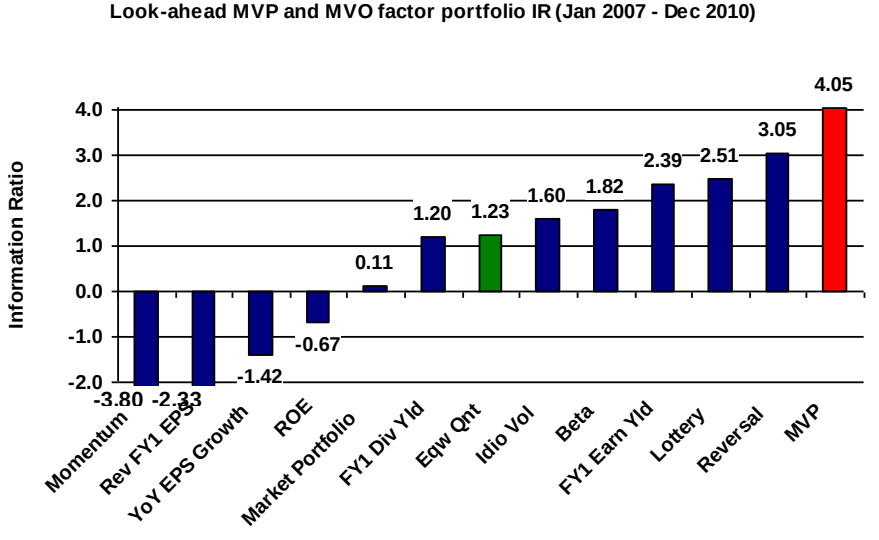
Does portfolio minimization really payoff?

- No argument that low-risk strategies produce superior returns. There are many examples: options risk sentiment, informational risk (high frequency), credit-risk, etc.
- But MVP is not necessarily a low-risk strategy – no real theory that says it works?
- Run backtests using next-months covariance matrix – if backtests don't improve then risk minimization is probably not too important.
- Results are spectacular. Improvement comes from better returns not risk control.

MVP, MVO factor portfolios with look ahead risk model



Recent period does even better: Jan 2007 – Dec 2010



Source: Axioma, Bloomberg Finance LP, Compustat, Haver, IBES, Russell, S&P, Thomson Reuters, Deutsche Bank

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MVP formulation

— Conventional formulation:

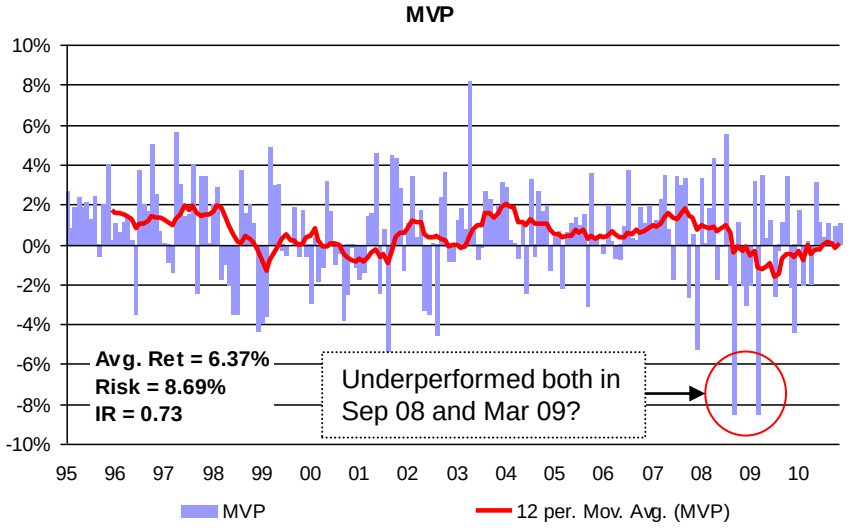
$$\min_h \boldsymbol{h'Vh} \quad \text{such that} \quad \boldsymbol{h'1} = \boldsymbol{1}$$

— Alternative mean-variance formulation (use a vector of 1's for the alpha):

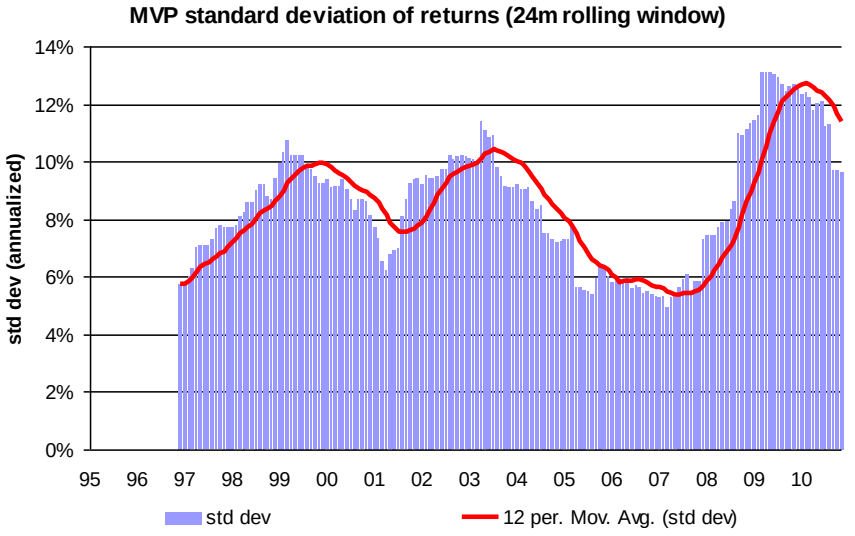
$$\max_h \boldsymbol{h'1} - 2\lambda \boldsymbol{h'Vh} \quad \text{such that} \quad \boldsymbol{h'1} = \boldsymbol{1}$$

— The net weight constraint is arbitrary – it actually causes a range of problems.

MVP returns over time



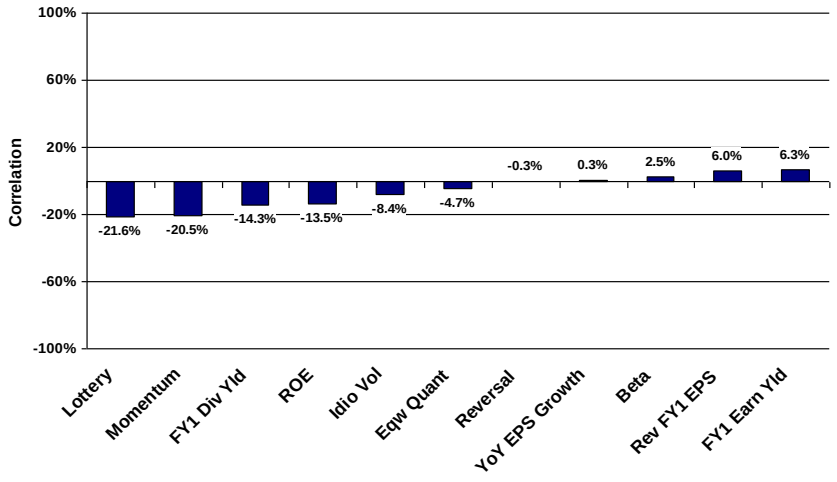
MVP realized volatility (24M rolling window)



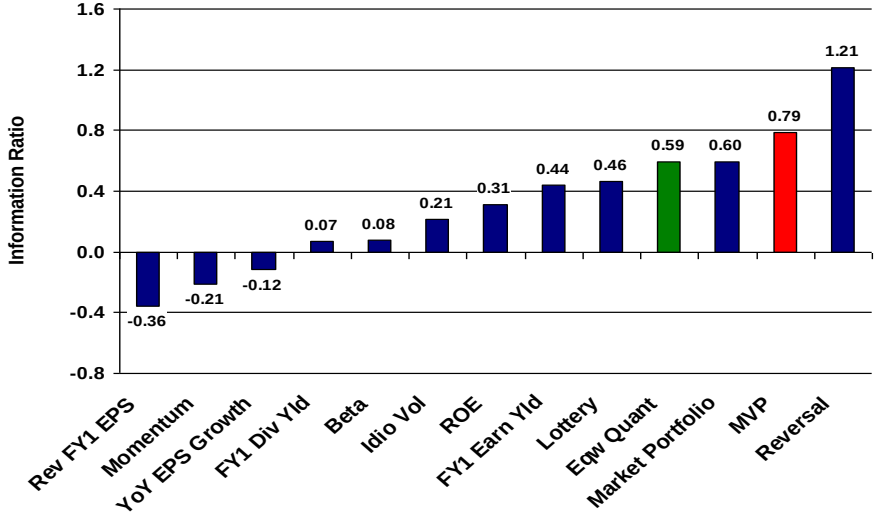
Source: Axioma, Bloomberg Finance LP, Compustat, Haver, IBES, Russell, S&P, Thomson Reuters, Deutsche Bank

Very useful properties

MVP correlation with other strategies (Jan 95 – Dec 10)



IR for Russell 1000 universe (Jan 95 – Dec 10)



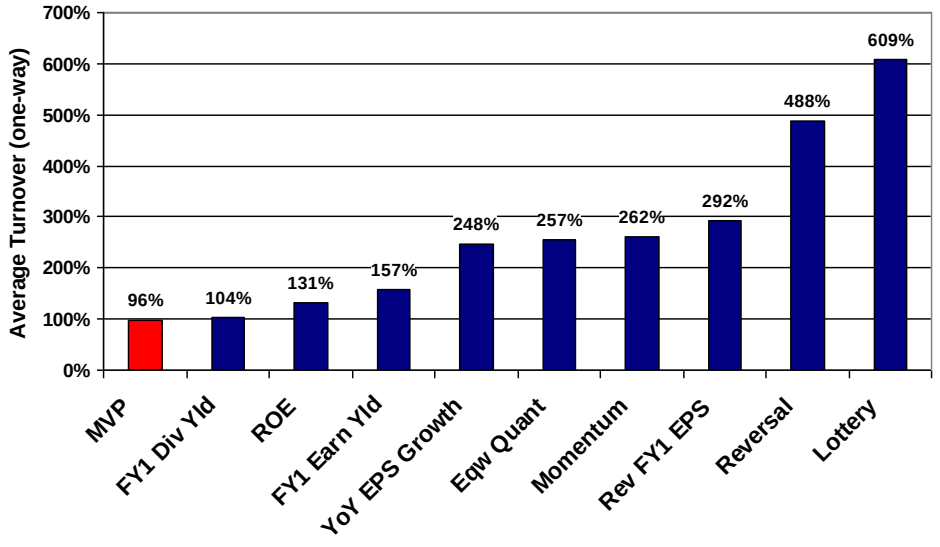
- Correlation with traditional quant factor portfolios is negligible.
- Correlation with quant factor z-scores is also negligible.
- Mathematically it can be shown that ex-ante correlation with factor z-scores is 0.

- Historically has worked well in large cap universe relative to other conventional quant factors.
- Recently (after Jan 2007) performance has been flat and more comparable to other quant factors.

Source: Axioma, Bloomberg Finance LP, Compustat, Haver, IBES, Russell, S&P, Thomson Reuters, Deutsche Bank

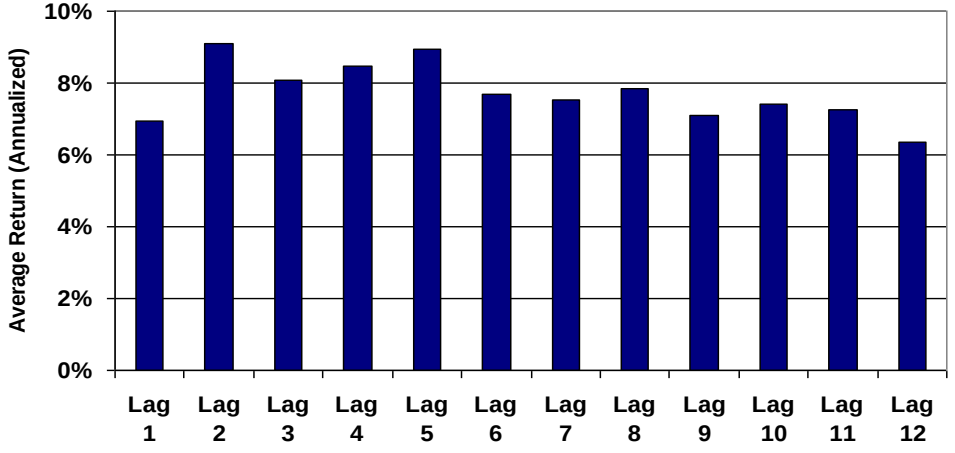
Even better properties

Turnover: MVP, factor portfolios (Jan 95 – Dec 10)



- Run all factor portfolios at the same ex-ante risk and compute turnover.
- MVP turnover is significantly lower than that for most quant strategies.
- However, it has increased since 2007; likely due to stronger changes in volatility.

MVP performance decay (Jan 95 – Dec 10)



- Performance decay is very slow. Can mix with faster signals to improve after t-cost performance.
- Decay has increased since 2007. This could be due to higher turnover and arbitrage decay.

Source: Axioma, Bloomberg Finance LP, Compustat, Haver, IBES, Russell, S&P, Thomson Reuters, Deutsche Bank

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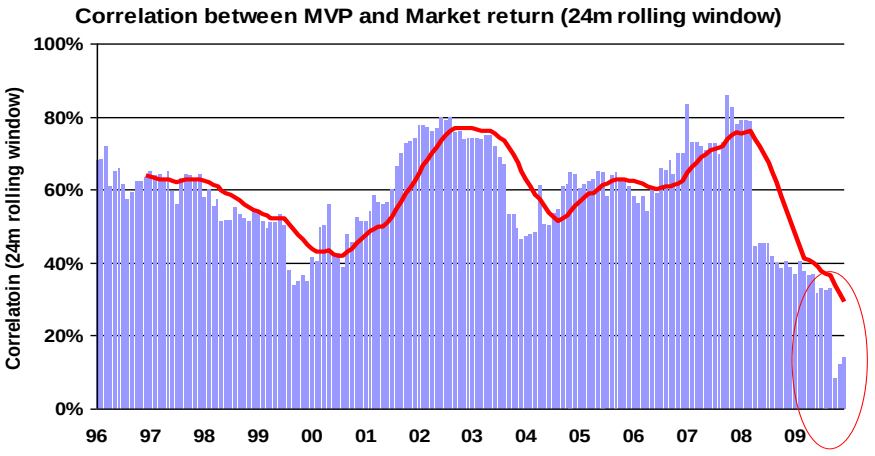
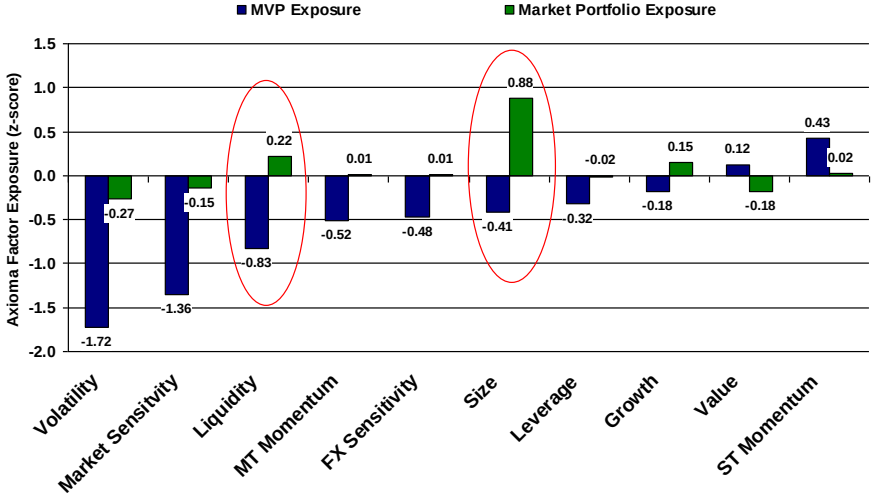
Other properties

Correlation with market returns (24-month window)



- Correlation with the market is historically high.
- However the correlation has come down recently. Why?
- The answer is that the correlation with the market (and any portfolio) is inversely related to its volatility.

Risk factor exposures relative to market (Jan95 – Dec10)



- The MVP strategy has the particularity that it loads up on small cap and illiquid stocks.
- This is because the long side of the portfolio underweighs these stocks while the short side of the portfolio overweighs (less short) them.
- These exposures have normalized recently.

Source: Axioma, Bloomberg Finance LP, Compustat, Haver, IBES, Russell, S&P, Thomson Reuters, Deutsche Bank

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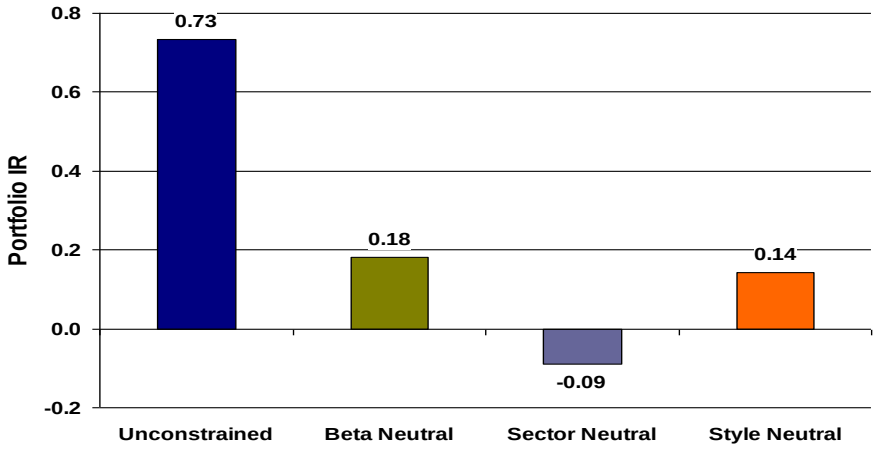
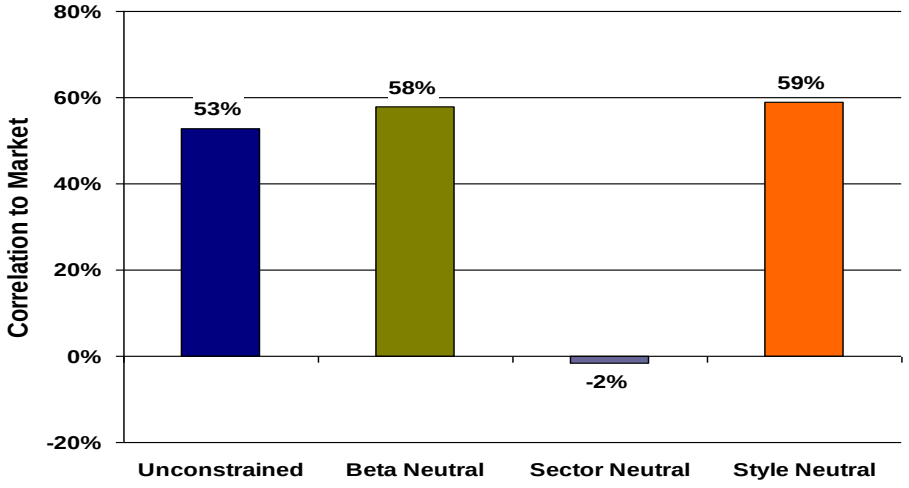
Constraints do not work

IR: Unconstrained vs. constrained (Jan95 – Dec10)



Correlation to the Market portfolio (Jan95 – Dec10)



- Constraining the MVP for beta, sectors or styles does not work.
- In fact, with exception to the sector constraint, every other scheme increased risk.
- Sector constrained decreased risk by less than 10% of unconstrained but performance is terrible.

- With exception to sector constrained the resulting portfolios demonstrated to be more correlated with the market.
- It can be shown mathematically, that conventional neutralization techniques do not work to remove the correlation with the market.

Source: Axioma, Bloomberg Finance LP, Compustat, Haver, IBES, Russell, S&P, Thomson Reuters, Deutsche Bank

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A simple and intuitive characterization

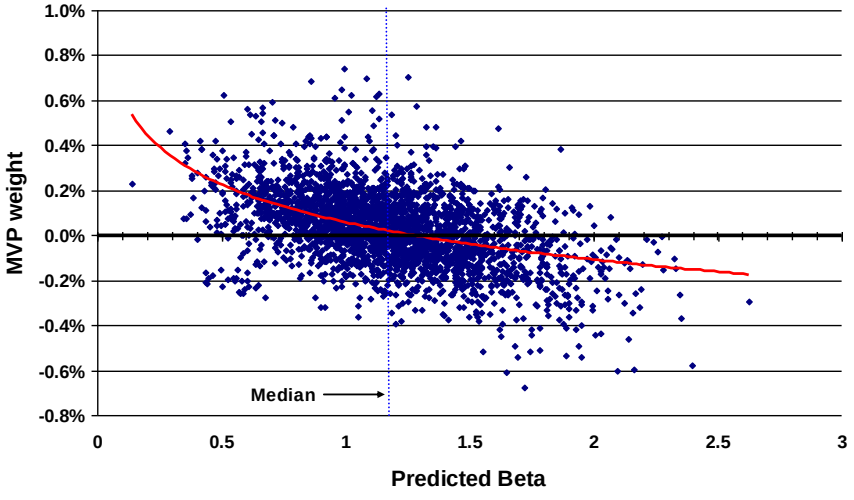
— Under a one-factor model (can be generalized) the holdings are given by:

$$h_i = \frac{\sigma^2_{MVP}}{\sigma^2_{\varepsilon,i}}\left(1 - \frac{\beta_i}{\beta_{LS}}\right) \quad \text{or} \quad h_i \approx \frac{\sigma^2_{MVP}}{\sigma^2_{\varepsilon,i}}\left(1 - \beta_i\right)$$

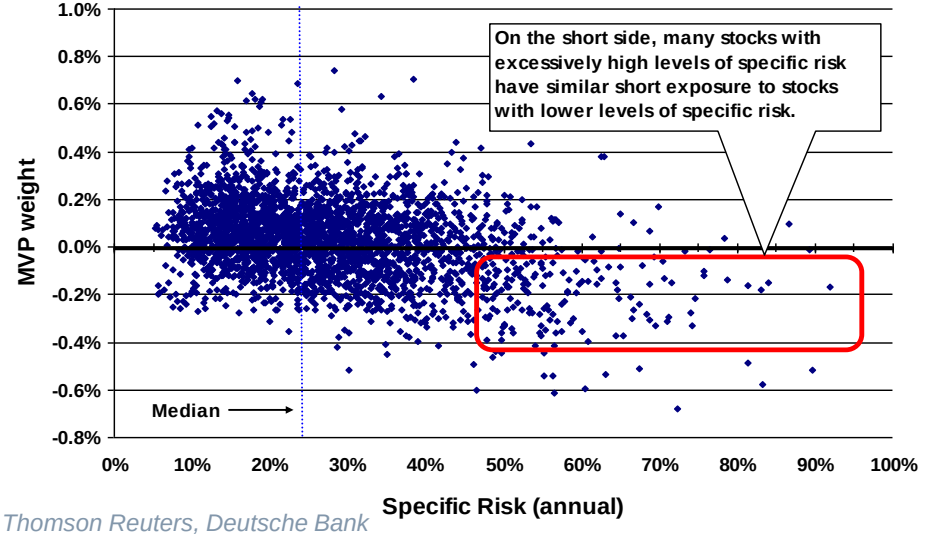
— The strategy is a negative Beta play: underweight high beta stocks, but less so on the short-side due to the correlation between Beta and Idio-Vol.

— Idio-Vol plays a controversial role. Causes the short-side of the portfolio to overweight high Idio-Vol stock. Not necessarily a low-volatility strategy.

MVP weights vs. Predicted Beta (Dec 2010)



MVP weights vs. Specific risk (Dec 2010)



Source: Axioma, Bloomberg Finance LP, Compustat, Haver, IBES, Russell, S&P, Thomson Reuters, Deutsche Bank

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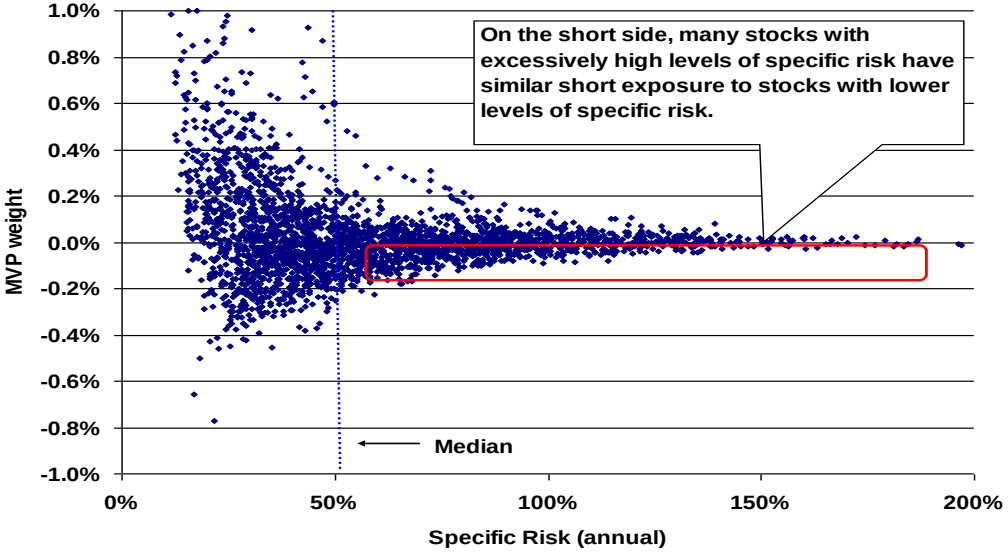
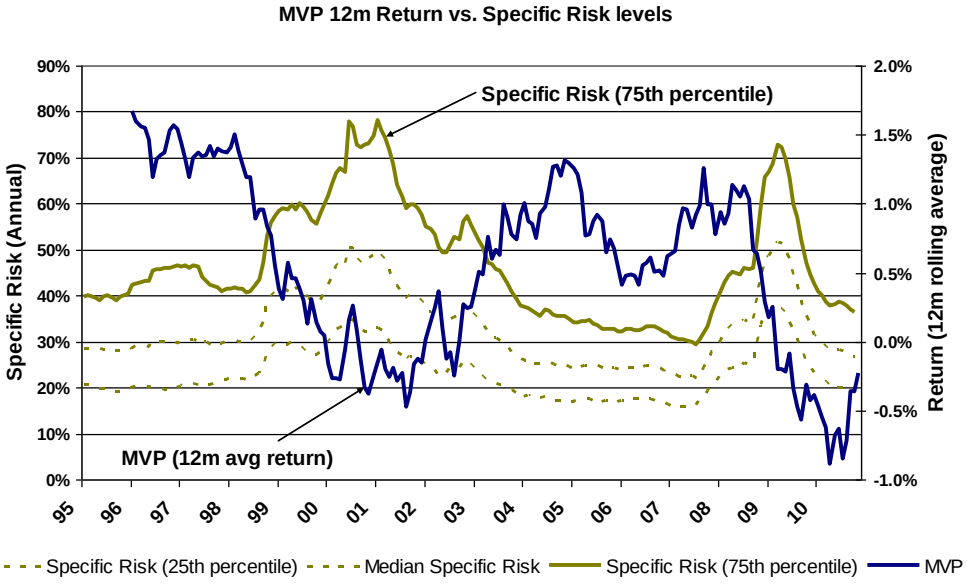
A vulnerability

- When idiosyncratic risk is at high levels the MVP strategy no longer resembles a low-risk strategy!
- Look at relationship between the weights and idiosyncratic risk during Jan 2001, a period when idiosyncratic risk was at high levels (beta is also affected).
- During Jan 2001 the short-side of the MVP is overweight (less short) and high idiosyncratic volatility stocks and vice-versa. From prior research this is dangerous!
- Performance is inversely related to idiosyncratic (specific) risk levels!

MVP weights vs. Specific risk (Jan 2001)



MVP 12m average performance vs. Specific Risk levels

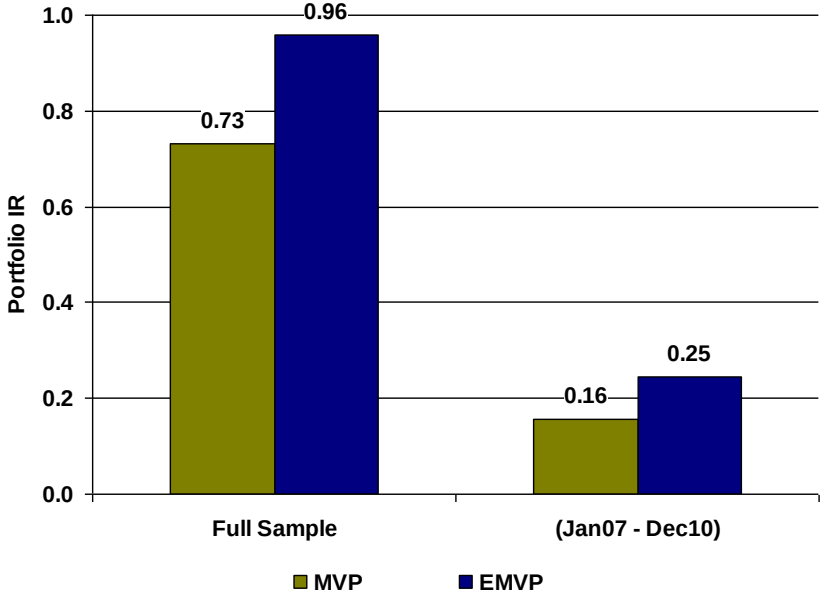


Source: Axioma, Bloomberg Finance LP, Compustat, Haver, IBES, Russell, S&P, Thomson Reuters, Deutsche Bank

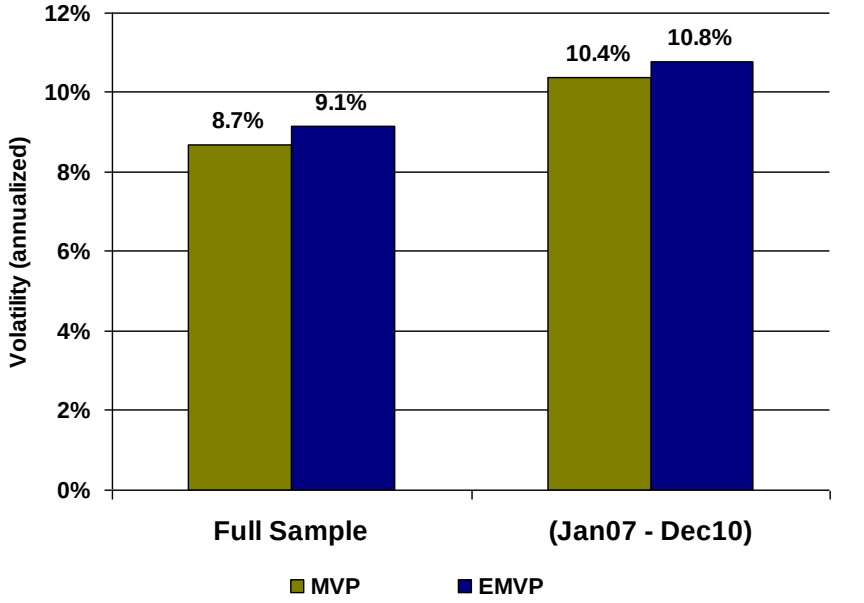
A Slight and Simple Enhancement

- Following the simple Beta/Idio-Vol characterization, we can generalize to show that specific risk plays the same ambiguous role in a multi-factor setting; i.e. causing the short side of the portfolio to implicitly overweight (less short) volatile stocks.
- ENHANCEMENT: replace stock-specific risk with universe average (or median) and then compute the asset covariance matrix used for MVP. Can be thought as shrinkage.
- Now the strategy is play against stock common factor risk (similar to beta play).
- Better IR for very little extra portfolio risk. Also less correlated to the market ~ 40%.

EMVP vs. MVP risk-adjusted return (IR)



EMVP vs. MVP realized volatility



Source: Axioma, Bloomberg Finance LP, Compustat, Haver, IBES, Russell, S&P, Thomson Reuters, Deutsche Bank

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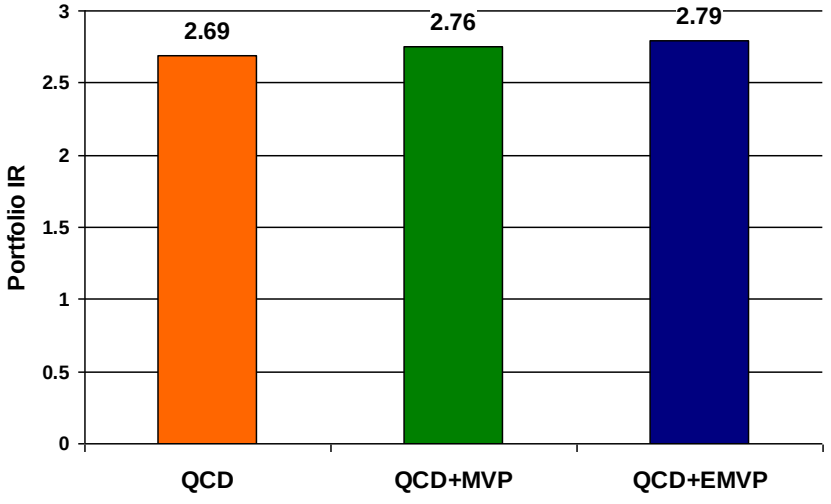
Good match with alpha strategies

— Can show that the expected correlation of the MVP with any portfolio is directly proportional to the net holdings of the portfolio and inversely to the portfolio's risk:

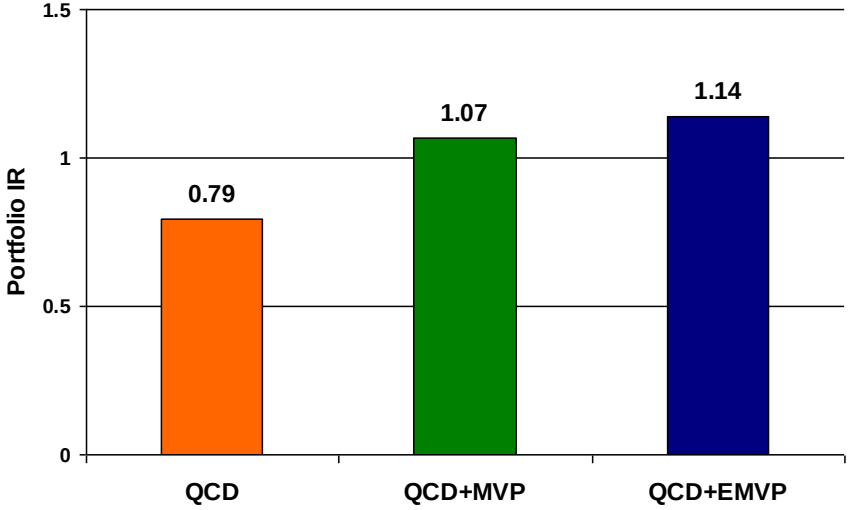
$$corr\left(r_{MVP}, r_P\right) = \frac{\sigma_{MVP}}{\sigma_P} \sum_i h_{p,i}$$

— Quant portfolio weights are typically balanced so correlations are low. Can be a great diversifier and can reduce total turnover. Works especially well when the net weight of the alpha implied portfolio is negative (since the correlation will be negative). A simple way to mix the portfolios is to assume E(MVP)=0 and Corr=0, then use the Grinold & Kahn (1999) mean-variance optimization approach.

Portfolio IR (Nov 1999 – Dec 2010)



Portfolio IR (Jan 2007 – Dec 2010)



Source: Axioma, Bloomberg Finance LP, Compustat, Haver, IBES, Russell, S&P, Thomson Reuters, Deutsche Bank

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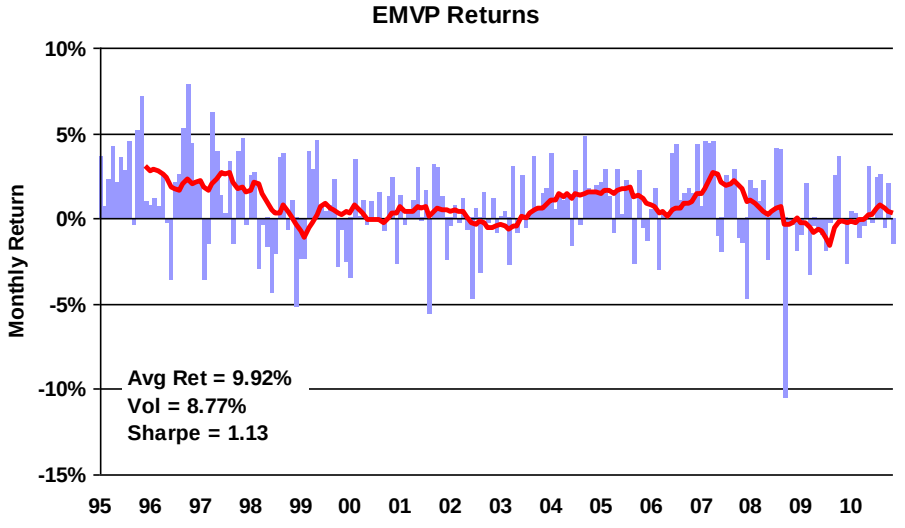
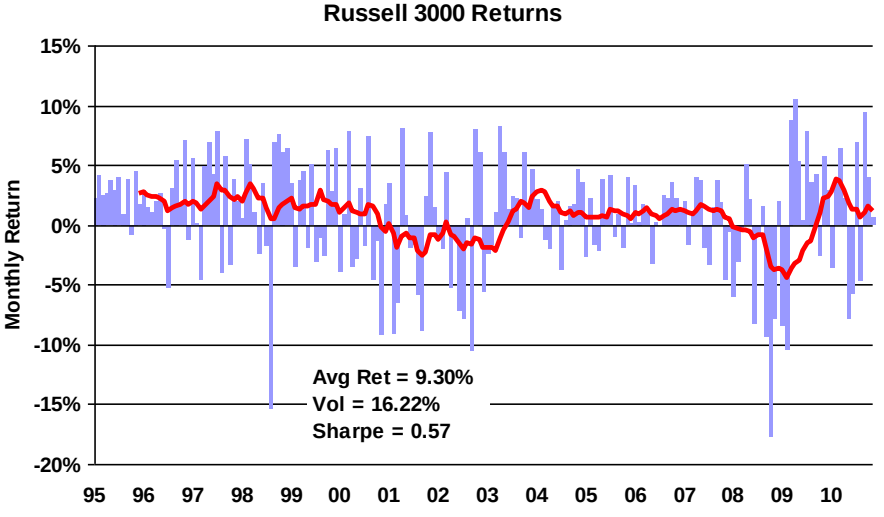
Creating a real MPV portfolio

- The holdings constraint leads to unrealistic portfolios with too much leverage.
- One nice property is that the MVP portfolio doesn't lose its optimality by changing the net weight constraint. The only limitation is that you cannot choose your net weight to be 0.
- Do not set constraints or neutralize…
- Settings:
  - Use a risk target of 6% - this will implicitly set the net-weight.
  - Use 20bps cost in the objective function to keep turnover low
  - Set turnover constraint to 40% two-way.

EMVP return, realized volatility and Sharpe ratio



Russell 3000 return, volatility and Sharpe ratio



Source: Axioma, Bloomberg Finance LP, Compustat, Haver, IBES, Russell, S&P, Thomson Reuters, Deutsche Bank

Factor neutralization as a defensive strategy

Quant factor exposure to volatility

- We find that common quant factors may have inherent and significant exposure to volatility
- We also find that that exposure to volatility can significantly impact performance

Factor neutralization can:

- Improve factor performance
- Protect against sudden and significant changes in risk-aversion
- Provide greater factor diversification
- Controls for risk with less factor distortion

Global Markets Research

Quantitative Strategy

Quantitative Strategy
North America United States

Deutsche Bank

16 June 2010

Portfolios Under Construction

Volatility = 1/N

Key summary
This research studies the dynamic relationship between quantitative factors and volatility. We find that quant factors have an inherent and significant volatility exposure and that controlling for this exposure can lower risk, increase factor performance and provide diversification.

Quantitative factors and the effects of volatility

Quantitative factors have significant exposure to volatility
In this report, we find that quantitative factors can have inherent and significant exposure to volatility. In addition, we find that this exposure can significantly impact their performance during episodes of investor de-risking and re-risking.

Neutralizing volatility exposure
We show a simple technique that can be used to mitigate the impact of volatility in any quant factor. We find that this technique will safe-guard factors from sudden changes in investor risk-aversion, improve factor performance over time, and provide better factor diversification. In addition, we show how this method can be used as a substitute to mean-variance optimization with surprising efficacy.

Avoiding the "value trap"
We find that during episodes of high uncertainty, value factors are more likely to fall into the infamous "value trap". We show a simple method that can be used to safe-guard against this phenomenon.

May 2010 and what to expect for June
We report on the impact that volatility had in May 2010 factor performance, and show how some quant factors are positioned for uncertainty in June 2010.

For clients in Europe, you can also contact our colleagues Altaf Kassam or Spyros Mesomeris at (+44 20 754 71684 or email dbeqs.global@db.com

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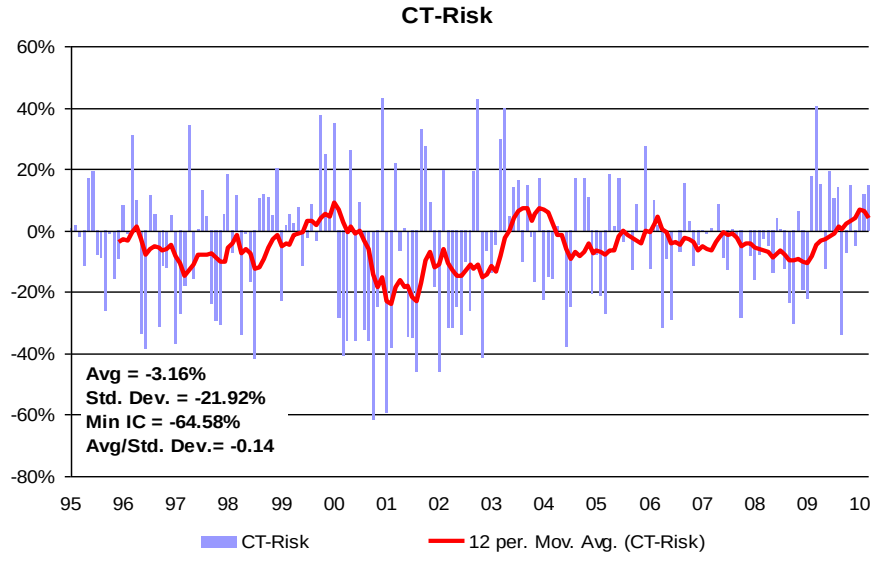
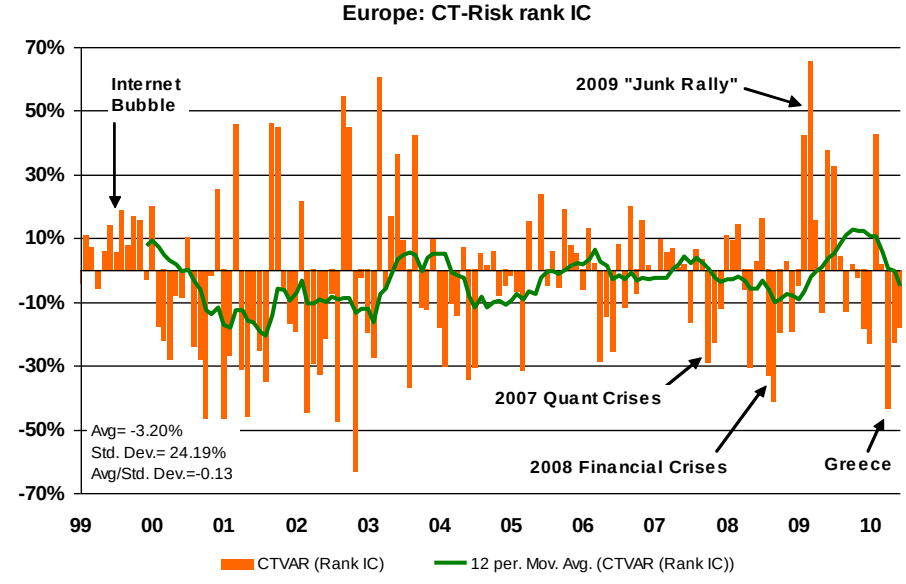
Condensed risk factors (US & Europe)

1) Define the *contribution to risk* (CT-Risk) factor as:

$$score_i = \mathrm{var}(r_i) + \sum_{j \neq i} \mathrm{cov}(r_i, r_j)$$

- Equivalent to ranking stocks by marginal contribution to risk (MCTR) with respect to the universe.
- Use the vendor provided asset-by-asset covariance matrix to estimate variances and covariances.
- Correlation between US and Europe = 76%.





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

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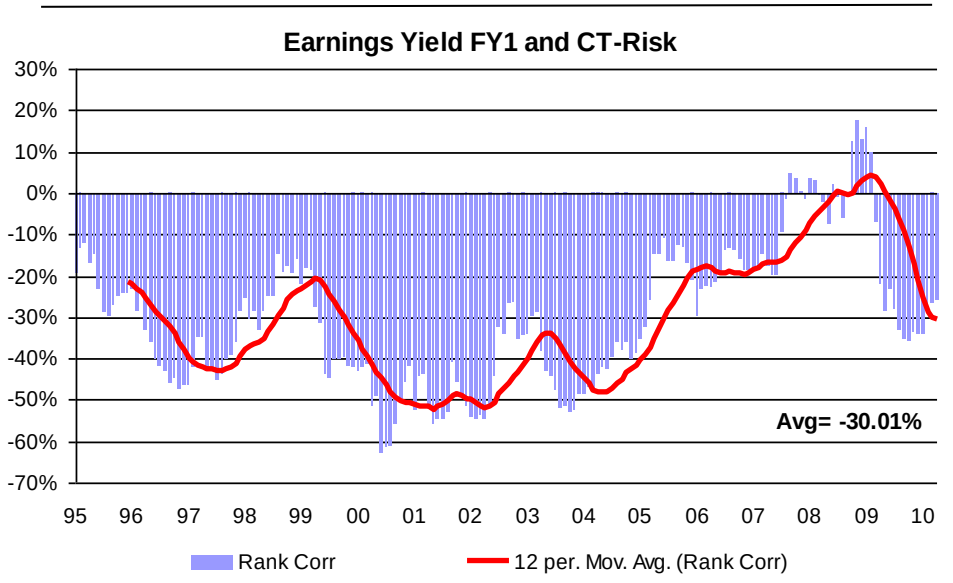
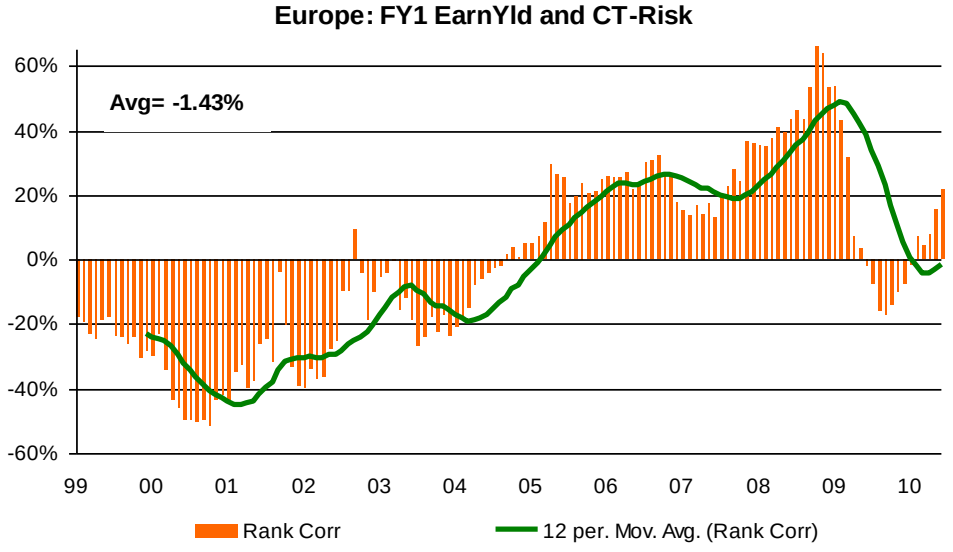
Factor correlation (alignment) with volatility

1) FY1 Earnings Yield

- We find that value factors tend to have an inherent and significant negative alignment with volatility. However, this correlation changes dynamically over time. Higher correlation implies that value is taking on more volatility contributing assets.
- Note the US correlation during July 2007 to end of 2008.
- The US factor suffered slightly during spring 2009 due to a small negative exposure to CT-Risk.
- The European factor benefited due to a positive exposure to CT-Risk.

Rank correlation with CT-Risk factor





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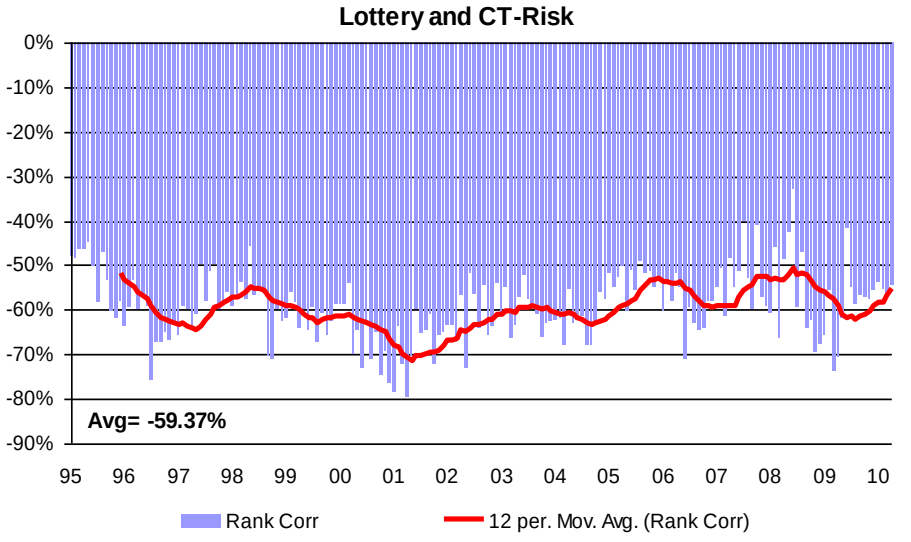
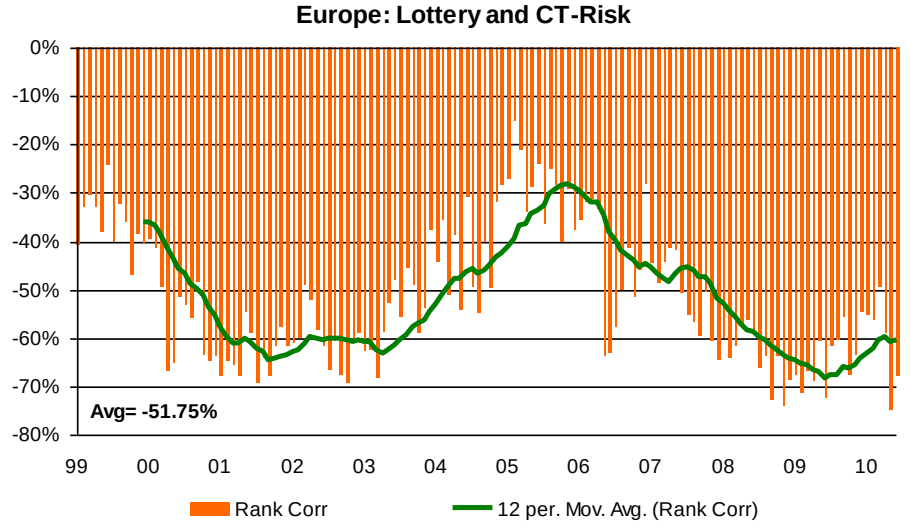
Factor correlation (alignment) with volatility, cont'd

2) Lottery factor:

- Scores stocks by highest one-day return over prior month. Strong consistent negative correlation with volatility since, all else equal, stocks with highest one-day return will be stocks with higher volatility.
- Factor will be misaligned for increases in risk appetite such as the "junk rally" in spring of 2009.
- Factor will be aligned well for increase in investor risk aversion.
- In the US, the correlation is more consistent, but this may be a consequence of the type of universe for each analysis.

Rank correlation with CT-Risk factor





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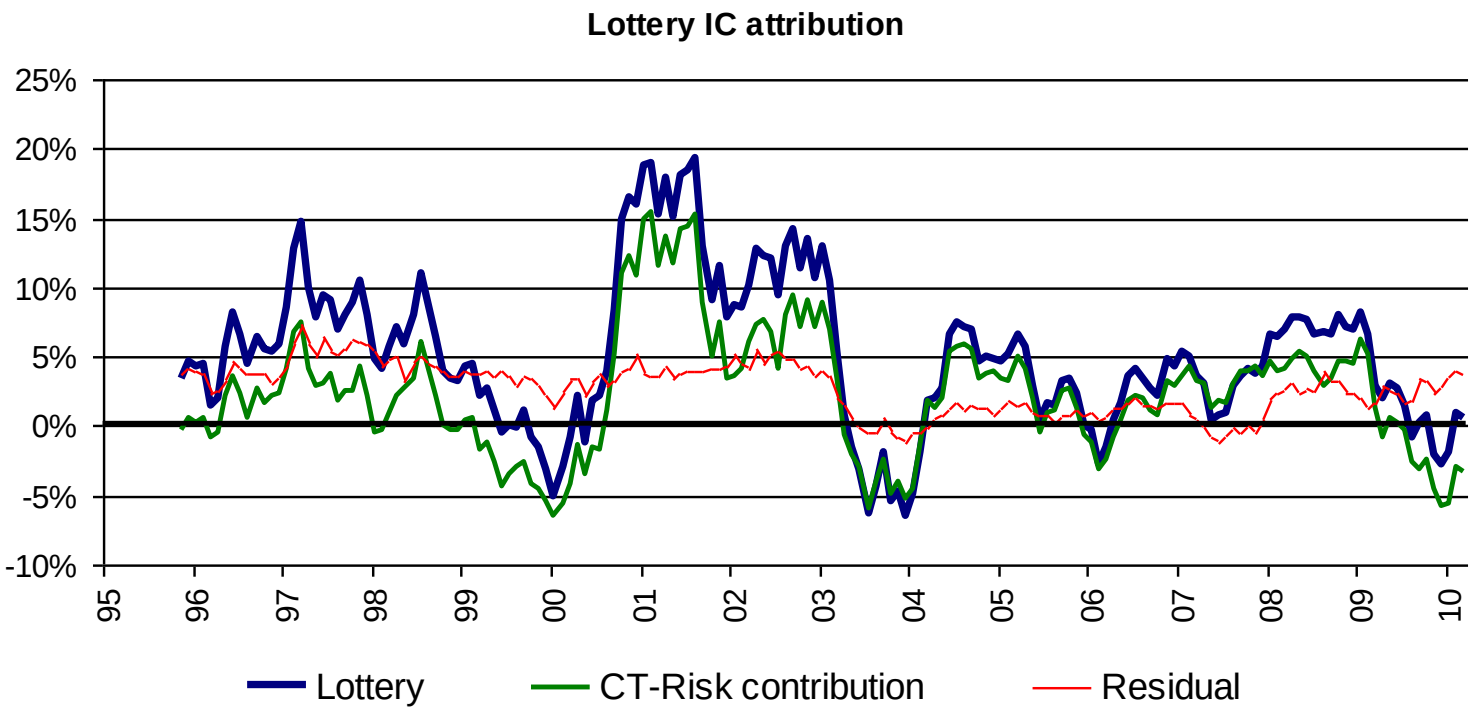
Factor attribution to volatility (US)

We can attribute factor skill (IC) to volatility for Lottery factor



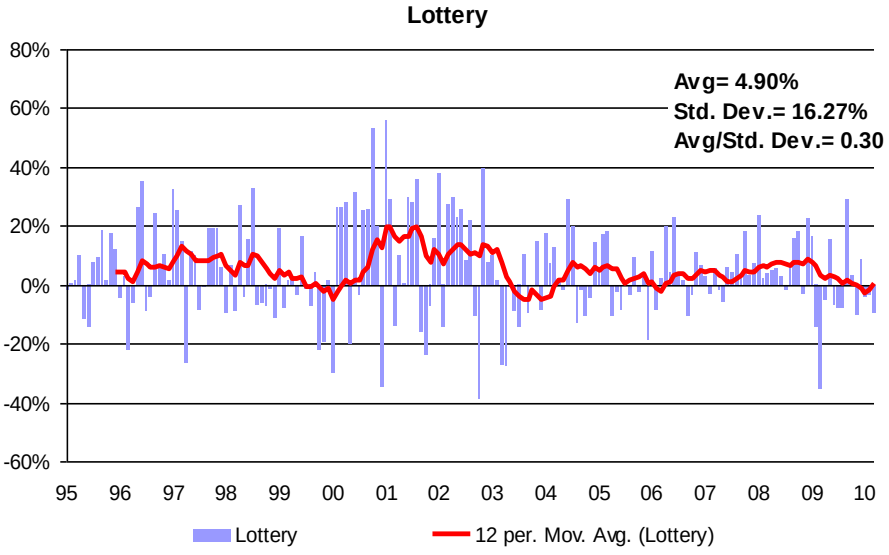
Source: Axioma, Bloomberg Finance LP, Compustat, IBES, Russell, S&P, Thomson Reuters, Deutsche Bank Quantitative Strategy

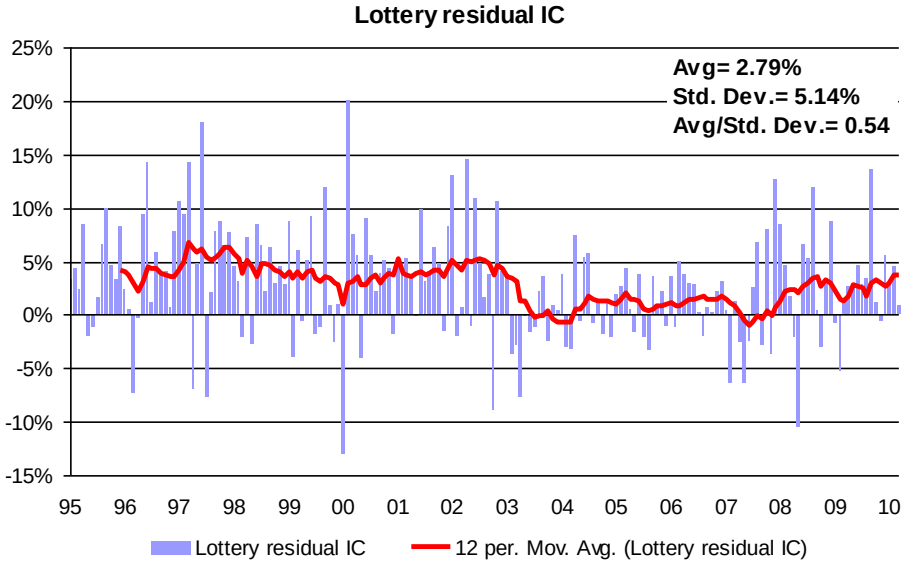
Note the significant amount of IC attributable to volatility. However, the residual component has some appealing properties:

- Consistently positive IC
- Much more stable (less risk)

Factor attribution to volatility, cont'd

The residual component has better risk-adjusted performance, telling us that the factor adds value above and beyond its volatility exposure.





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

Lottery factor attribution summary (Jan 1995 – April 2010)

Component	Average IC	Std Dev of IC	Min IC	Avg/Std ~ IR
Lottery factor (total)	4.82%	16.26%	-38.55%	0.30
CT-Risk	2.03%	13.91%	-36.52%	0.15
Residual	2.79%	5.14%	-12.98%	0.54

Source: Axioma, Compustat, IBES, Russell, S&P, Deutsche Bank

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Neutralizing volatility exposure

We can apply the following neutralization scheme to extract the residual component of a factor to volatility:

$$f_{neut,i} = f_i - \left(\rho_{f,risk} \frac{\sigma_f}{\sigma_{risk}} \right) f_{risk,i}$$

We find neutralization can:

- Improve factor performance
- Protect factors from episodes of sudden and significant changes in risk aversion
- Provide factor diversification

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Appendix 1
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