Risk modelling, portfolio optimisation and performance backtest

Ely Klepfish, Analyst (Tel: +44 20 7568 3421)

NAG Quant Day – London 2008

21 February 2008

This document has been prepared by UBS Limited

ANALYST CERTIFICATION AND REQUIRED DISCLOSURES BEGIN ON PAGE 39

UBS does and seeks to do business with companies covered in its research reports. As a result, investors should be aware that the firm may have a conflict of interest that could affect the objectivity of this report. Investors should consider this report as only a single factor in making their investment decision.

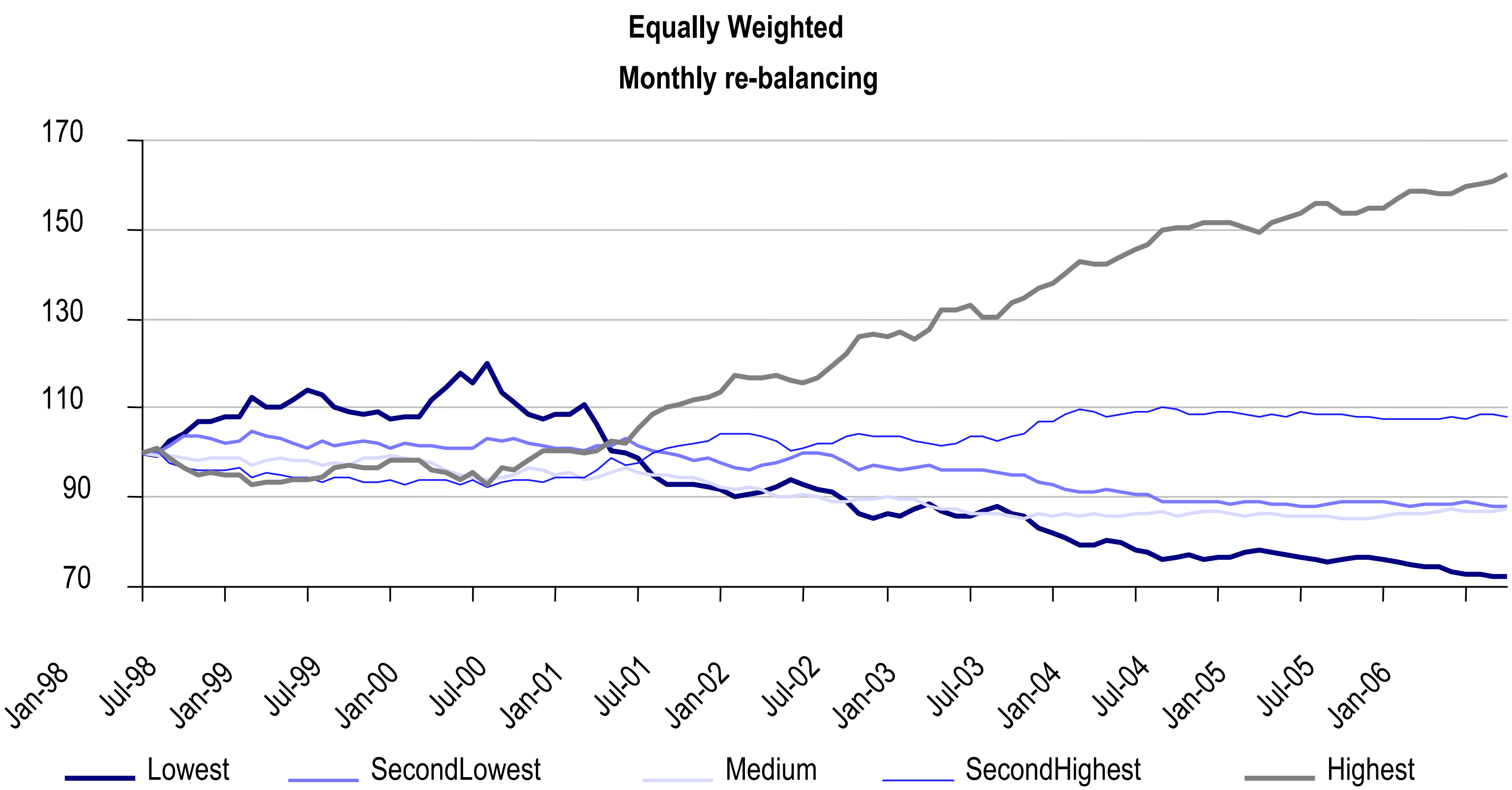
Backtest – **does the skill justify the fees?**

- What are the principal drivers of *OUT*-performance?
- How is performance affected by practicalities?
- Do I invest according to my selection (macro and micro)?
- What affects my performance – alpha or beta?
- Am I too risk avert?
- Is my constraint too tight?
- Ultimately: Have I been good or lucky?

Introduction

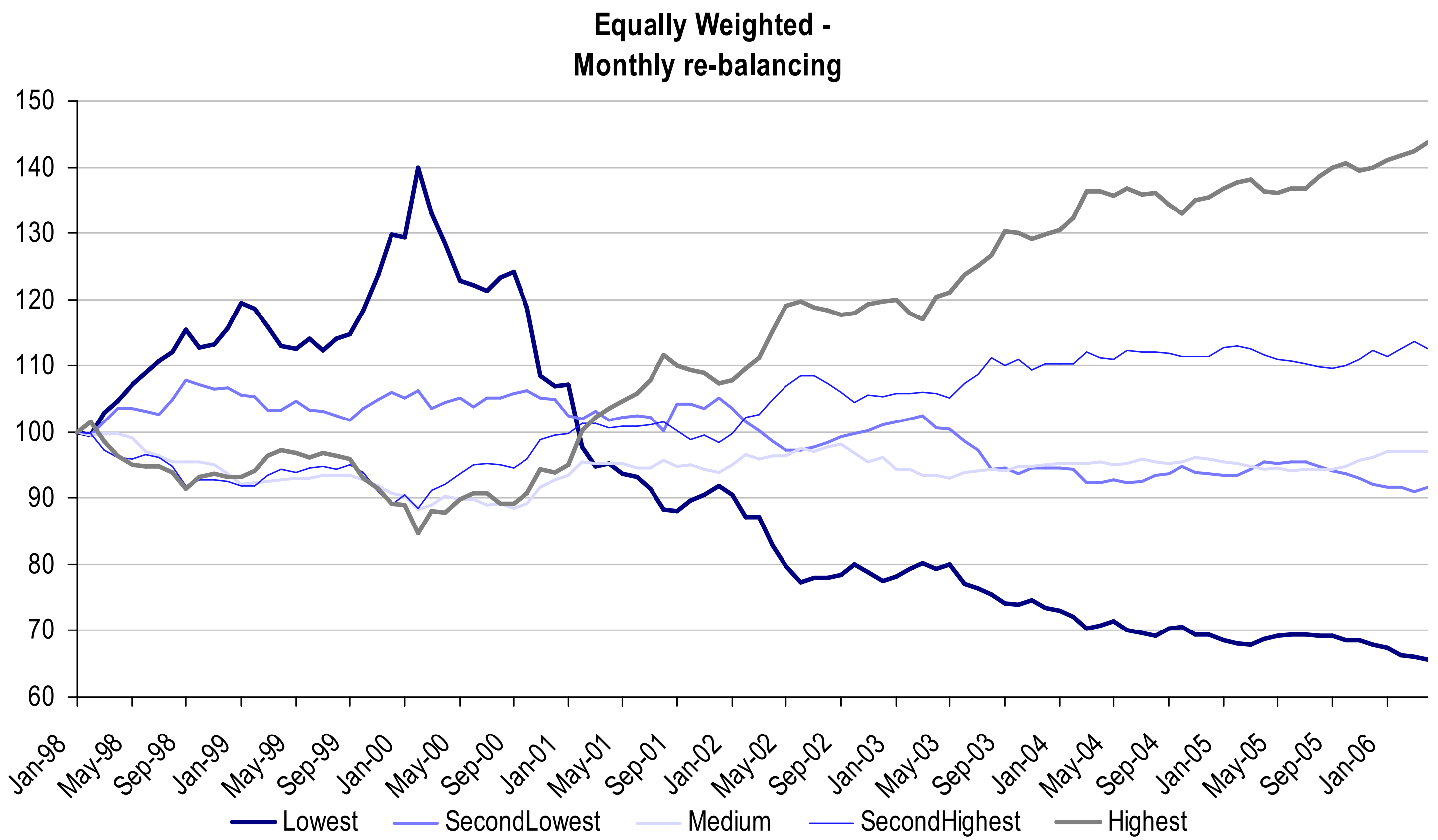
- Contents
  - Performance factor backtest (almost like a style)
  - Optimisation – problems and solutions
  - Brief introduction into the PAS risk model
  - Risk and return attribution
  - Optimised backtest
- Publications:
  - Understanding Risk: A New Global Country-Sector Model, J. Sefton and A. Scowcroft, UBS-January 2002, UBS-October 2002
  - Global Country-Sector Risk Model, Risk breakdown quarterly update, Ely Klepfish, D. Jessop, UBS – quarterly since July 2004.
  - Optimisation with Alphas, D. Jessop, et al. UBS – March 2005
  - European return attribution – Nick Nelson et al. March 2006

Sales to EV as performance factor – sector neutral



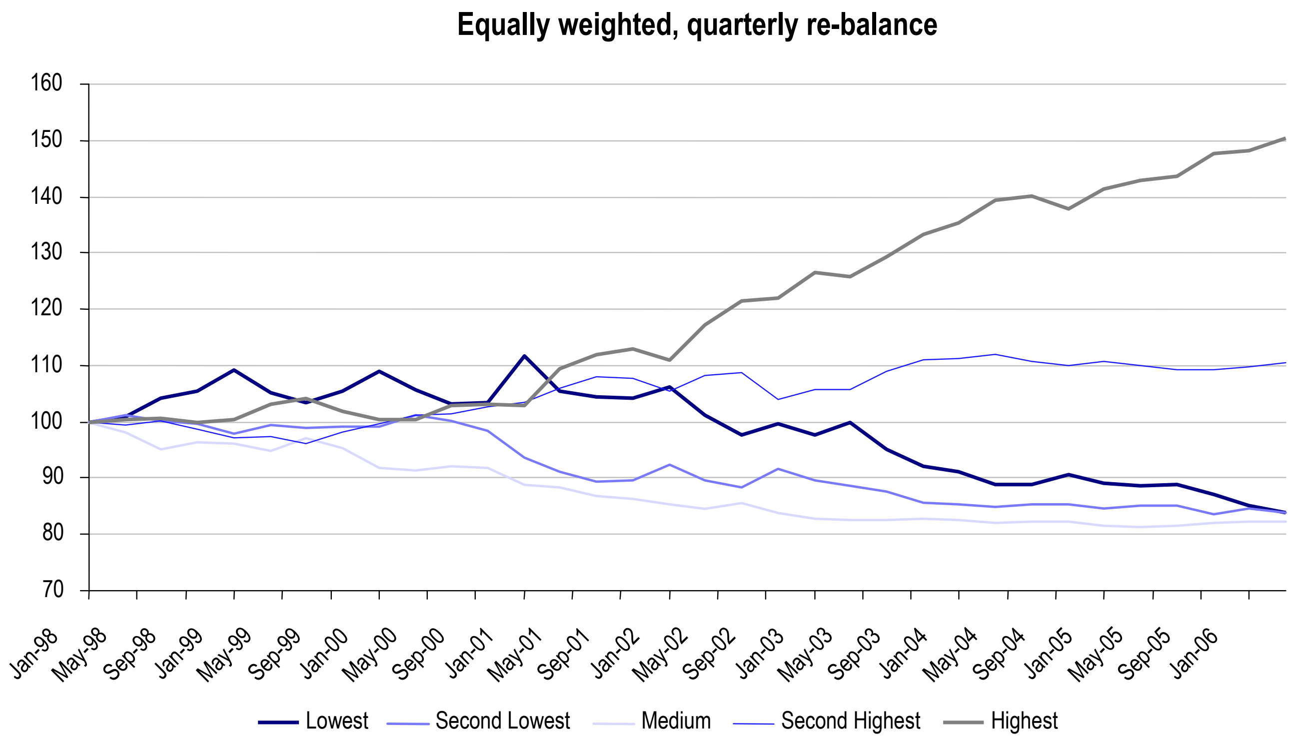
Source UBS

Sales to EV as performance factor – sector bias



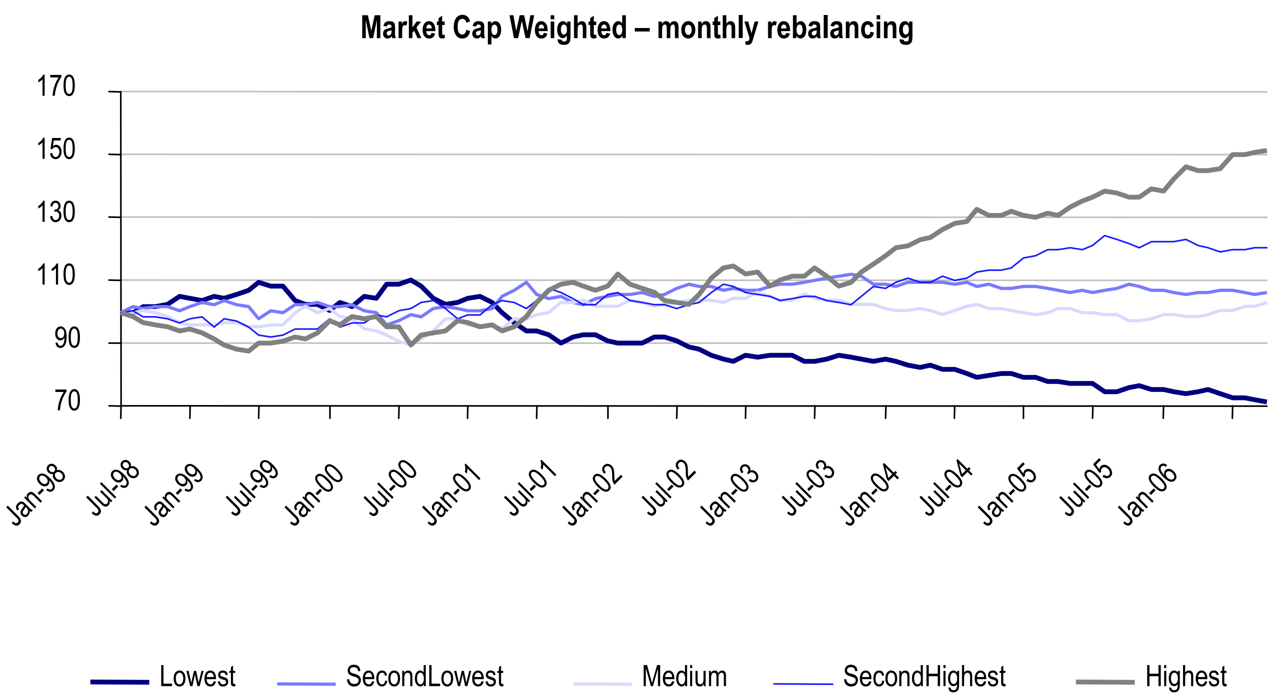
Source UBS

Rebalance impact



Source UBS

Weighting impact



Source UBS

UBS

Optimisation: Problem definition and constraints

- Maximise objective function

$$U = \sum_i \alpha_i (w_i - b_i) - \lambda \sum_{i,j} (w_i - b_i) \Omega_{ij} (w_j - b_j)$$

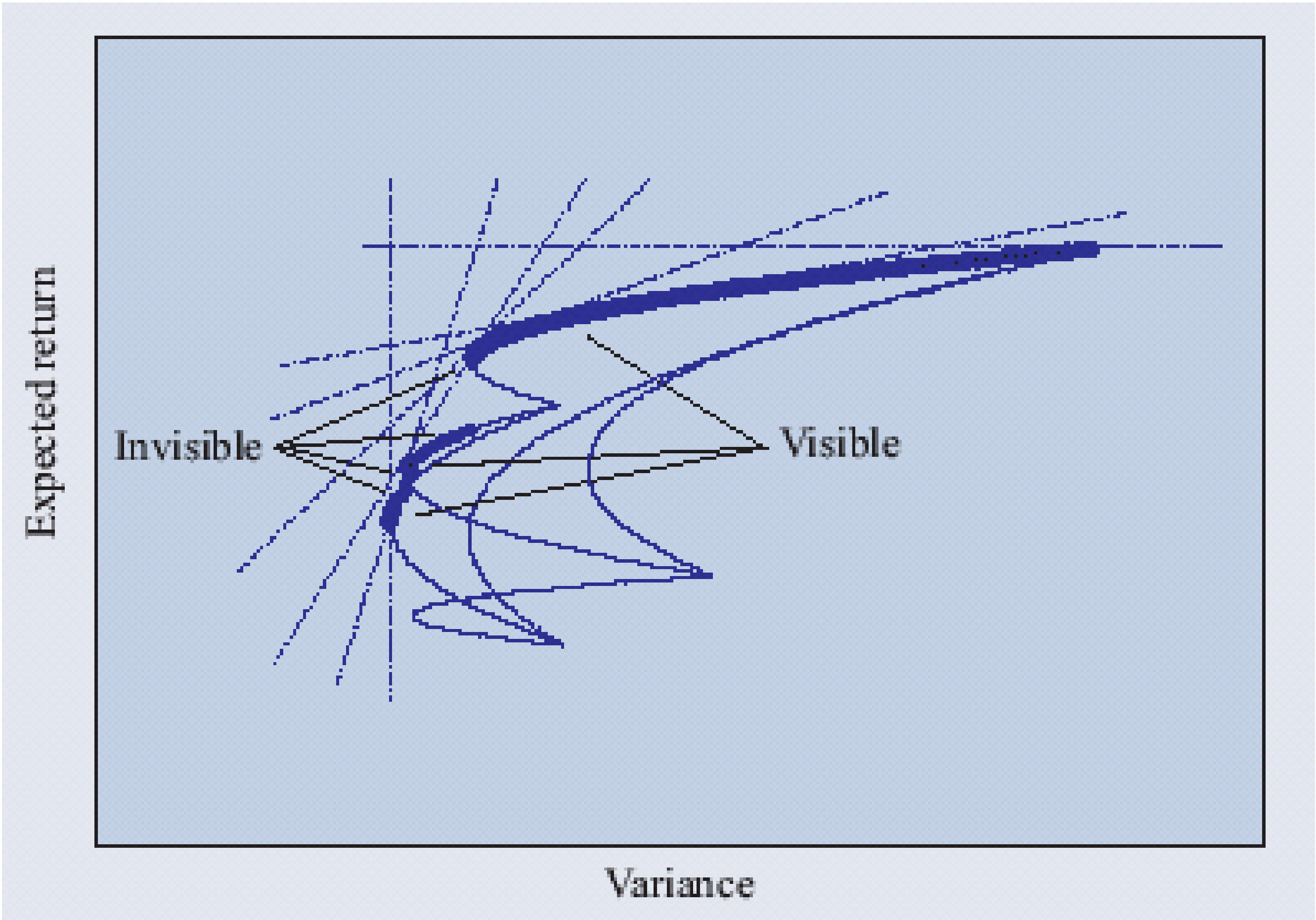
subject to constraints of

1. Long only portfolio – positive portfolio weights
2. Limited turnover (transaction costs)
3. Lower and upper limits of holdings
4. Maximum number of stocks
5. Minimum and maximum exposure to industry, country, style and market risk

Why is optimisation hard?

- Optimisation would be easy except for the integer restrictions we put on the solution
  - –The most common of these is of the form “give me a 100 stock portfolio from the S&P 500”
  - –This could be generalised to limit the number of assets, including options etc. in a fund.
  - –There can be other integer constraints – e.g. limit the number of trades, threshold constraints
- It is impossible to solve these problems exactly for any reasonable size problem: in choosing 100 stocks from 500 there are around $2*10^{107}$ possible combinations of stocks (if there are no constraints).

The efficient frontier with discrete constraints



♦ Source: Jobst, N. J., M. D. Horniman, C. A. Lucas and G. Mitra (2001) “Computational aspects of alternative portfolio selection models in the presence of discrete asset choice constraints”, Quantitative Finance Volume 1, pp1-13

UBS

Optimisation in practice

The optimisation algorithm – Mixed Integer Programming

– uses the factor risk model

– adds discrete decision variables to represent integer constraints

– splits the risk aversion parameter λ into systematic and specific, thus allowing separate control of active and passive risk

– uses penalty function to soften the boundaries of holding and turnover constraints

Backtest with optimisation

- Read in initial portfolio (benchmark is a possible choice for a start)
- Read in candidate set and user alphas
- If user alphas are to be combined with other views use mixed estimation capability for outperformance forecast – was not use din the present example
- Estimate risk model for the time of portfolio construction, based on 60 month stock and factor return data (prior to the portfolio date).
- Pass to the optimiser program risk information (stock specific risk, factor covariance matrix, stock betas.
- Set up boundaries of holdings, turnover and exposure
- Run the optimisation
- Calculate optimised portfolio return, tracking error, turnover, MCAR's …
- Use solution portfolio as initial for the next rebalancing

The mathematics of intuition – *the matrix of returns*

- Asset returns vary with time and across market.
- Algebraic representation – a matrix – an array of values each identified by a time and cross-sectional label
- Investment history is an analogous array of portfolio weights selected by an investor. A skilful investor has selected the right assets at the right times, thus covering the returns with a winning array of portfolio weights.
- Time-axis continuity and its definite direction of causality create an asymmetry in the way asset returns are analysed in time and the cross-sectional direction. This asymmetry is further enhanced by human disposition to treat historical sample as an adequate representation of ensemble of probabilities.

Is the mean of last sixty monthly returns a better estimate of the next month's return than the mean of the last month's returns of all the stocks in the market?

The mathematics of intuition – *in search of simplicity*

- Linear model: small change in factors results in small change in stock returns

$$\begin{pmatrix} r_{1,1} & \cdots\cdots\cdots & r_{1,N} \\ r_{2,1} & \cdots\cdots\cdots & \cdots \\ \cdots & \cdots\cdots\cdots & \cdots \\ \cdots & \cdots\cdots\cdots & \cdots \\ r_{T,1} & \cdots\cdots\cdots & r_{T,N} \end{pmatrix} = \begin{pmatrix} f_{1,1} & \cdots & f_{1,K} \\ f_{2,1} & \cdots & \cdots \\ \cdots & \cdots & \cdots \\ \cdots & \cdots & \cdots \\ f_{T,1} & \cdots & f_{T,K} \end{pmatrix} \times \begin{pmatrix} \beta_{1,1} & \cdots\cdots\cdots & \beta_{1,N} \\ \cdots & \cdots\cdots\cdots & \cdots \\ \beta_{K,1} & \cdots\cdots\cdots & \beta_{K,N} \end{pmatrix} + \begin{pmatrix} \varepsilon_{1,1} & \varepsilon_{1,2} & \cdots\cdots & \varepsilon_{1,N} \\ \varepsilon_{2,1} & \cdots & \cdots\cdots & \cdots \\ \cdots & \cdots & \cdots\cdots & \cdots \\ \cdots & \cdots & \cdots\cdots & \cdots \\ \varepsilon_{T,1} & \cdots & \cdots\cdots & \varepsilon_{T,N} \end{pmatrix}$$

- Factors can be regarded as aggregated asset returns. In what follows, we argue, however, that the widely available market indices do not represent adequately risk factors.

The mathematics of intuition – *time series* **vs** *cross sectional*

- Time series regression

$$\begin{pmatrix} r_{1,p} \\ r_{2,p} \\ \dots \\ \dots \\ r_{T,p} \end{pmatrix} = \alpha_p \begin{pmatrix} 1 \\ 1 \\ \dots \\ \dots \\ 1 \end{pmatrix} + \beta_{1,p} \begin{pmatrix} f_{1,1} \\ f_{2,1} \\ \dots \\ \dots \\ f_{T,1} \end{pmatrix} + \beta_{2,p} \begin{pmatrix} f_{1,2} \\ f_{2,2} \\ \dots \\ \dots \\ f_{T,2} \end{pmatrix} + \dots + \beta_{N,p} \begin{pmatrix} f_{1,K} \\ f_{2,K} \\ \dots \\ \dots \\ f_{T,K} \end{pmatrix}$$

- Presumed factors
- Large number (NxK) of estimated parameters – betas, N regressions
- Smaller out of sample errors

- Cross sectional regression

$$\begin{aligned} &(r_{t,1} \quad \dots \quad \dots \quad \dots \quad r_{t,N}) = (\alpha_1 \quad \dots \quad \dots \quad \dots \quad a_N) + \\ &f_{t,1}(\beta_{1,1} \quad \dots \quad \dots \quad \dots \quad \beta_{1,N}) + \\ &f_{t,2}(\beta_{2,1} \quad \dots \quad \dots \quad \dots \quad \beta_{2,S}) + \dots + f_{t,K}(\beta_{K,1} \quad \dots \quad \dots \quad \dots \quad \beta_{K,N}) \end{aligned}$$

- Presumed loadings (betas)
- Smaller number (TxK) of estimated parameters – factor returns, T regressions
- Larger out of sample errors
- Quicker response to changes in constituents.

- Matrix algebra offers a third method of regression, based on Principal Component Analysis (PCA) or similar techniques. This method does not presume risk factors or loadings, it uses only the returns' matrix.

Limitations common to all three regression methods

All three methods, different as they appear, require (approximate at least) normality of the return distribution.

All three regressions do not take into account possible change of the loading during the sampled period.

Unproven (and sometimes plainly non-existent) adequacy of historical sampling is a shortcoming of all three methods.

Estimating UBS Country Sector Model

–The objective – time series regression for reliable risk attribution.

–It requires a set of reliable factor returns

- Be aware of the shortcomings of the readily available market cap weighted indices:
  - possible spurious correlations with local markets (*e.g.* UK oil companies, Pharmaceuticals and Banks in Switzerland, Nokia in Finland, until not long ago Nortel in Canada)
  - business conducted across market borders and yet multinationals are listed somewhere
  - Industry composition bias – practically all markets. Bias is created by dominant constituents and dominant markets. It is not an artifact, but a reflection of economic reality. Needs to be accounted for in controlled manner.

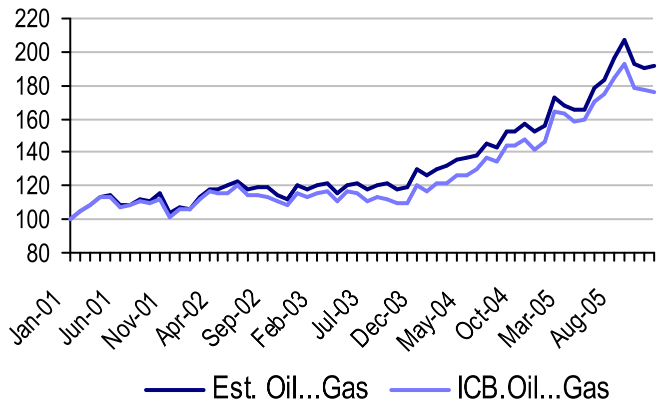
In our model we use *Global Market, 10 Global Sector and 8 Local Market factors*

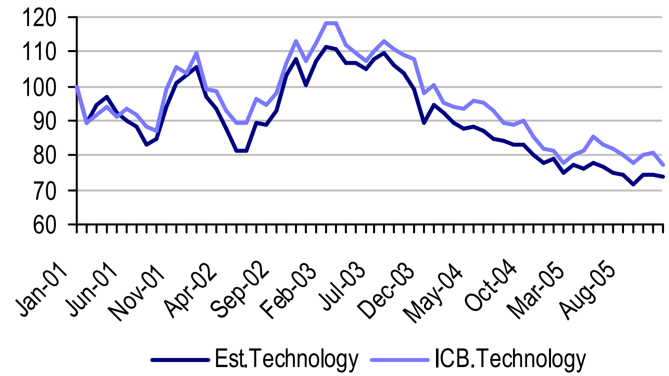
- We estimate the factors in an iterative procedure; each iteration a two-step constrained least square regression
  - Cross sectional estimate of factor returns
  - Time series estimate of loadings

NAG chapters used: e04, f06, g02,m01

UBS

Estimated factors and ICB indices ex-Global Market

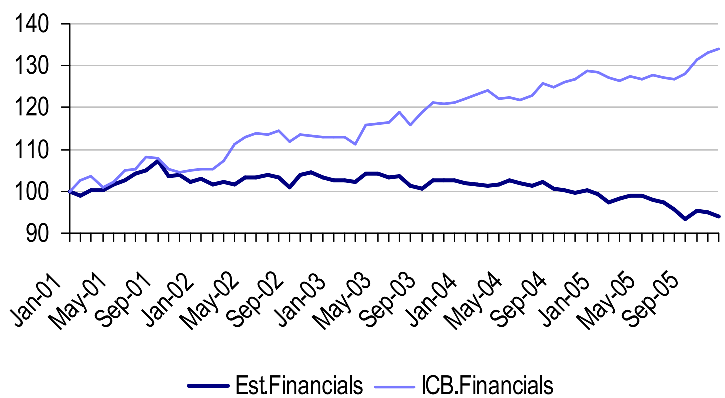


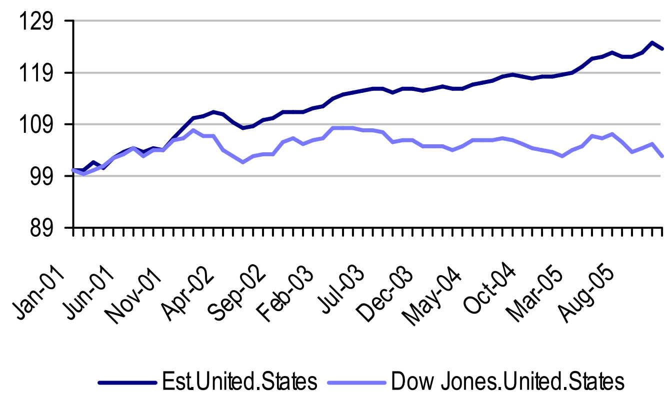


Oil and Gas and Technology – estimated ***Global Sector risk*** factor is close to the ICB index of largely global industries

Financials – the estimated ***Global Sector*** factor does not include sector index gains due to local effects (*e.g.* interest rates)

US – the estimated ***Local Market*** factor distinguishes between the performance of US and the global slowing down.





Source: UBS

UBS

Estimating UBS Country Sector Model – correlations and constraints

In industries of global nature, the correlation of Global Sector risk factor and the ICB index high

In regions with local effect dominant, the correlation of Local Market and Dow Jones index is high

Sector	Oil&Gas	Basic Materials	Industrials	Cons. Goods	Health Care	Cons.Services	Telecomms	Utilities	Financials	Technology
Correlation	0.97	0.95	0.63	0.93	0.87	0.76	0.86	0.94	0.43	0.92

Market	Canada	UK	Japan	United States	EMU	Europe Ex EMU UK	Asia Pacific Ex Japan	Latin America
Correlation	0.75	0.76	0.97	0.74	0.88	0.74	0.94	0.91

Source: UBS

We impose a set of fairly intuitive constraints:

- market cap weighted sum of Global Market betas = 1 (World's beta with Global Market =1)
- analogous constraints for industry and regional constituents (e.g. US equity beta with respect to US Local Market =1)
- market cap weighted sum of alpha (free terms) = 0 (no self-outperformance)
- market cap weighted sum of excess Global Sector returns=market cap weighted sum of excess Local Market returns=0
- excess Global Sectors returns, excess Local Markets returns orthogonal to Global Market returns

UBS

w_i

Risk Model for Portfolio Analysis System (PAS)

The global country-sector model is used in the Portfolio Analysis System (PAS).

Upon establishing the factor (Global Market, Global Sector and Local Market) returns time series, stock loadings with respect to these factors are estimated.

$$Var(P) = \sum_{i,j \in P} w_i w_j \sum_{qp} \beta_{q,i} \beta_{p,j} Var(f)_{qp} + \Delta$$

w_i - weight of the stock *i* in a portfolio, benchmark or active

$Var(f)_{qp}$ - factor covariance matrix

Δ - share of the variance unexplained by the model

$$MCAR_i = \frac{\partial (T.E.)}{\partial w_i} = \frac{\sum_j \Omega_{ij} \left(w_j - w_{Bj}\right)}{\sqrt{\left(\sum_{j'j} \left(w_{j'} - w_{Bj'}\right) \Omega_{j'j} \left(w_j - w_{Bj}\right)\right)}}$$

UBS

Sectors, Countries, Styles

$$Var(P)_{Sector} = \sum_{ij \in P} \left[w_i w_j \sum_{S,S'} \beta_{i,S} \beta_{j,S'} \Phi_{S,S'} \right]$$

$$Var(P)_{Country} = \sum_{ij \in P} \left[w_i w_j \sum_{C,C'} \beta_{i,C} \beta_{j,C'} \Phi_{C,C'} \right]$$

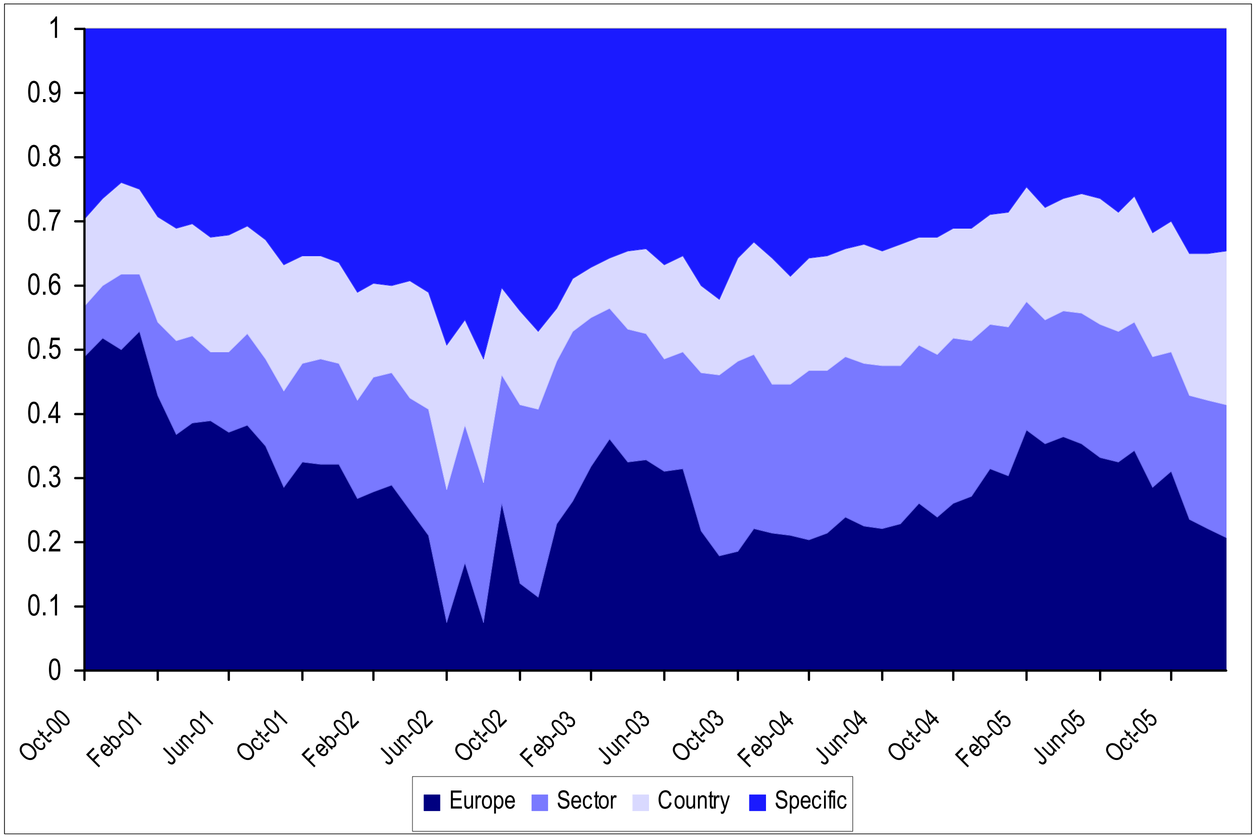
$$Var(P)_{Style} = \sum_{ij \in P} \left[w_i w_j \sum_{F,F'} \beta_{i,F} \beta_{j,F'} \Phi_{F,F'} \right]$$

$$+ \; Var(P)_{MKT} = \; Var(P)_{Factor}$$

$$Var(P) = Var(P)_{Factor} + Var(P)_{Specific}$$

UBS

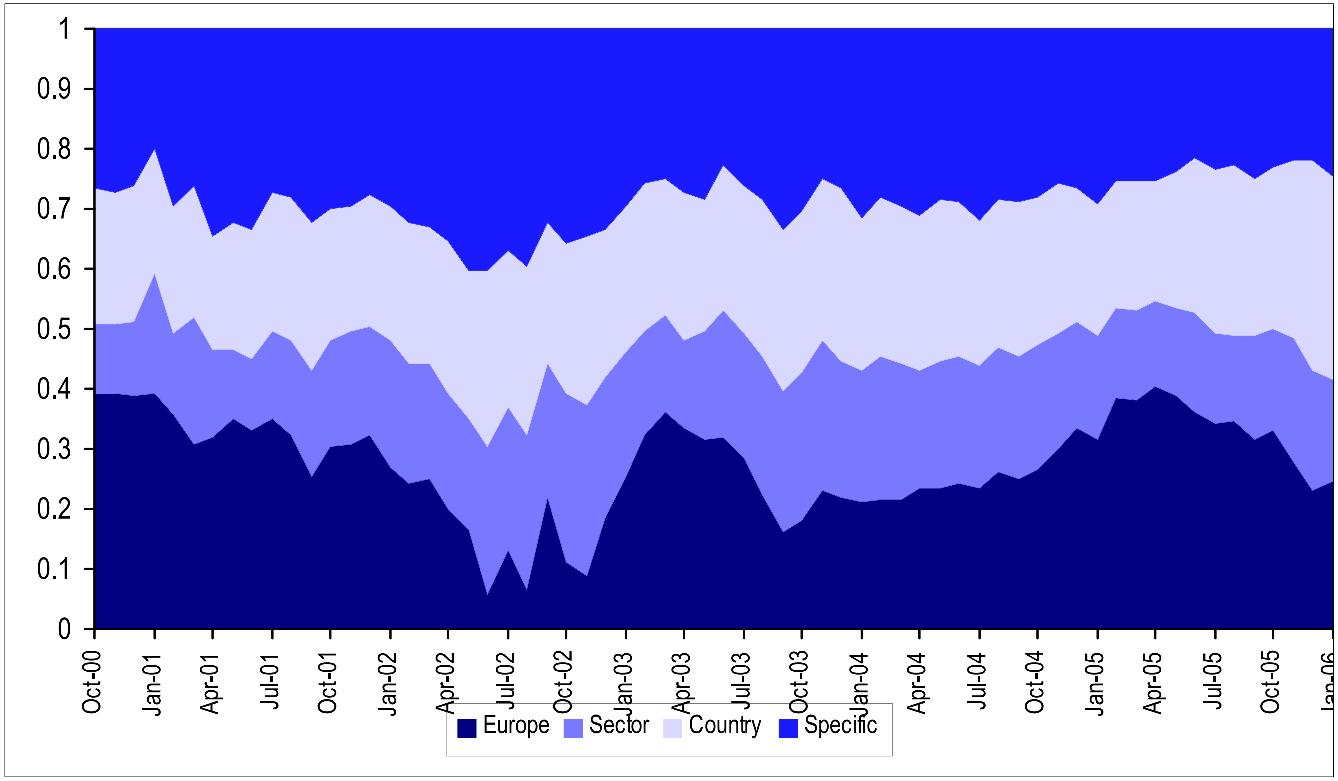
Return Attribution - Germany



Source UBS

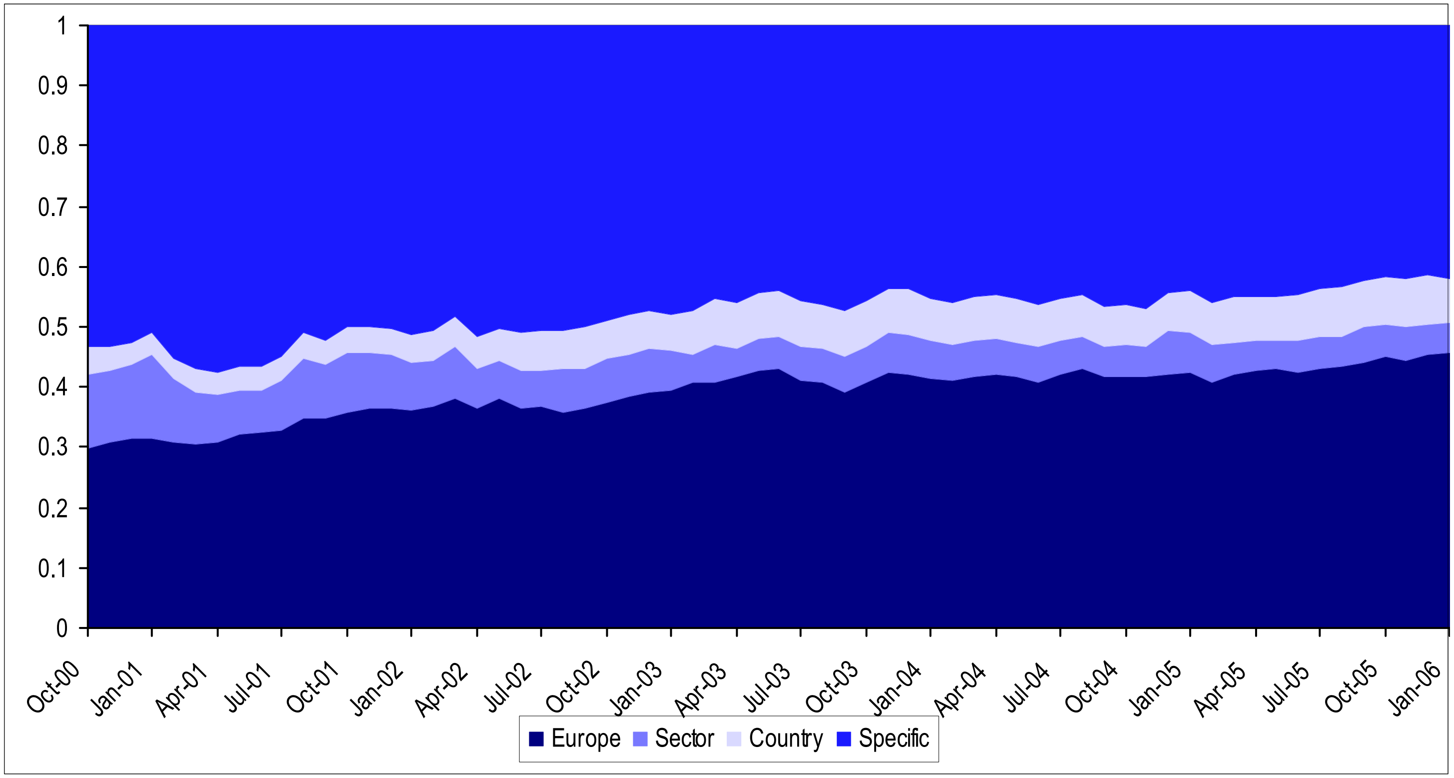
UBS

Return Attribution - Sweden



Source UBS

Risk attribution – Sweden, growing impact of Europe



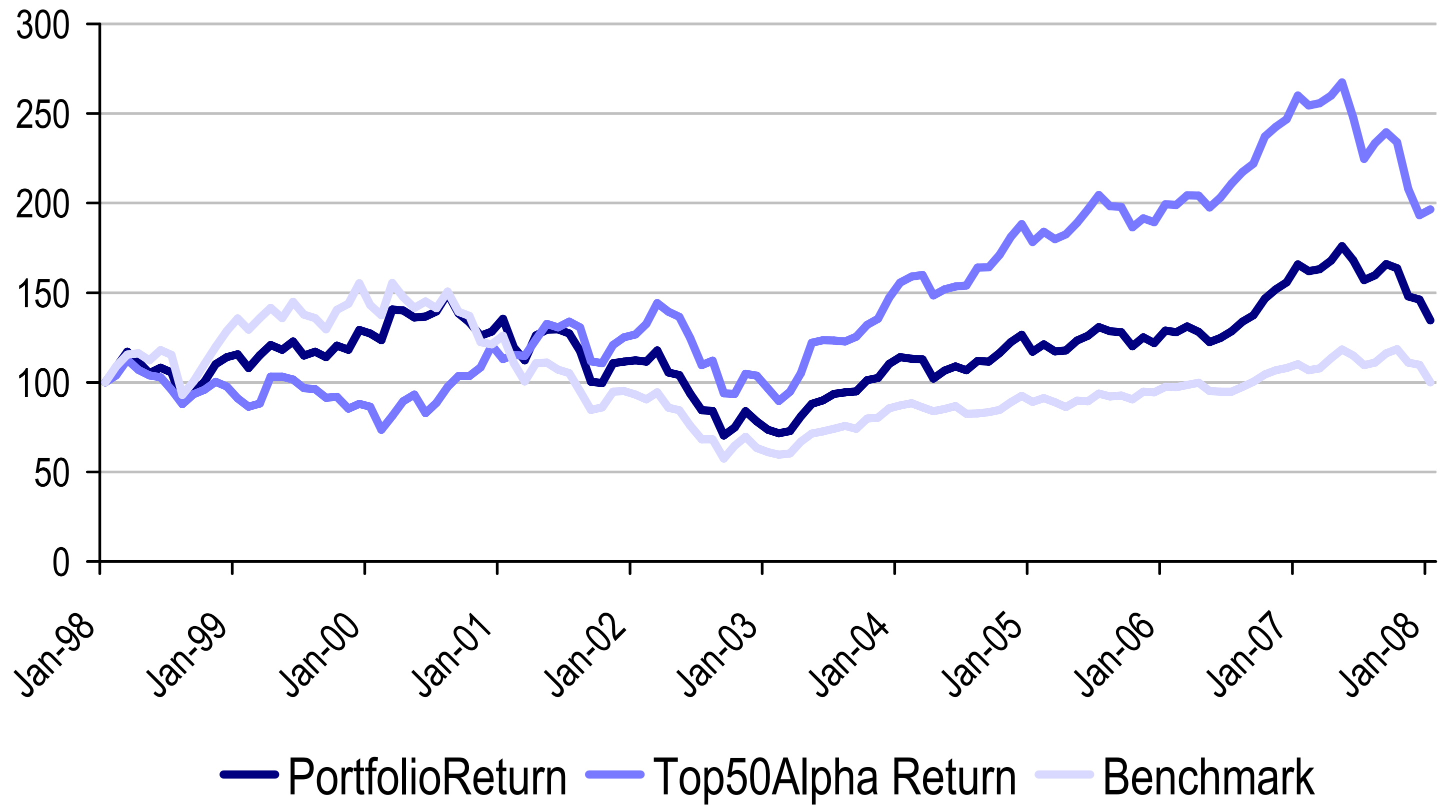
Source UBS

Optimisation result (a fraction)

Sedol	Portfolio	Benchmark	Initial	Solution	Active	Alpha	Beta	wmcar	Buy	Sell	AvTradVolM
2023748	HESS CORP	0.206038	0	0	-0.20604	0.465763	0.948081	0.030818	100	100	427.7867
2326618	EXXON MOI	3.798173	0	1.908847	-1.88933	0.978916	1.065178	0.036541	100	100	2337.588
2685717	CONOCOPH	0.492057	0	0	-0.49206	1.1719	0.994433	0.03405	100	100	1352.466
2838555	CHEVRON C	1.427728	2.947958	3.362552	1.934824	1.600322	1.068332	0.037687	100	100	955.0865
2859868	SUNOCO IN	0.059338	0	0	-0.05934	0.90095	1.379245	0.047849	100	100	169.0146
2655408	OCCIDENTA	0.446895	0	0.869826	0.422931	0.911087	1.148692	0.039456	100	100	613.4385
2611206	MURPHY OI	0.052191	0	0	-0.05219	0.610235	0.918325	0.029927	100	100	111.9328
2026242	AMERICAN	0.13552	0	0	-0.13552	1.967978	0.87347	0.031794	100	100	174.5564
2073408	CONSTELLA	0.134421	0	0	-0.13442	0.998778	0.851974	0.029926	100	100	177.9406
2216850	CONSOLIDA	0.0936	3.586829	0	-0.0936	2.825563	0.680261	0.025564	100	100	119.4374
2280220	DTE ENERGY	0.057688	1.199267	0	-0.05769	2.524502	0.718578	0.026413	100	100	77.83524

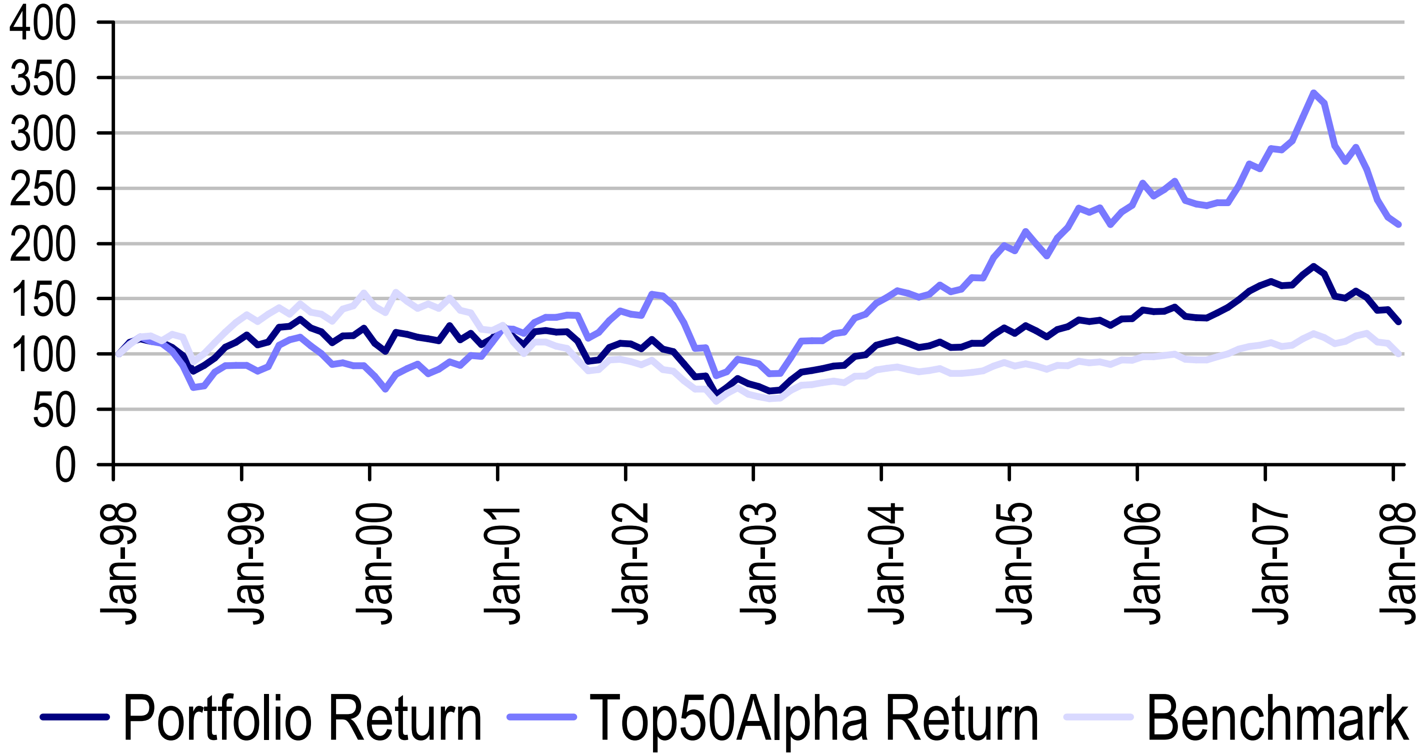
Source UBS

Portfolio performance – US, Dividend Yield alpha



Source: UBS

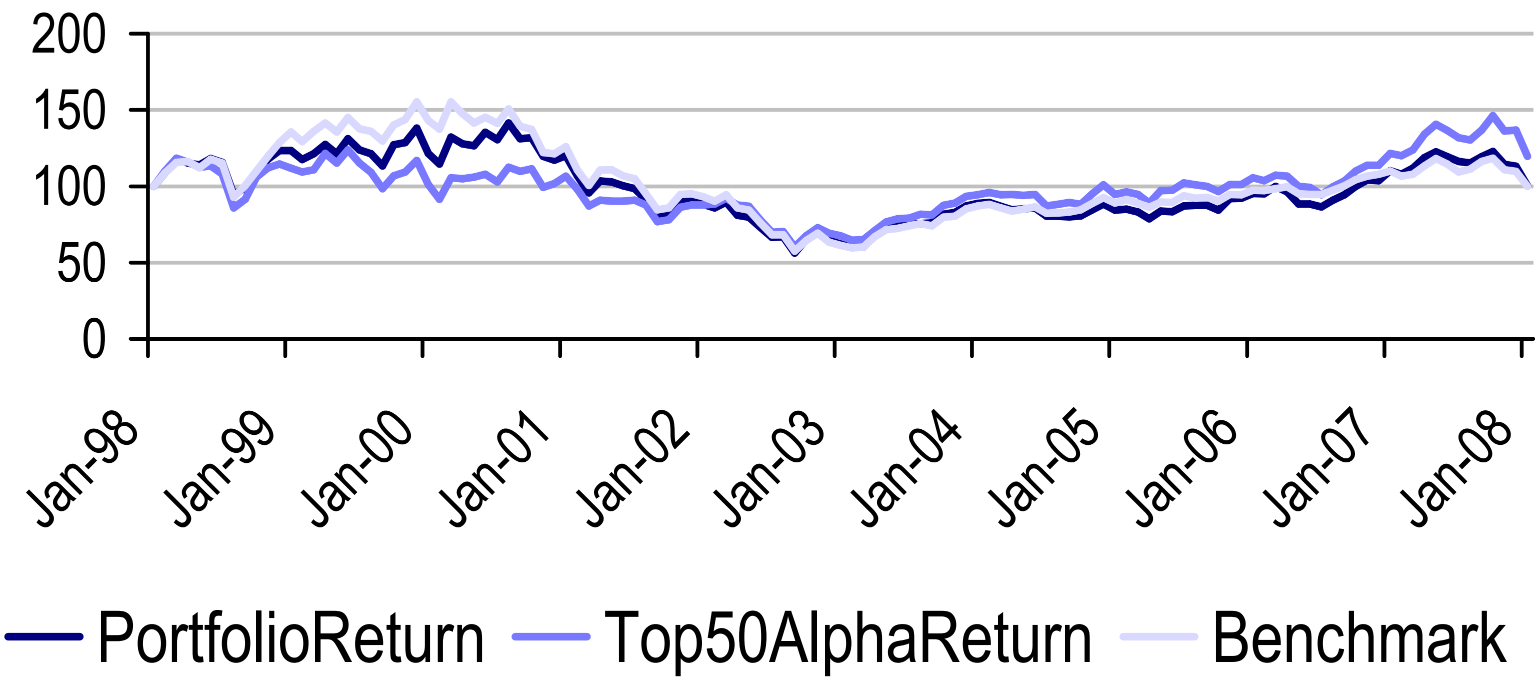
Portfolio performance – US, Earnings Yield alpha



Source: UBS

UBS

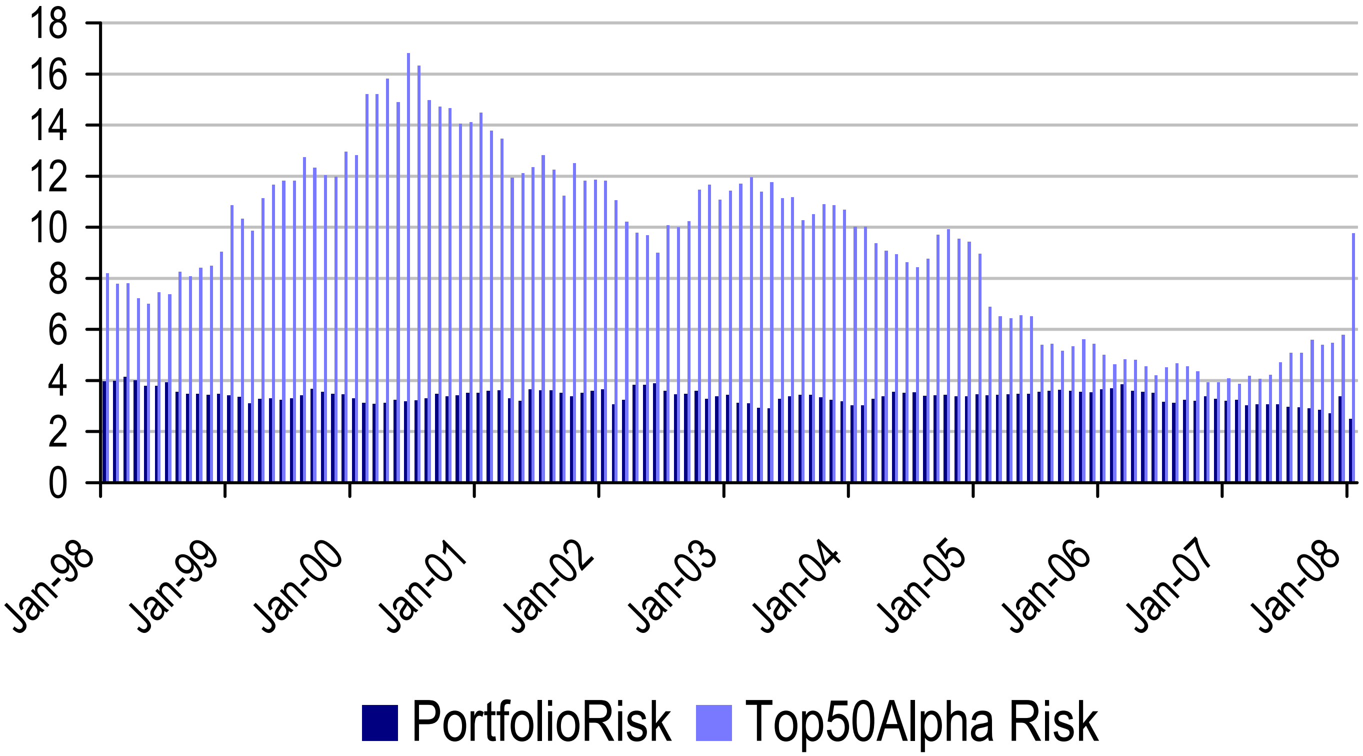
Portfolio performance – US, ROE alpha



Source: UBS

UBS

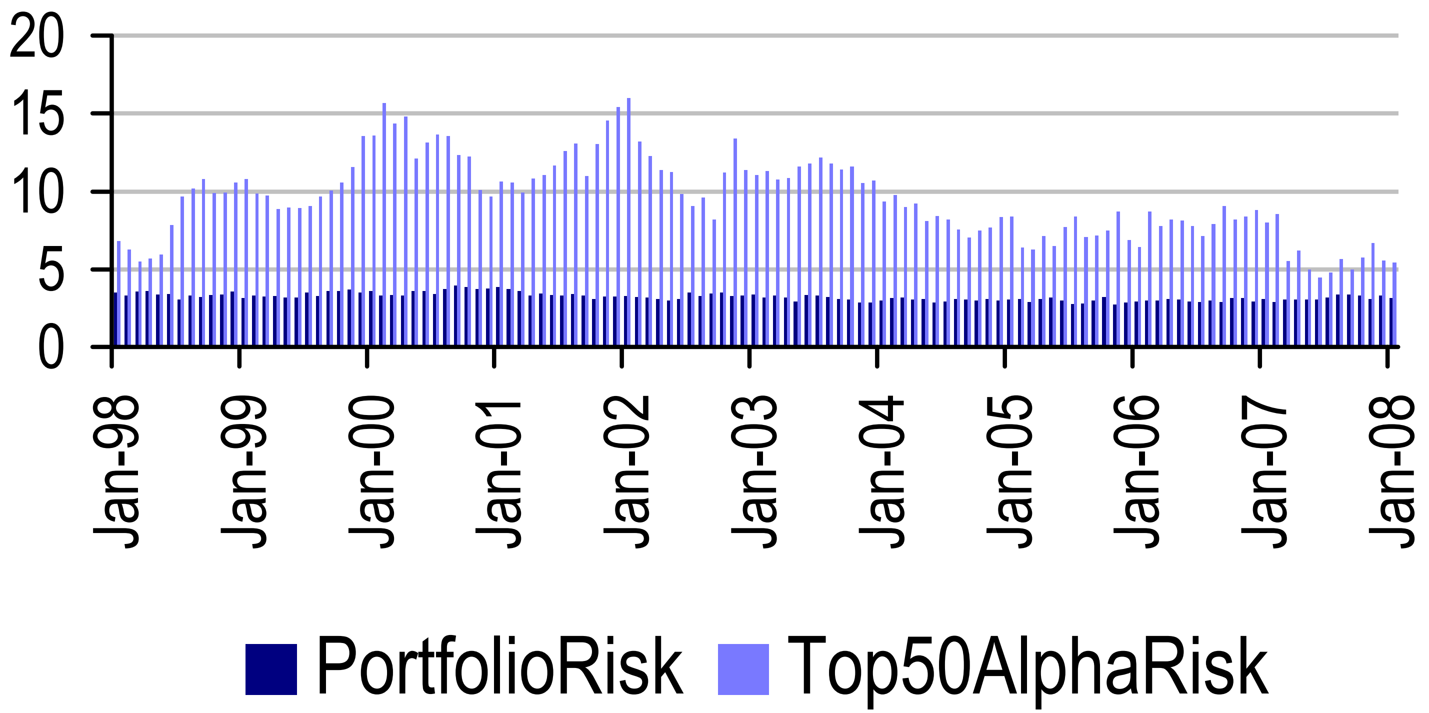
Portfolio tracking errors – US, Dividend Yield alpha



Source: UBS

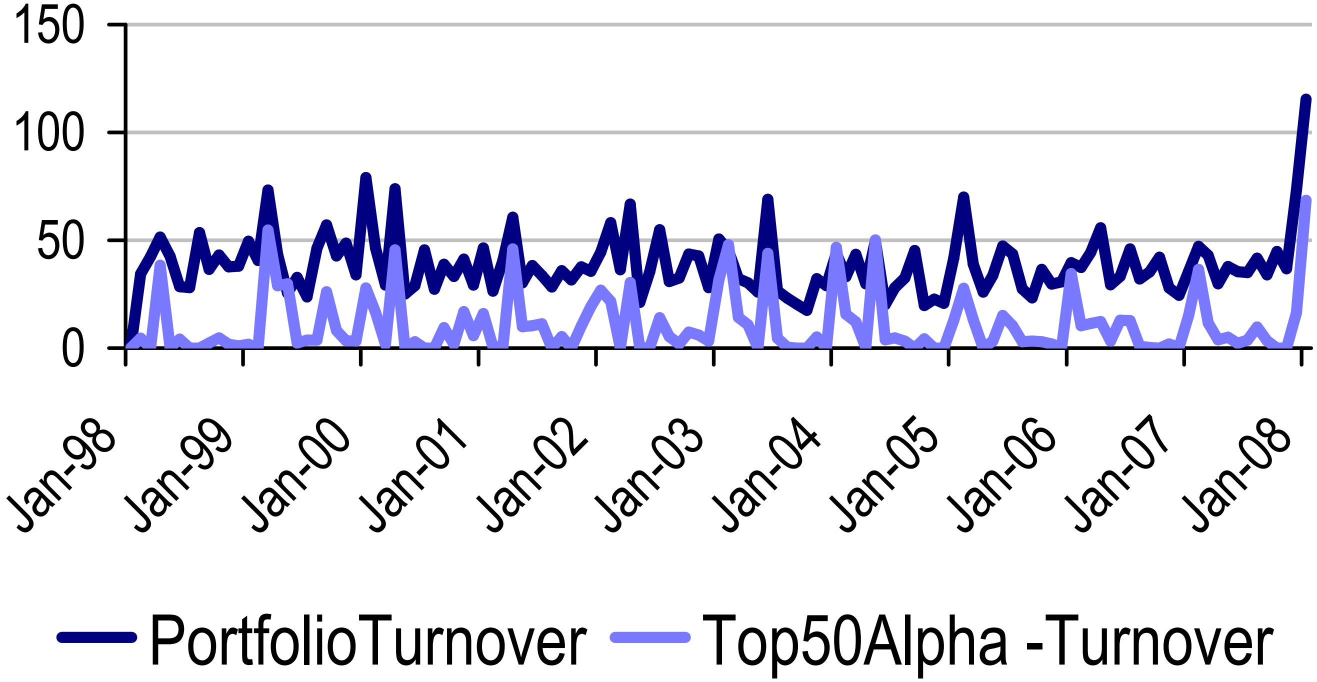
UBS

Portfolio tracking errors – US, Earnings Yield alpha



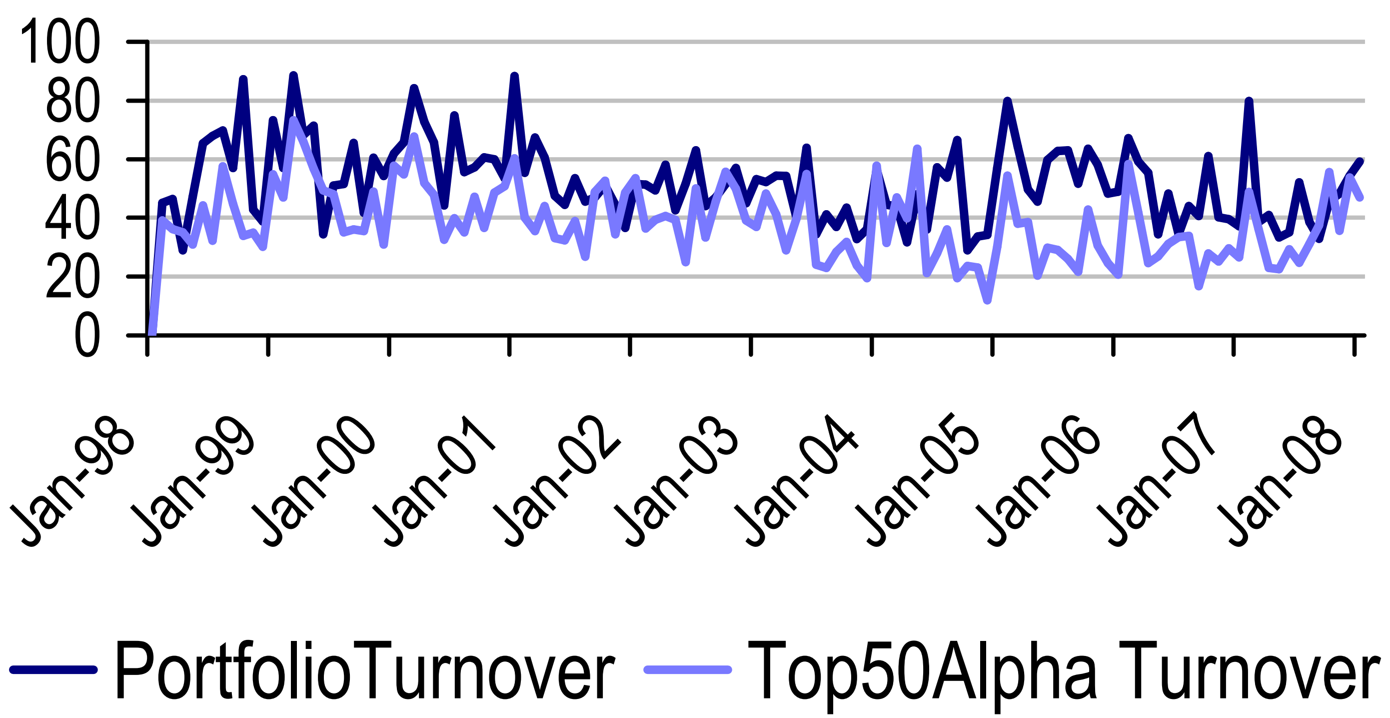
Source: UBS

Turnover – US, Dividend Yield alpha



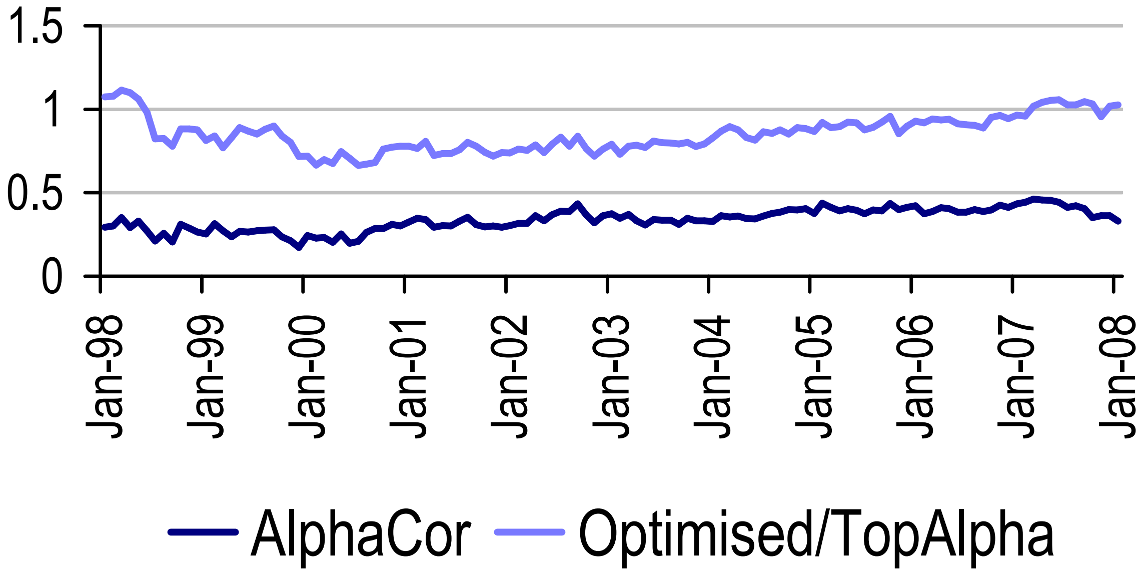
Source: UBS

Turnover – US, Earnings Yield alpha



Source: UBS

Portfolio Alpha Ratio Optimised to Top 50 Alpha



Source: UBS

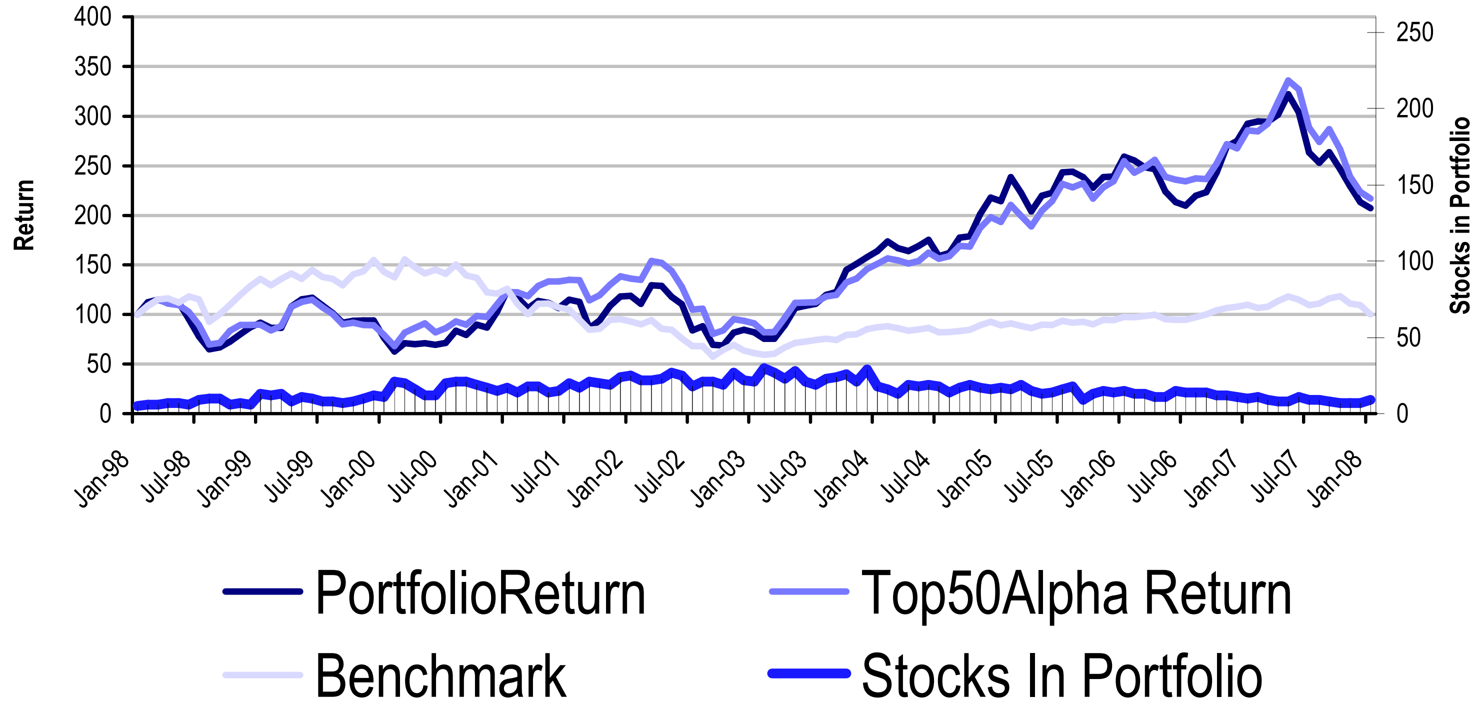
Does the fund follow the alpha? – correlate weights with alpha

or

measure fund’s alpha ratio of top 50 alpha stock portfolio

UBS

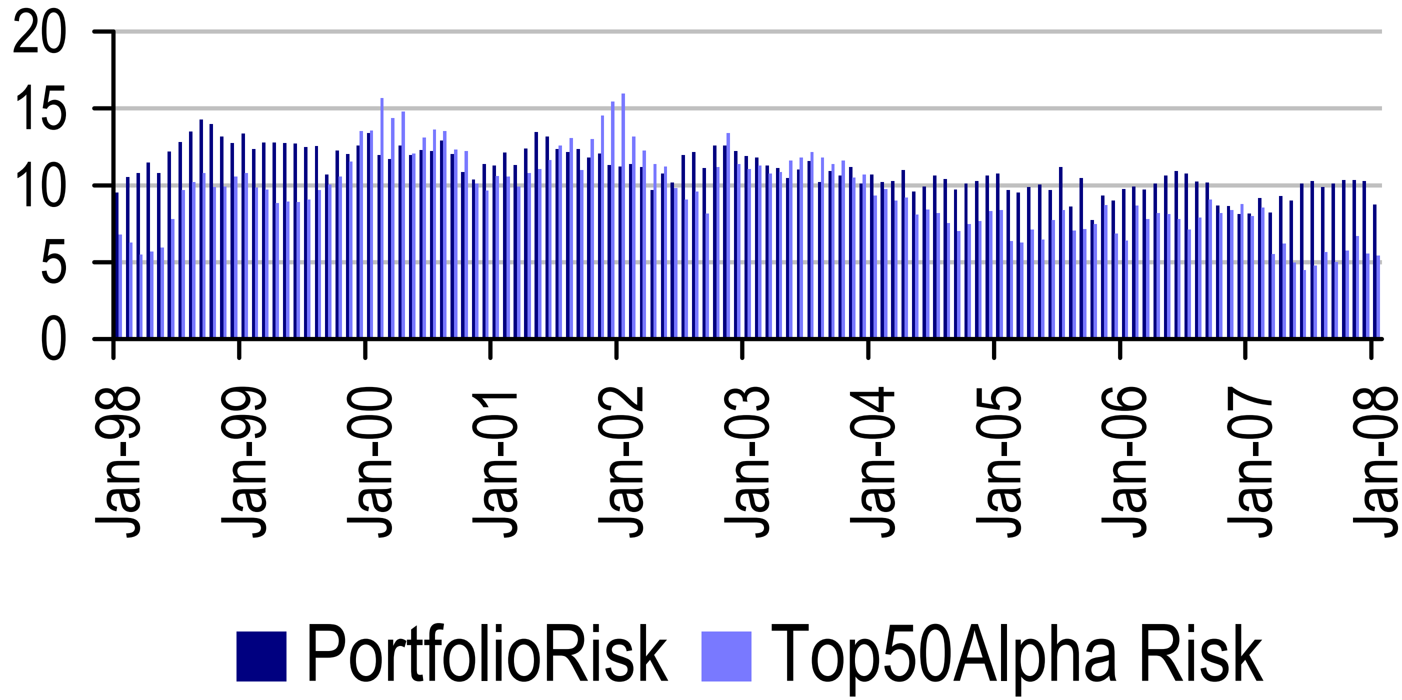
Earnings Yield Alpha – high risk gains in performance



Source: UBS

UBS

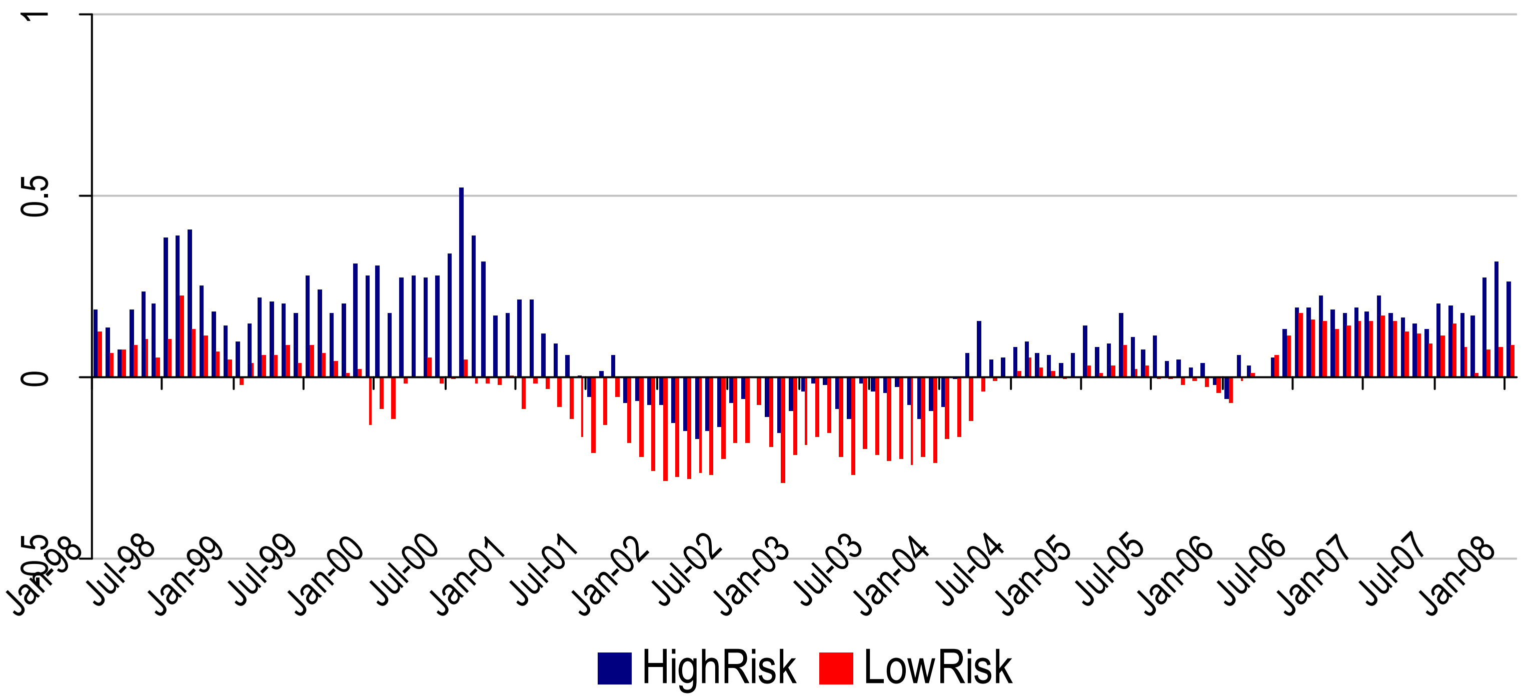
Earnings Yield Alpha – small count portfolio risk



Source: UBS

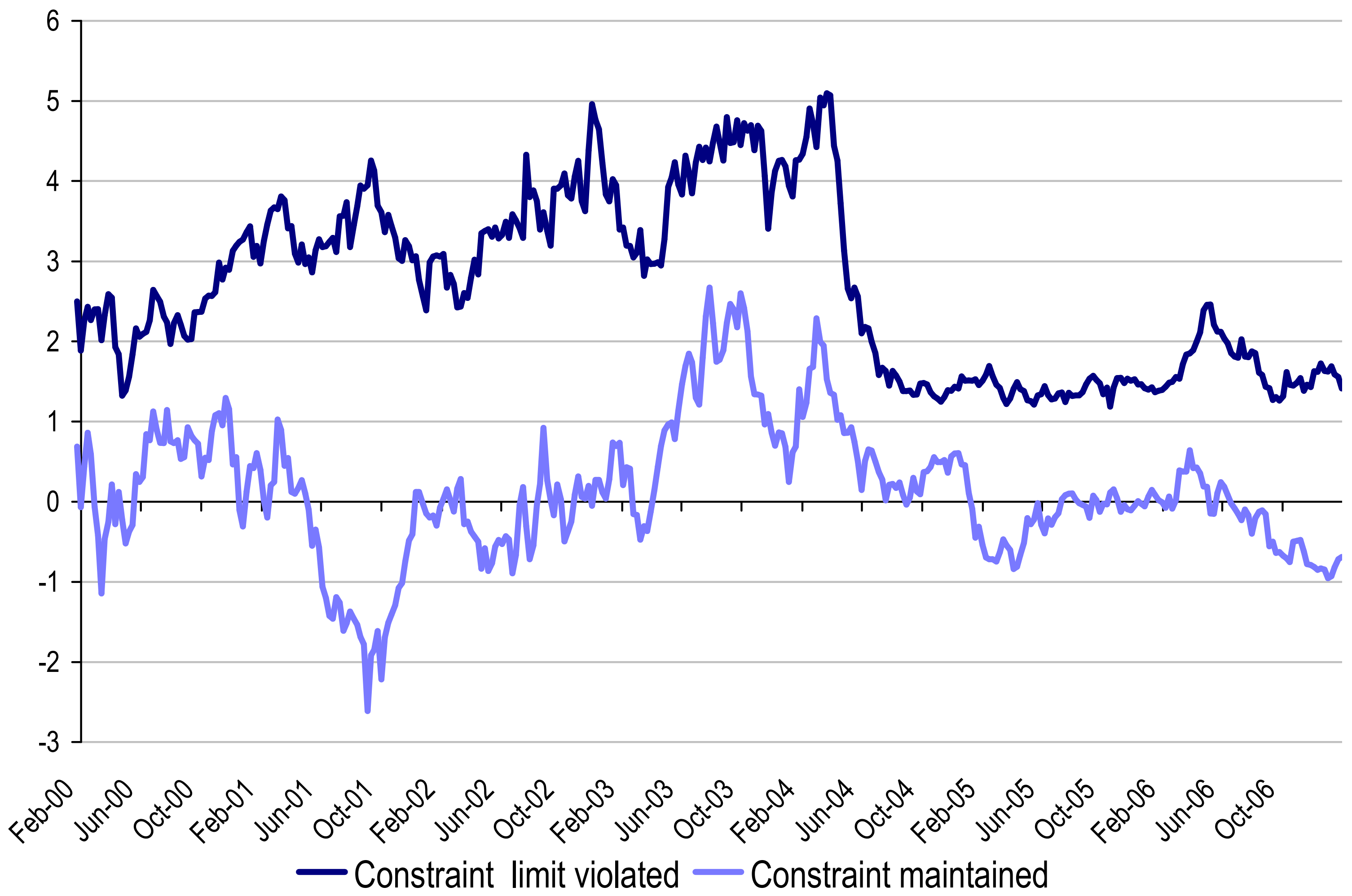
High and Low risk implied alpha

Max unconstrained Utility $\Rightarrow \alpha_I = \lambda C_{ij} w_j$



Source: UBS

IR for constrained and unconstrained holdings

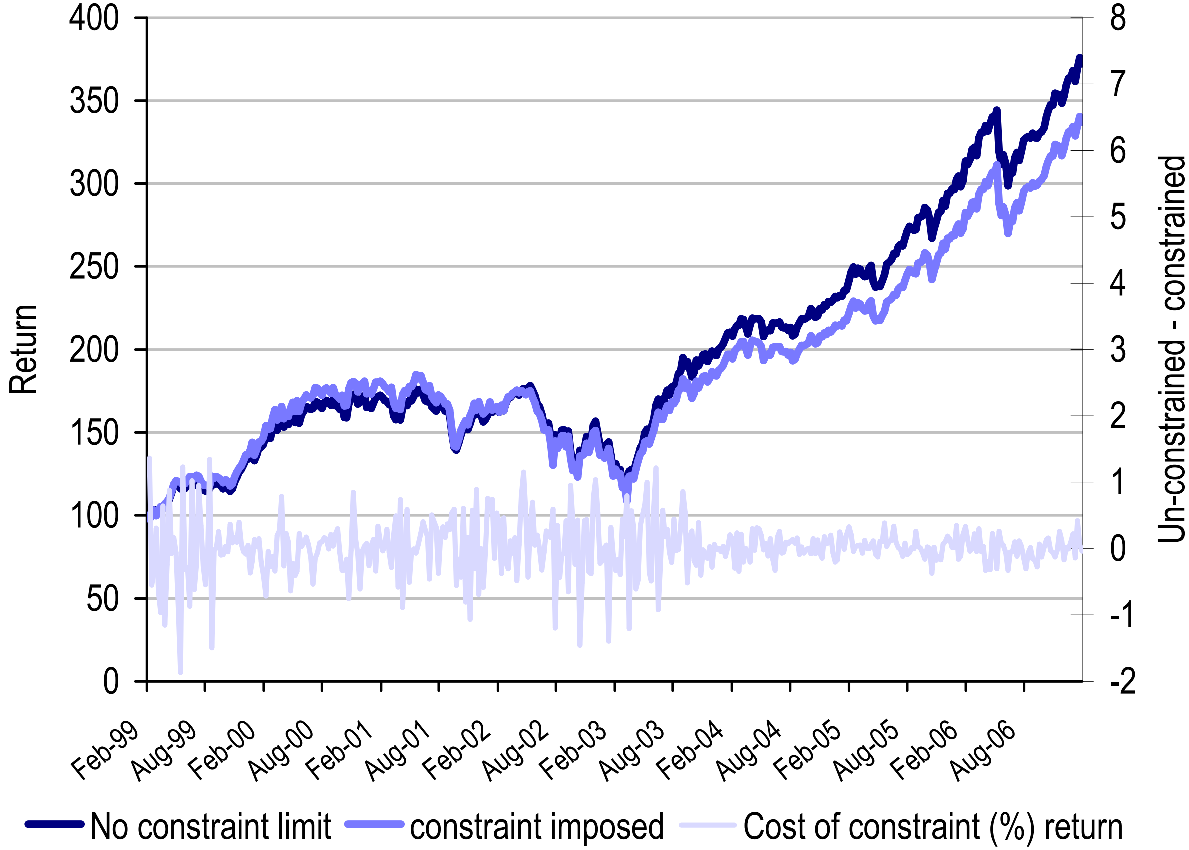


Source: UBS

IR=active return/TE

UBS

The cost of constraint



Source UBS

Summary

- Initial backtest of performance drivers required for top – bottom selection and alpha generation.
- Rebalancing frequency, industry tilt, weighting scheme, all can affect performance.
- To examine true performance of a fund we need to include risk aversion and holding constraints in the backtest – optimise at each rebalancing.
- Solution analysis: Fundamental statistics – tracking error; information ratios; active position; principal contributors to the tracking error and to outperformance holding.

  Does the fund follow my strategist recommendation?
  – Did I pick up the stocks with high beta to expected outperforming factors?

  Do I follow my stock selector recommendation?
  – Did I pick up the stocks with high alpha?
  – How is my performance affected by constraints?
- Alpha fund - make sure the return forecasts are represented in the holdings – beware of over-constraining and of excessive risk aversion.

Required Disclosures

This report has been prepared by UBS Limited, an affiliate of UBS AG. UBS AG, its subsidiaries, branches and affiliates are referred to herein as UBS.

For information on the ways in which UBS manages conflicts and maintains independence of its research product; historical performance information; and certain additional disclosures concerning UBS research recommendations, please visit www.ubs.com/disclosures.

UBS Investment Research: Global Equity Rating Allocations

UBS 12-Month Rating	Rating Category	Coverage[1]	IB Services[2]
Buy	**Buy**	55%	39%
Neutral	**Hold/Neutral**	36%	36%
Sell	**Sell**	8%	20%
UBS Short-Term Rating	**Rating Category**	**Coverage[3]**	**IB Services[4]**
Buy	**Buy**	less than 1%	25%
Sell	**Sell**	less than 1%	50%

1:Percentage of companies under coverage globally within the 12-month rating category.
2:Percentage of companies within the 12-month rating category for which investment banking (IB) services were provided within the past 12 months.
3:Percentage of companies under coverage globally within the Short-Term rating category.
4:Percentage of companies within the Short-Term rating category for which investment banking (IB) services were provided within the past 12 months.

Source: UBS. Rating allocations are as of 31 December 2007.

UBS Investment Research: Global Equity Rating Definitions

UBS 12-Month Rating	Definition
Buy	FSR is > 6% above the MRA.
Neutral	FSR is between -6% and 6% of the MRA.
Sell	FSR is > 6% below the MRA.
UBS Short-Term Rating	**Definition**
Buy	Buy: Stock price expected to rise within three months from the time the rating was assigned because of a specific catalyst or event.
Sell	Sell: Stock price expected to fall within three months from the time the rating was assigned because of a specific catalyst or event.

Definitions & exceptions

KEY DEFINITIONS

Forecast Stock Return (FSR) is defined as expected percentage price appreciation plus gross dividend yield over the next 12 months.
Market Return Assumption (MRA) is defined as the one-year local market interest rate plus 5% (a proxy for, and not a forecast of, the equity risk premium).
Under Review (UR) Stocks may be flagged as UR by the analyst, indicating that the stock's price target and/or rating are subject to possible change in the near term, usually in response to an event that may affect the investment case or valuation.
Short-Term Ratings reflect the expected near-term (up to three months) performance of the stock and do not reflect any change in the fundamental view or investment case.

EXCEPTIONS AND SPECIAL CASES

US Closed-End Fund ratings and definitions are: Buy: Higher stability of principal and higher stability of dividends; Neutral: Potential loss of principal, stability of dividend; Reduce: High potential for loss of principal and dividend risk.
UK and European Investment Fund ratings and definitions are: Buy: Positive on factors such as structure, management, performance record, discount; Neutral: Neutral on factors such as structure, management, performance record, discount; Reduce: Negative on factors such as structure, management, performance record, discount.
Core Banding Exceptions (CBE): Exceptions to the standard +/-6% bands may be granted by the Investment Review Committee (IRC). Factors considered by the IRC include the stock's volatility and the credit spread of the respective company's debt. As a result, stocks deemed to be very high or low risk may be subject to higher or lower bands as they relate to the rating. When such exceptions apply, they will be identified in the Companies Mentioned or Company Disclosure table in the relevant research piece.

Global Disclaimer

This report has been prepared by UBS Limited, an affiliate of UBS AG. UBS AG, its subsidiaries, branches and affiliates are referred to herein as UBS. In certain countries, UBS AG is referred to as UBS SA.

This report is for distribution only under such circumstances as may be permitted by applicable law. Nothing in this report constitutes a representation that any investment strategy or recommendation contained herein is suitable or appropriate to a recipient's individual circumstances or otherwise constitute a personal recommendation. It is published solely for information purposes, it does not constitute an advertisement and is not to be construed as a solicitation or an offer to buy or sell any securities or related financial instruments in any jurisdiction. No representation or warranty, either express or implied, is provided in relation to the accuracy, completeness or reliability of the information contained herein, except with respect to information concerning UBS AG, its subsidiaries and affiliates, nor is it intended to be a complete statement or summary of the securities, markets or developments referred to in the report. UBS does not undertake that investors will obtain profits, nor will it share with investors any investment profits nor accept any liability for any investment losses. Investments involve risks and investors should exercise prudence in making their investment decisions. The report should not be regarded by recipients as a substitute for the exercise of their own judgement. Any opinions expressed in this report are subject to change without notice and may differ or be contrary to opinions expressed by other business areas or groups of UBS as a result of using different assumptions and criteria. Research will initiate, update and cease coverage solely at the discretion of UBS Investment Bank Research Management. The analysis contained herein is based on numerous assumptions. Different assumptions could result in materially different results. The analyst(s) responsible for the preparation of this report may interact with trading desk personnel, sales personnel and other constituencies for the purpose of gathering, synthesizing and interpreting market information. UBS is under no obligation to update or keep current the information contained herein. UBS relies on information barriers to control the flow of information contained in one or more areas within UBS, into other areas, units, groups or affiliates of UBS. The compensation of the analyst who prepared this report is determined exclusively by research management and senior management (not including investment banking). Analyst compensation is not based on investment banking revenues, however, compensation may relate to the revenues of UBS Investment Bank as a whole, of which investment banking, sales and trading are a part.

The securities described herein may not be eligible for sale in all jurisdictions or to certain categories of investors. Options, derivative products and futures are not suitable for all investors, and trading in these instruments is considered risky. Mortgage and asset-backed securities may involve a high degree of risk and may be highly volatile in response to fluctuations in interest rates and other market conditions. Past performance is not necessarily indicative of future results. Foreign currency rates of exchange may adversely affect the value, price or income of any security or related instrument mentioned in this report. For investment advice, trade execution or other enquiries, clients should contact their local sales representative. Neither UBS nor any of its affiliates, nor any of UBS' or any of its affiliates, directors, employees or agents accepts any liability for any loss or damage arising out of the use of all or any part of this report. Additional information will be made available upon request.

For financial instruments admitted to trading on an EU regulated market: UBS AG, its affiliates or subsidiaries (excluding UBS Securities LLC and/or UBS Capital Markets LP) acts as a market maker or liquidity provider (in accordance with the interpretation of these terms in the UK) in the financial instruments of the issuer save that where the activity of liquidity provider is carried out in accordance with the definition given to it by the laws and regulations of any other EU jurisdictions, such information is separately disclosed in this research report.

United Kingdom and the rest of Europe: Except as otherwise specified herein, this material is communicated by UBS Limited, a subsidiary of UBS AG, to persons who are eligible counterparties or professional clients and is only available to such persons. The information contained herein does not apply to, and should not be relied upon by, retail clients.. UBS Limited is authorised and regulated by the Financial Services Authority (FSA). UBS research complies with all the FSA requirements and laws concerning disclosures and these are indicated on the research where applicable. **France:** Prepared by UBS Limited and distributed by UBS Limited and UBS Securities France SA. UBS Securities France S.A. is regulated by the Autorité des Marchés Financiers (AMF). Where an analyst of UBS Securities France S.A. has contributed to this report, the report is also deemed to have been prepared by UBS Securities France S.A. **Germany:** Prepared by UBS Limited and distributed by UBS Limited and UBS Deutschland AG. UBS Deutschland AG is regulated by the Bundesanstalt fur Finanzdienstleistungsaufsicht (BaFin). **Spain:** Prepared by UBS Limited and distributed by UBS Limited and UBS Securities España SV, SA. UBS Securities España SV, SA is regulated by the Comisión Nacional del Mercado de Valores (CNMV). **Turkey:** Prepared by UBS Menkul Degerler AS on behalf of and distributed by UBS Limited. **Russia:** Prepared and distributed by ZAO UBS Securities. **Switzerland:** Distributed by UBS AG to persons who are institutional investors only. **Italy:** Prepared by UBS Limited and distributed by UBS Limited and UBS Italia Sim S.p.A.. UBS Italia Sim S.p.A. is regulated by the Bank of Italy and by the Commissione Nazionale per le Società e la Borsa (CONSOB). Where an analyst of UBS Italia Sim S.p.A. has contributed to this report, the report is also deemed to have been prepared by UBS Italia Sim S.p.A.. **South Africa:** UBS South Africa (Pty) Limited (Registration No. 1995/011140/07) is a member of the JSE Limited, the South African Futures Exchange and the Bond Exchange of South Africa. UBS South Africa (Pty) Limited is an authorised Financial Services Provider. Details of its postal and physical address and a list of its directors are available on request or may be accessed at http:www.ubs.co.za. **United States:** Distributed to US persons by either UBS Securities LLC or by UBS Financial Services Inc., subsidiaries of UBS AG; or by a group, subsidiary or affiliate of UBS AG that is not registered as a US broker-dealer (a '**non-US affiliate'**), to major US institutional investors only. UBS Securities LLC or UBS Financial Services Inc. accepts responsibility for the content of a report prepared by another non-US affiliate when distributed to US persons by UBS Securities LLC or UBS Financial Services Inc. All transactions by a US person in the securities mentioned in this report must be effected through UBS Securities LLC or UBS Financial Services Inc., and not through a non-US affiliate. **Canada:** Distributed by UBS Securities Canada Inc., a subsidiary of UBS AG and a member of the principal Canadian stock exchanges & CIPF. A statement of its financial condition and a list of its directors and senior officers will be provided upon request. **Hong Kong:** Distributed by UBS Securities Asia Limited. **Singapore:** Distributed by UBS Securities Pte. Ltd or UBS AG, Singapore Branch. **Japan:** Distributed by UBS Securities Japan Ltd to institutional investors only. **Australia:** Distributed by UBS AG (Holder of Australian Financial Services Licence No. 231087) and UBS Securities Australia Ltd (Holder of Australian Financial Services Licence No. 231098) only to 'Wholesale' clients as defined by s761G of the Corporations Act 2001. **New Zealand:** Distributed by UBS New Zealand Ltd. **China:** Distributed by UBS Securities Co. Limited.

The disclosures contained in research reports produced by UBS Limited shall be governed by and construed in accordance with English law.

UBS specifically prohibits the redistribution of this material in whole or in part without the written permission of UBS and UBS accepts no liability whatsoever for the actions of third parties in this respect. © UBS 2008. The key symbol and UBS are among the registered and unregistered trademarks of UBS. All rights reserved.