HSBC EQUITY QUANTITATIVE RESEARCH

Quantitative Research

Beta-blocker revisited

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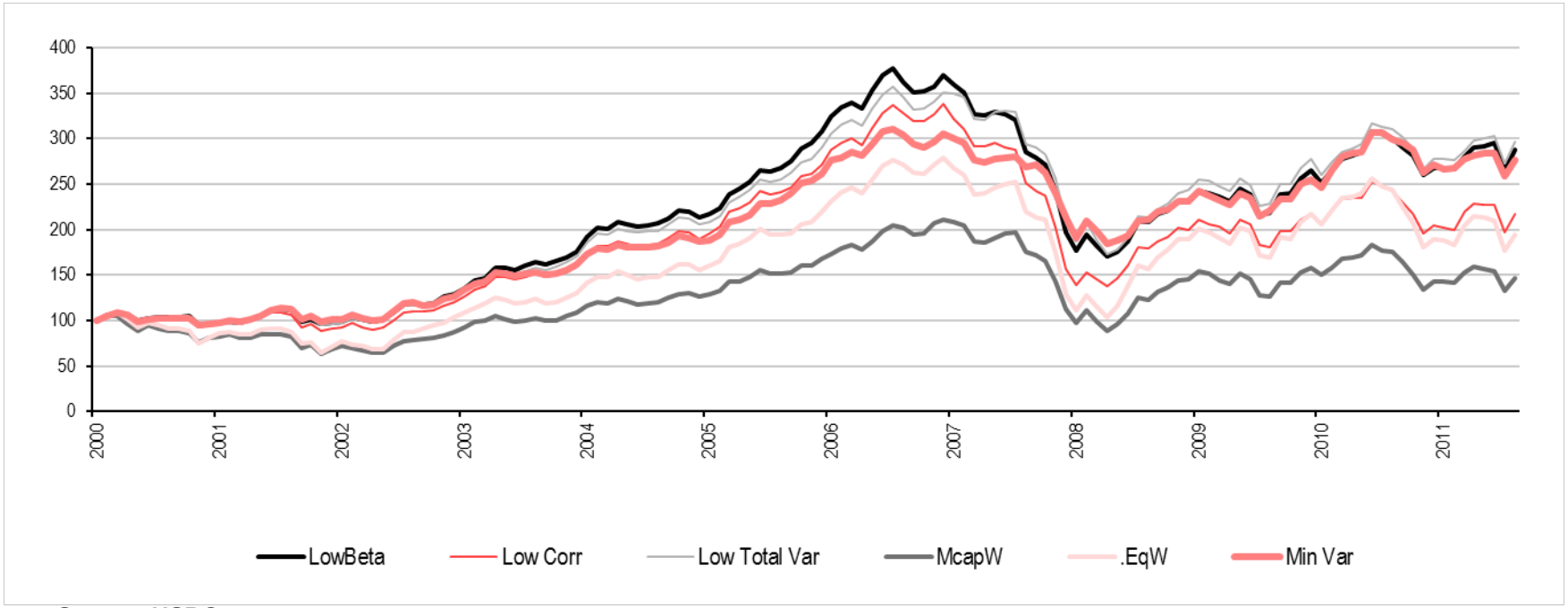
Outperformance with low-risk – the meek shall inherit

European Equities , DJ Stoxx 600 universe – 2000-12 total return performance



Source: HSBC

(See Baker, N L and R A Haugen (2012) *Low Risk Stocks, Outperform within All Observable Markets of the World*, http://ssrn.com/abstract=2055431)

The objective and the challenge

- Objective – high performance during rising market and protection against market downturn
- Historical evidence of low-risk selection outperforming the markets (*where has risk-return trade-off gone?*)
- Low risk portfolio –

I. Minimum variance

- ü **Minimise total risk**
- ü **Optimisation driven**
- ü **Limited diversification**

II. Minimum market risk (low-beta)

- ü **Style – stock characteristic**
- ü **Market risk targeted**
- ü **Diversification – tracking error control**

- Sought – selection criterion for low market risk stocks (what is market beta?)

  Required qualifications – robust, unambiguous, simple to implement, intuitive (performance record)

Stock beta estimation

Formal definition

Stock beta = covariance with the market divided by market variance

- CAPM relation – (systematic) expected return of a stock is proportional to market return

beta – proportionality coefficient (see Bender J, *To Beta or Not to Beta* – MSCI Barra research Insights, July 2007)

Time series regression stock *vs* market – **beta assumed constant, in fact varies with time**, sample size, frequency – ambiguous and unstable

Enter factor risk models

1. Stock risk projected on risk factors – equity, macro …. + stock specific element
2. (1) generalised for portfolio risk
3. Covariance of stock and portfolio given by overlap of their risk projections

(see Bali, T G and R F, Engle, (2010) *Resurrecting the Conditional CAPM with Dynamic Conditional Correlations* http://srn.com/abstract=1364865)

Sampling bias (ambiguity) reduced by model's systematic adjustments

Factor impact on time variations of market beta

Useful formuale

$$W_{ij} = \sum_{pq} b_{ip} F_{pq} b_{jq} + D_{ij}$$

Covariance matrix from risk model

$$C_{12} = \sum_{ij} w_i^1 \left(\sum_{pq} b_{ip} F_{pq} b_{jq} + D_{ij} \right) w_j^2$$

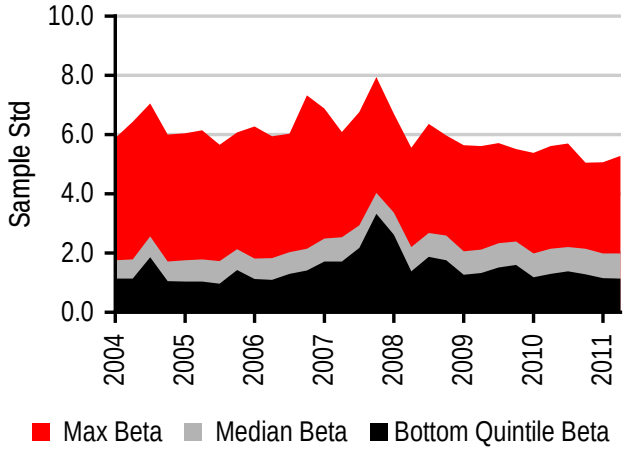
Covariance of two portfolios

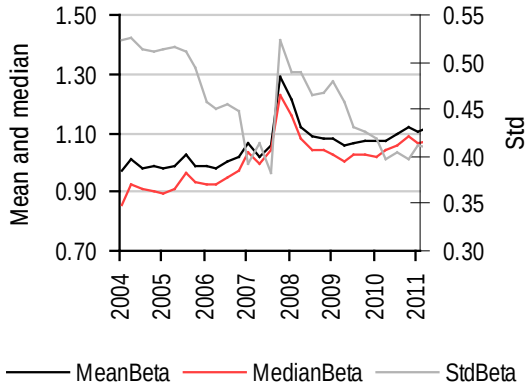
$$b_i = \frac{\sum_j w_j^M W_{ij}}{\sum_{jk} w_j^M W_{jk} w_k^M}$$

Beta to the market follows

Distribution of estimated market beta values

Fig 1. Cross-sectional distribution of estimated beta values (positive skew)





Source: HSBC

Sufficient diversity of values, 'sensible' distribution – information content, outperformance potential

Note peaks of statistics in summer 2008

Here and in what follows, results are presented for DJ Stoxx 600 universe, total return, base currency US dollar

Beta factorisation

Stock beta can be factorised into correlation and volatility factor- market alignment and riskiness

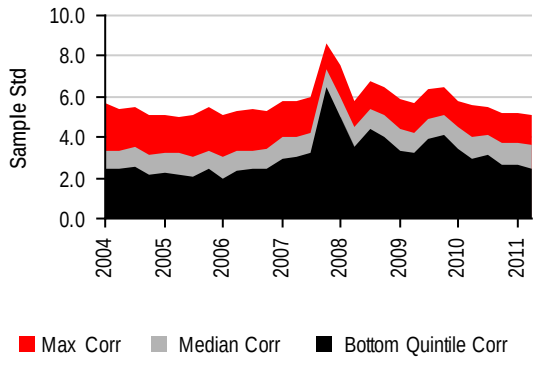
beta – stock return response to market return

correlation – stock Sharpe ratio response to market Sharpe ratio

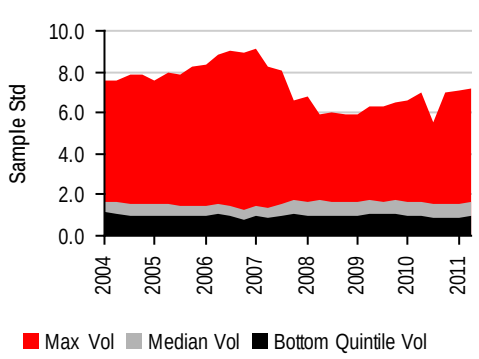
Volatility – not a linear reponse factor

Fig 2. Cross sectional distribution of correlation (a) and volatility (b)

a



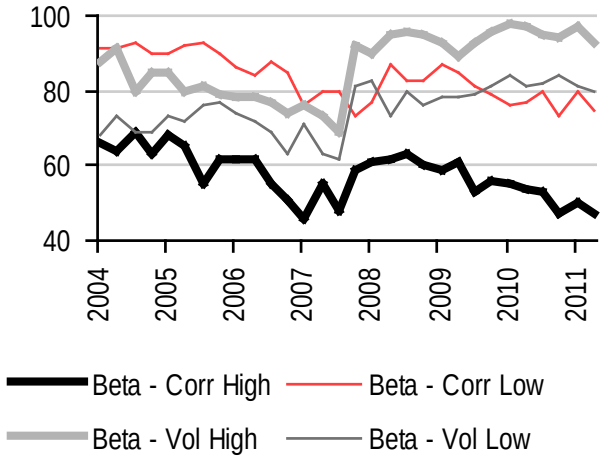
b



Source: HSBC

How the three selections are correlated

Fig 3. Overlap of beta, correlation and volatility quintiles (top and bottom)



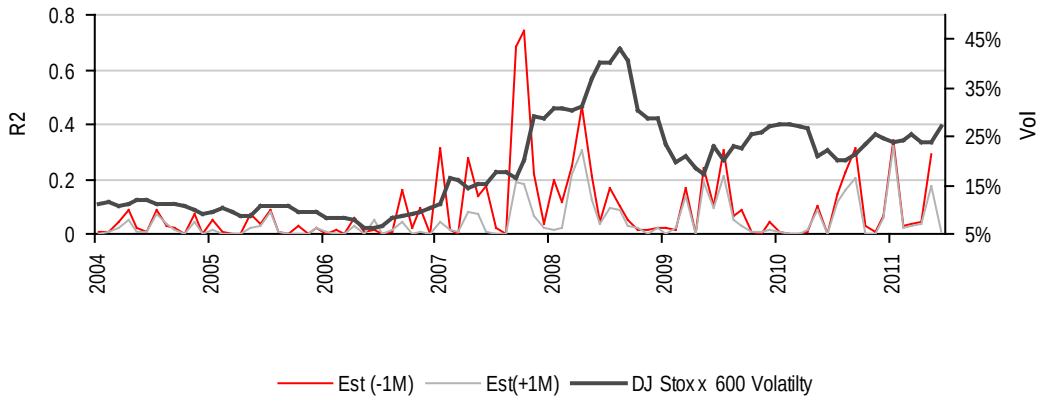
Source: HSBC

- **Large beta dominated by volatility**
- **Small beta overlap with volatility and correlations**
- **Correlation overlap decreases, volatility increases (jumps in 2007)**

Explanatory power of the beta estimation model

Stock returns regressed against estimated betas

Fig 4. Model explanatory power – stock return variance explained by stock beta



Source: HSBC and Bloomberg

Note:

- **increase of explanatory power since 2007**
- **impact of concentrated risk – rising volatility, loss of diversification of risk factors**

Low-beta screen – reverse optimisation of market portfolio

Apply CAPM definition of beta through risk model – the results ofscreen proportional to market-implied alphas – reverse optimisation

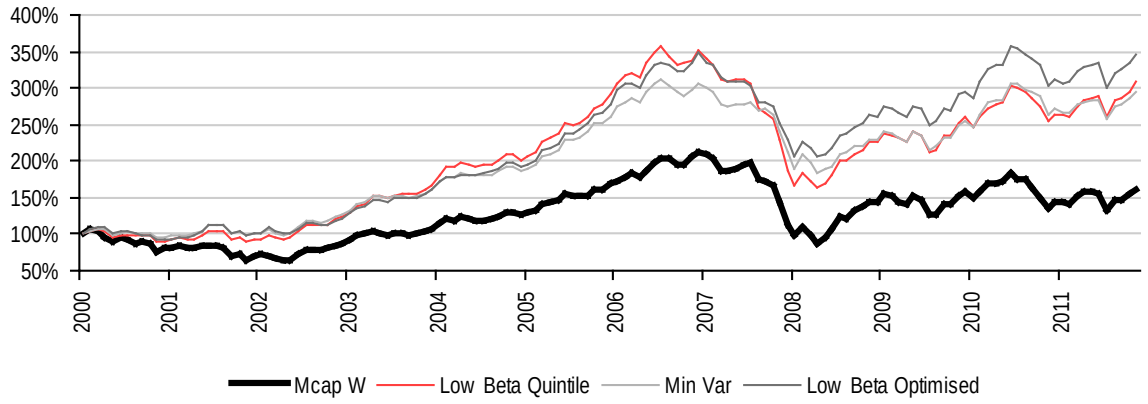
Principal differences with Minimum Variance solution allocation and provides

- ü Avoids numerical instabilities in the inversion of the covariance matrix
- ü Allows overlay of low-risk stock selection with other performance indicators (value, profitability, governances, fundamental indexation)
- ü Targeted active risk control – additional diversification and benchmarking

Minimum-Variance optimisation needs numerous restrictions on holdings. Such constraints, due to their largely arbitrary nature, undermine the knowledge derived from historical sampling or from the risk modelling. A low-beta manager controls the diversification by re-defining the optimisation objective relative to a benchmark. The optimised portfolio minimises the tracking error to a benchmark, conditional on the maximum allowed market exposure of the portfolio. Instead of numerous stock-level holding restrictions, a manager selects the benchmark deemed most appropriate and controls the level of diversification with a single parameter of active risk aversion.

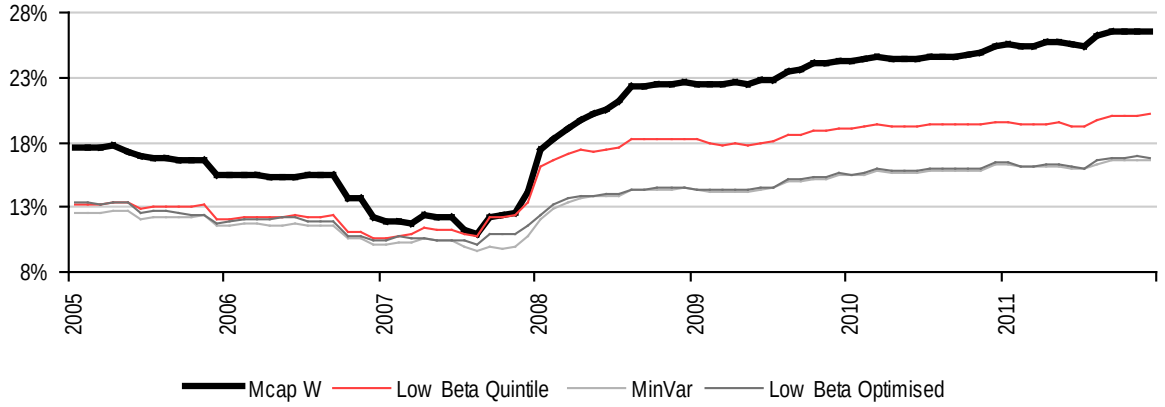
Performance and realised tracking error

Fig 5a. Total return of low risk and market cap weighted benchmark DJ Stoxx600 universe



Source: HSBC

Fig 5b. Realised 6-month volatility of low risk and market cap weighted benchmark DJ Stoxx600 universe



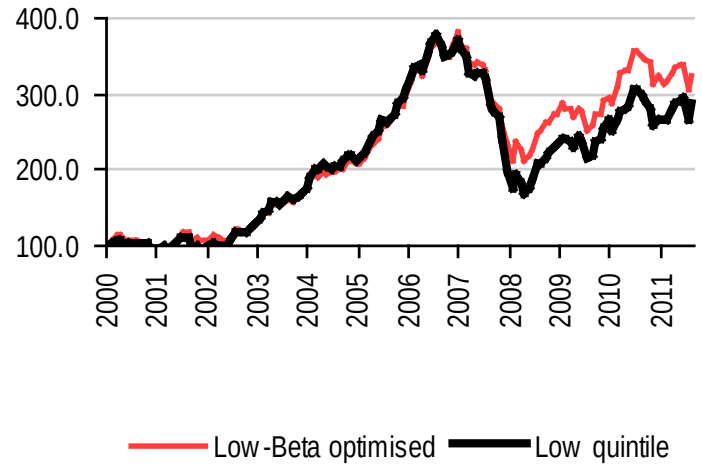
Source: HSBC

Optimisation-enhanced performance

Controlling tracking error to an equally-weighted benchmark

Fig 6. Optimised *vs* equal allocation of bottom beta quintile

(monthly rebalancing)



Source: HSBC

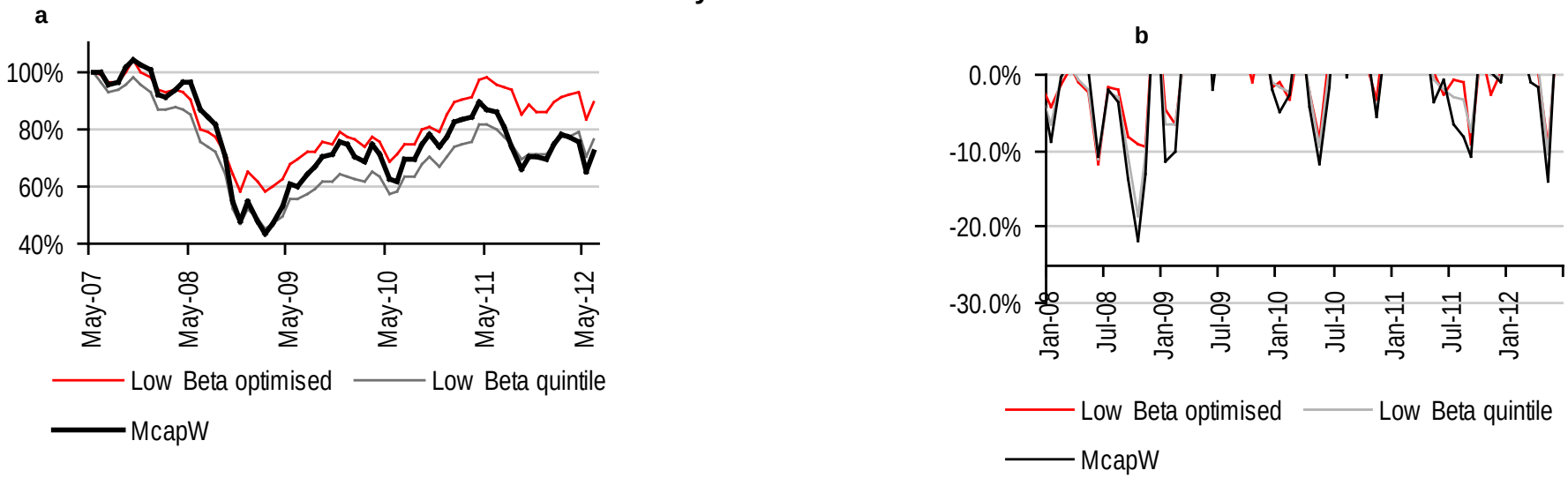
The benefit of optimisation – contain the impact of the 2008 market downturn

Downturn protection

Fig 7. Downturn protection optimised *vs* equal allocation of bottom beta quintile

(a) – cumulative since summer 2007

(b) – monthly downside since Jan 2008

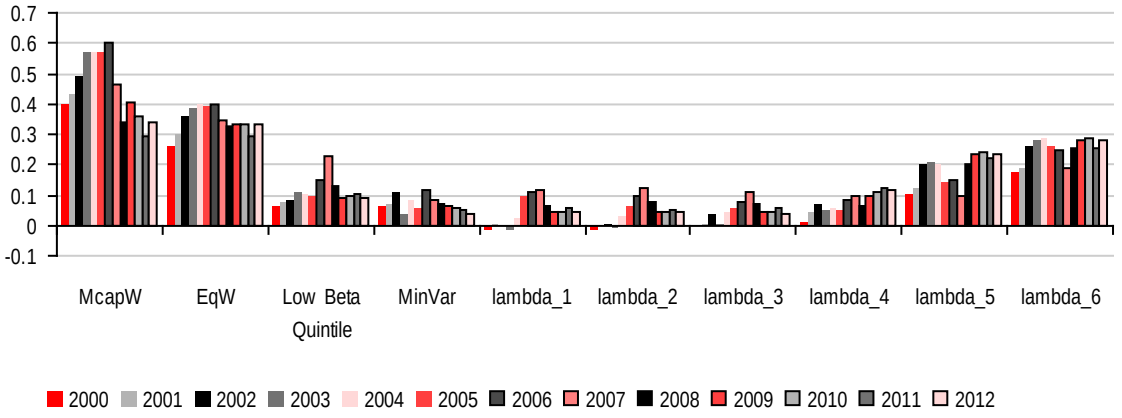


Source: HSBC

Optimised portfolio controls positive exposure to Value, present in the low-beta selection and prevents sharp drawdown at 2007Q2-Q3

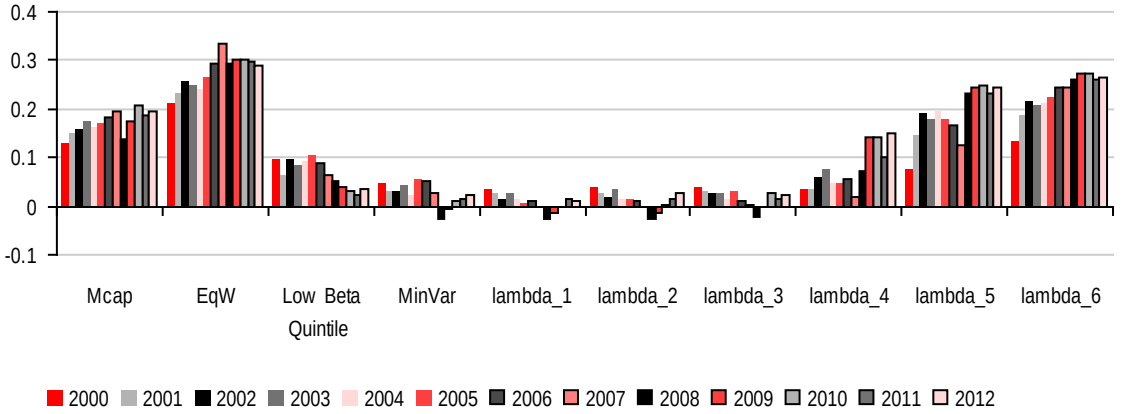
Leading industry exposures

Fig 8a. Exposure to interest rates sensitive (Financials)



Source: HSBC

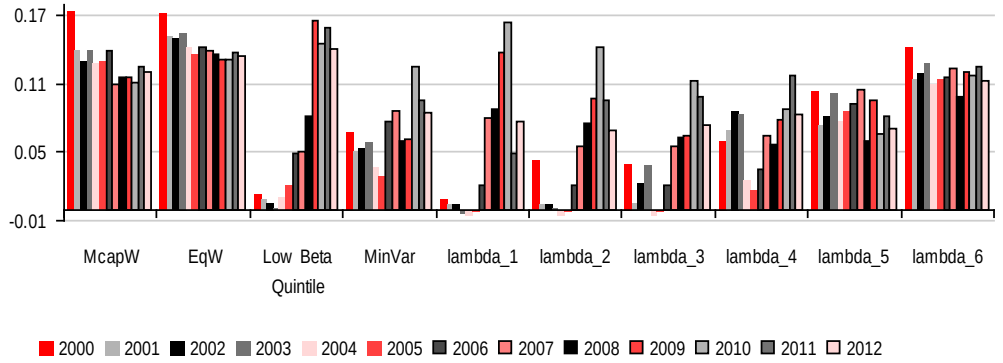
Fig 8b. Exposure to Industrials



Source: HSBC

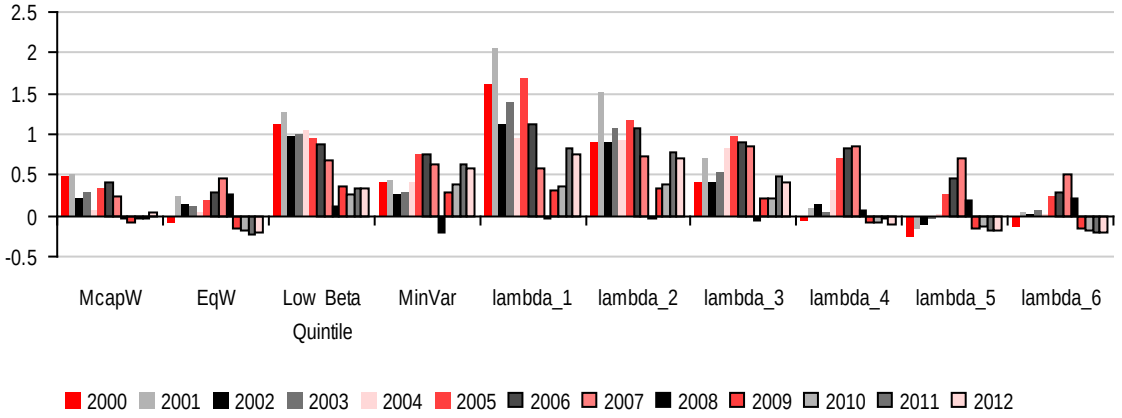
Dynamics of risk factor exposures

Fig 9. Increasing exposure to Technology

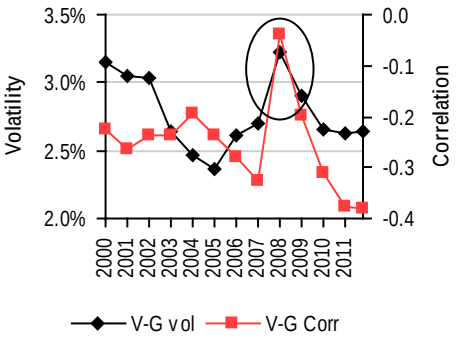


Source: HSBC

Fig 10 . Dynamics of Exposure to Value-Growth spread reflects factor riskiness



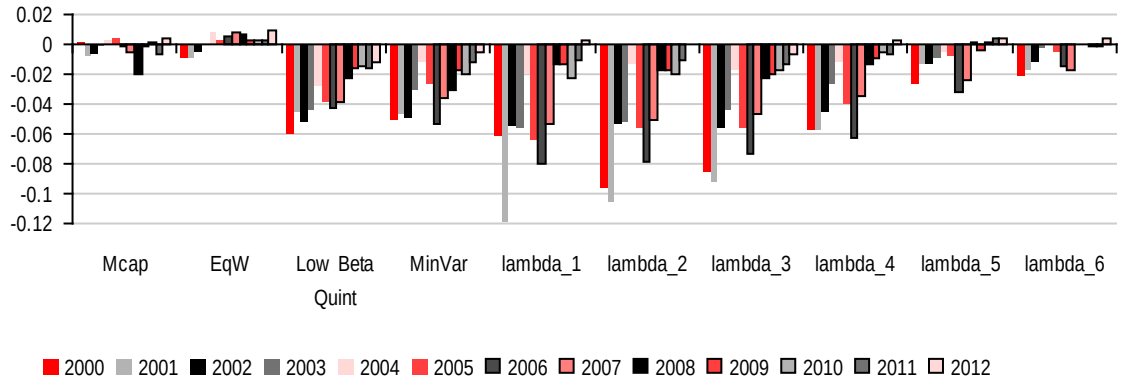
Source: HSBC



Source: HSBC

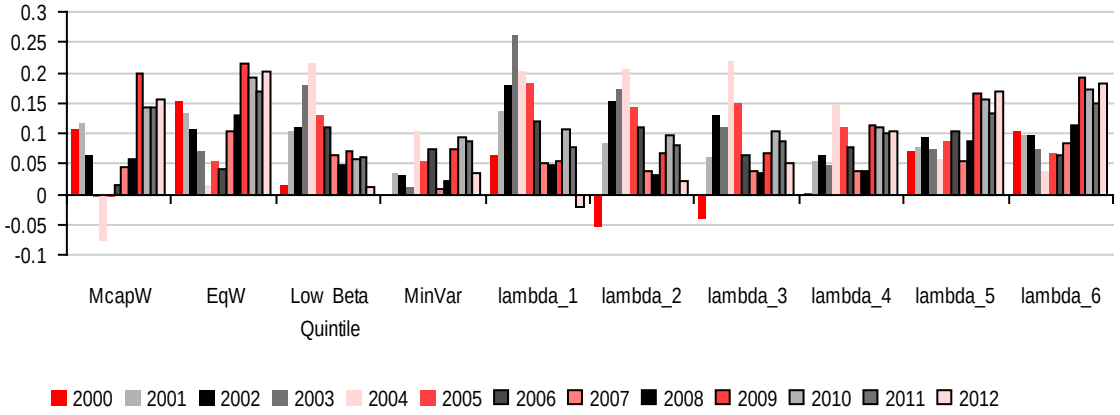
Low-beta going global – aversion to English-speaking and Emerging markets decreases

Fig 11 a. Exposure to English-speaking factor



Source: HSBC

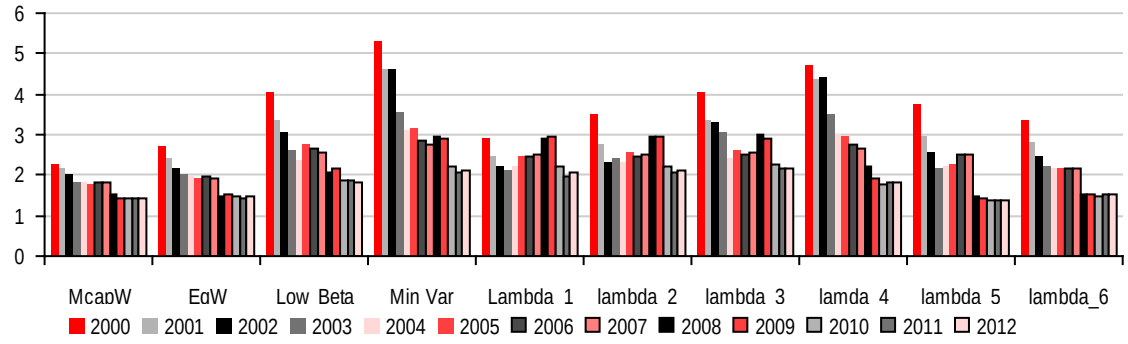
Fig 11 b. Exposure to Developed - Emerging



Source: HSBC

Diversification capacity

Fig 12 Diversification ratio – how effective is the risk reduction in optimised portfolio?



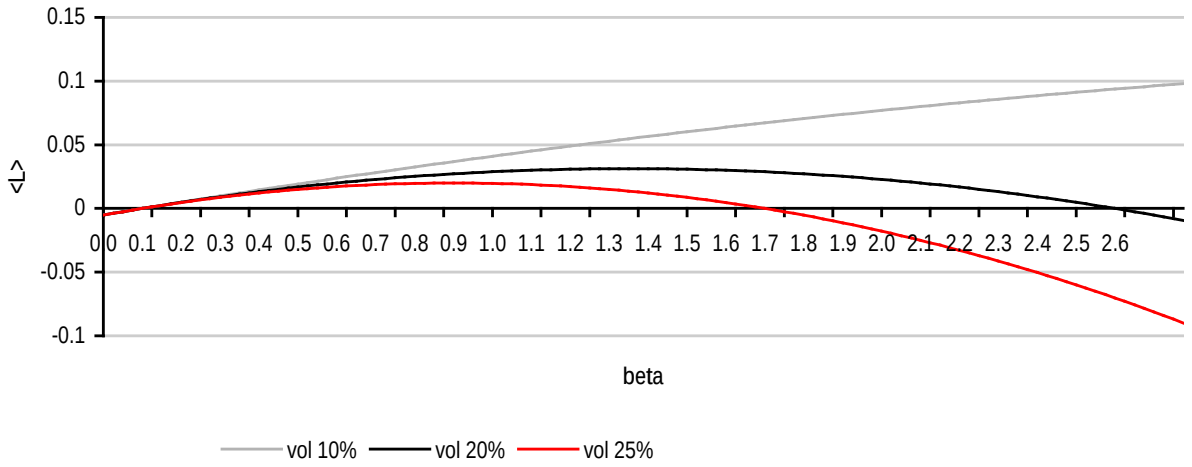
Source: HSBC

Diversification ratio – portfolio weighted sum of volatilities divided by portfolio volatility

See Y Choueifaty and Y Coignars, *Toward Maximum Diversification*, The Journal of Portfolio Management, (Fall 2008), p 40

A simple model of optimal portfolio-beta

Figure 13: Compound return as a function of beta – for small, medium and large volatility



Source: HSBC

Optimal value of beta decreases with the square of volatility

$$b_c = \frac{m_M}{s_M^2}$$

See – Dan diBartolomeo 2007 Northfield News, Northfield Annual Research Conference, London 2012

Simple example of volatility damping of compound returns

	T=0	T=1	T=2	T=3
beta=1.0; dR=0.35	1.000	1.050	1.470	1.029
beta=0.8; dR=0.35	1.000	1.040	1.373	1.043
beta=1.0; dR=0.25	1.000	1.050	1.365	1.092
beta=0.8; dR=0.25	1.000	1.040	1.290	1.083

Compare constant return with volatile

$$R_{comp} = (1+r_1)\times(1+r_2)\times\ldots\times(1+r_T) - 1$$

$$R_{comp} = (r_1 + r_2 + \ldots + r_T) + r_1(r_2 + \ldots + r_T) + r_2(r_3 + \ldots + r_T) + \ldots + r_{T-1}(r_T) + \ldots$$

$$\sum_{i<j}(r_i r_j) = \frac{1}{2}\left[\sum_{i,j}(r_i r_j) - \sum_i r_i^2\right] \quad \Rightarrow \quad R_{comp} = \sum_i r_i + \sum_{i<j}(r_i r_j) = \sum_i r_i + \frac{1}{2}\left[\sum_{i,j}(r_i r_j) - \sum_i r_i^2\right]$$

$$\frac{1}{2}T^2\langle r\rangle^2 - \frac{1}{2}T\langle r^2\rangle = \frac{1}{2}T(T-1)\langle r\rangle^2 + \frac{1}{2}T\langle r\rangle^2 - \frac{1}{2}T\langle r^2\rangle = \frac{1}{2}T(T-1)\langle r\rangle^2 - T\frac{1}{2}\sigma^2$$

$$R_{comp}^{(const)} = \left(1+\langle r\rangle\right)^T - 1 = T\langle r\rangle + \frac{1}{2}T(T-1)\langle r\rangle^2$$

$$R_{comp} = T\left[\langle r\rangle - \frac{1}{2}\sigma^2\right] + \frac{1}{2}T(T-1)\langle r\rangle^2$$

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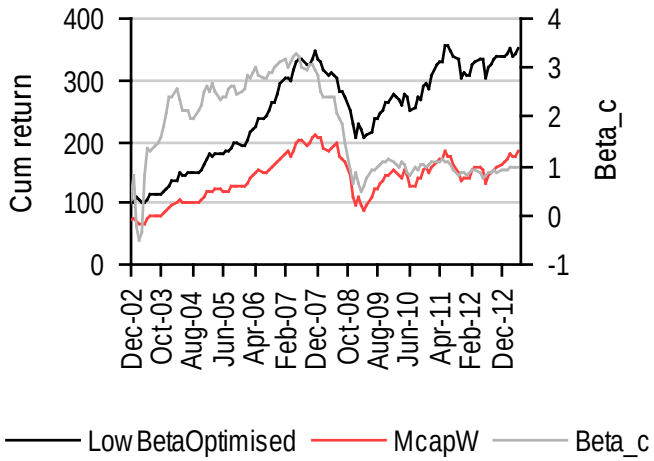
Two regimes of low-beta outperformance

Figure 14-a: Cumulative total return for low-beta optimised fund and DJ Stoxx 600



Source: HSBC

Note the drop in critical beta in summer 2007

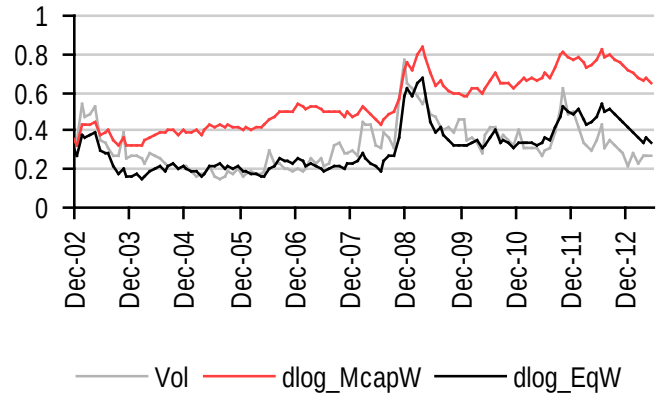
Prior to 2007 low-beta outperformance was driven by its association with value

After 2007 the outperformance is a consequence of low optimal beta

Damping by market volatility

Figure 14-b Logarithmic returns' differentials for low-beta and market portfolio and for low-beta and the equally weighted allocation in DJ Stoxx 600

Plotted together with the market volatility



Source: HSBC and Bloomberg

Low-beta outperformance relative to the *equally weighted allocation aligned* with the market volatility.

The equally weighted allocation leverages market upward trend, but its performance is undermined by the volatility of the market.

The volatility-damping in the equally weighted allocation is seen in the logarithmic return differential with the low-beta portfolio.

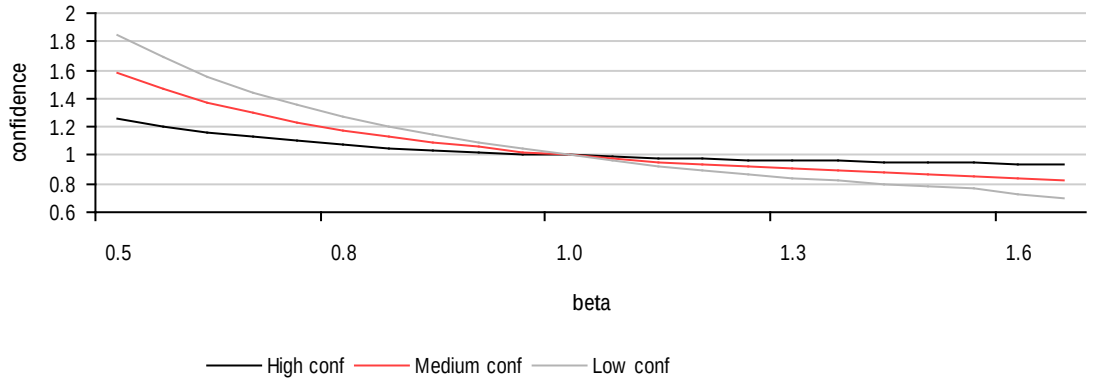
Low beta advantage in conditioning returns' forecast on market equilibrium

Inclusion of market-equilibrium views reduces the volatility of estimated returns, thus increasing the confidence in the forecast.

The confidence boost is stronger for the low-beta section of the market

Figure 15: Confidence of conditional forecast as a function of beta relative to the confidence of forecast for the market

Shown for three values of confidence in manager's specific forecast



Source: HSBC

When manager-specific volatility is low (high confidence), the impact of the conditioning upon market is weaker than for the low-confidence forecast.

Note that the dependence on beta gradually declines, particularly for the high-confidence of the manager-specific forecast**.**

Conclusions …

- Low-beta portfolios – downturn protection and possible arbitrage opportunity
- Reducing risk exposure to the factors dominating market risk is the driver behind the long-term performance of the low-beta portfolio
- Optimisation of low-beta with controlled tracking error to equally weighted benchmark enhances performance and diversification – single risk aversion parameter instead of numerous holding constraints
- A simple mathematical model describes the damping effect of the volatility upon compounding of returns
- An optimal value of portfolio beta is defined dependent on the expected market trend and market volatility
- For a regime of high market volatility, this critical beta may fall below 1, resulting in outperformance of the market by the low-beta portfolio
- The leverage of high-beta portfolio is sustainable only as long as the market volatility remains low
- Combining estimation of returns with market equilibrium benefits the confidence of the forecast for the low-beta section of the market

… and outlook – *In sickness and health ?* – can beta-blocker survive bull market?

Source: Bloomberg

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Questions to be answered in the coming 6-12 months

1. Estimation bias – e.g. changing riskiness of country, industry and style

examples: Peripheral Europe – from low to high risk;

Utilities – from low to high risk;

Value – low, high and, probably, low again

2. Volatility-damping of cumulative returns – what is the *effective value* of market volatility?

3. Is there an *alpha* (distinctly non-market return) in low-beta?

See

B Scherer 2010 A new look at Minimum variance Investing http://ssrn.com/abstract=1681306 – FF factors explaining low beta anomaly

E Fishwick 2013 Dynamic CAPM Geometry Oxford LQG Autumn Seminar www.lqg.org.uk - decline inrisk free rate + FF (modified)

A Frazzini and L H Pedersen 2011 Betting against beta, Swiss Finance Institute, http://ssrn.com/abstract=2049939

Disclosure appendix

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