For professional investors only

Old Mutual

Portfolio risk models, from white swans to black swans

Northfield Information Services (UK) Spring 2008 Investment Seminar

April 2008

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Agenda

- The context
- The issues
- Linear factor models
- Tail risks

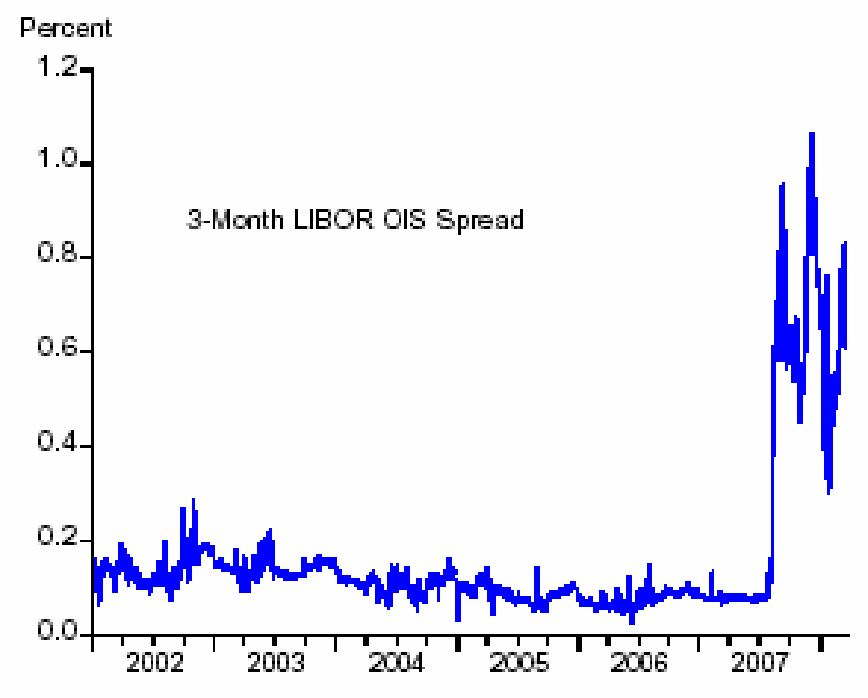
The context

Black swans

- Attributes:
  - "An outlier, … outside the realms of regular expectations"
  - "Extreme impact"
  - "Retrospective predictability …makes us concoct explanations after the fact, making it explainable and predictable"
- "Go ask your portfolio manager for his definition of 'risk', and odds are that he will supply you with a *measure* that *excludes* the possibility of the Black Swan – hence one that has no better predictive value for assessing the total risks than astrology, we will see how they dress up the intellectual fraud with mathematics"
  - 'The Black Swan: the impact of the highly improbable' by Nassim Nicholas Taleb

Source:'The Black Swan: the impact of the highly improbable' by Nassim Nicholas Taleb

An example



> "The mean through March 20 was 16 standard deviations above the old mean, which under normality would have been an extraordinarily improbable event"
>
> - 'A Black Swan in the Money Market' by John B Taylor and John C Williams, April 2008, Federal Reserve Bank of San Francisco working paper

Source: 'A Black Swan in the Money Market' by John B Taylor and John C Williams, April 2008, Federal Reserve Bank of San Francisco working paper

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The infinite improbability drive

> “We were seeing things that were 25 standard deviation moves, several days in a row”
> - David Viniar, CFO, Goldman Sachs, August 2007

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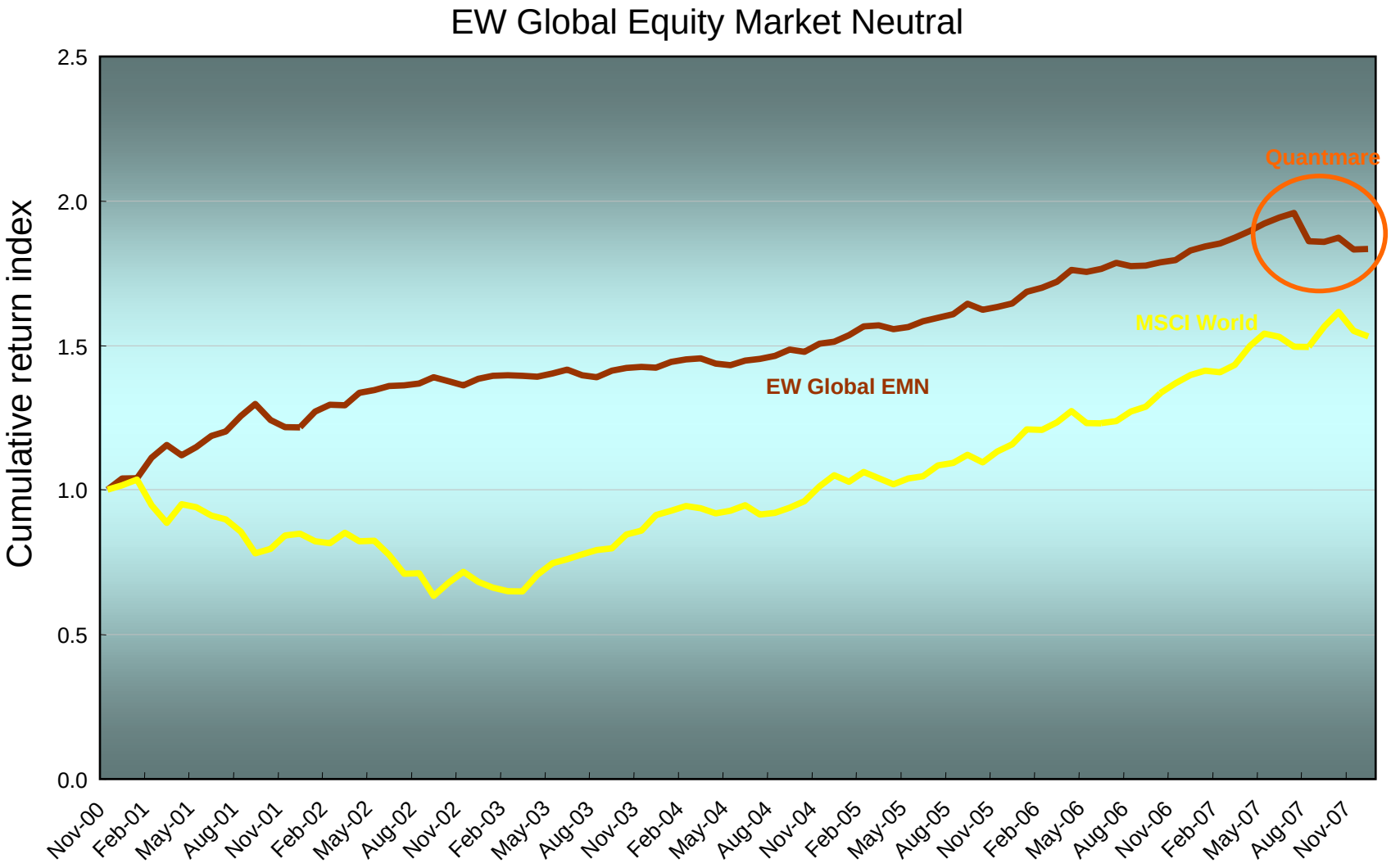
The issues

This decade's performance



Source: OMAM/Bisys/Citi/MSCI

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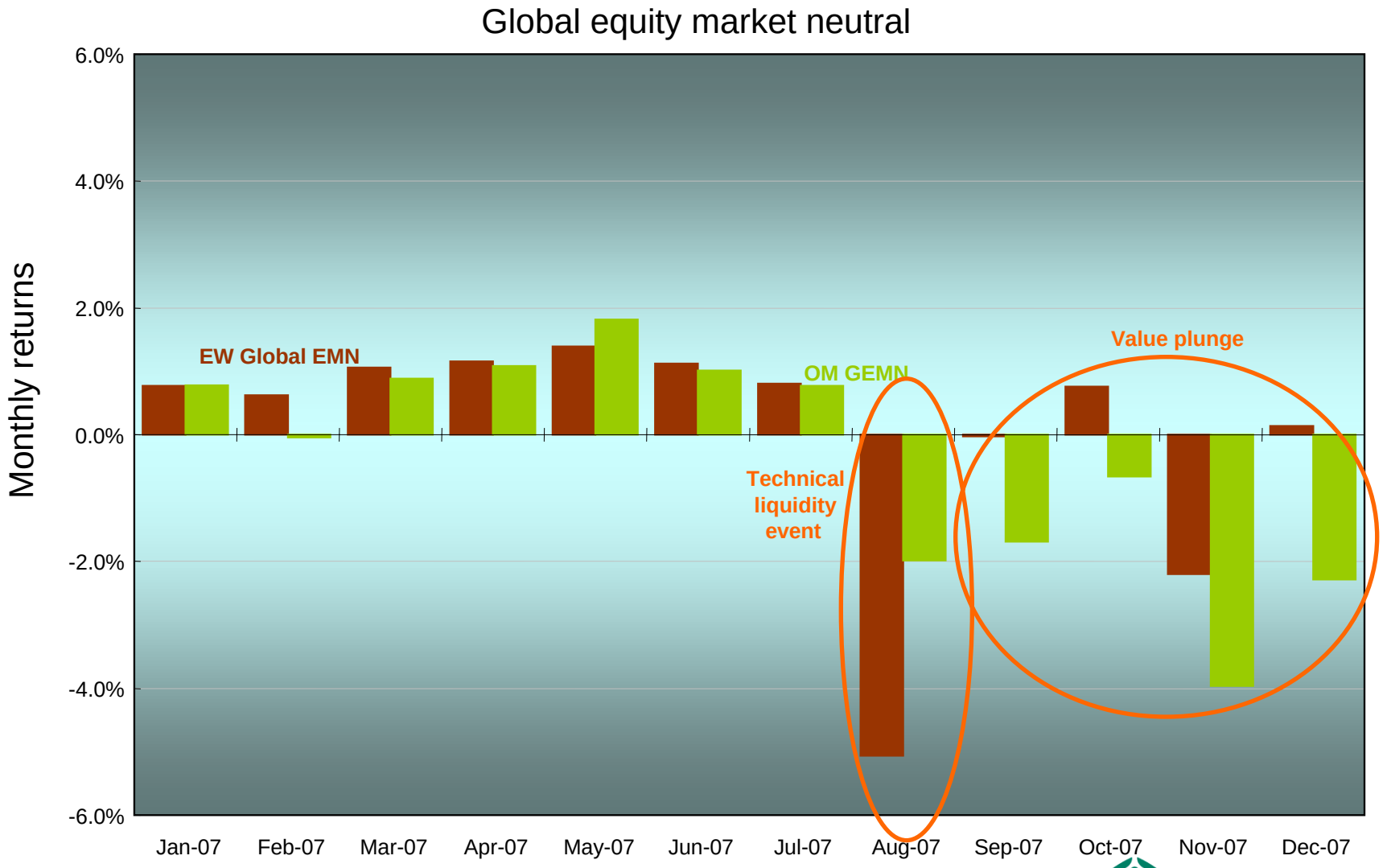
2007 performance



Source: OMAM/Bisys/Citi

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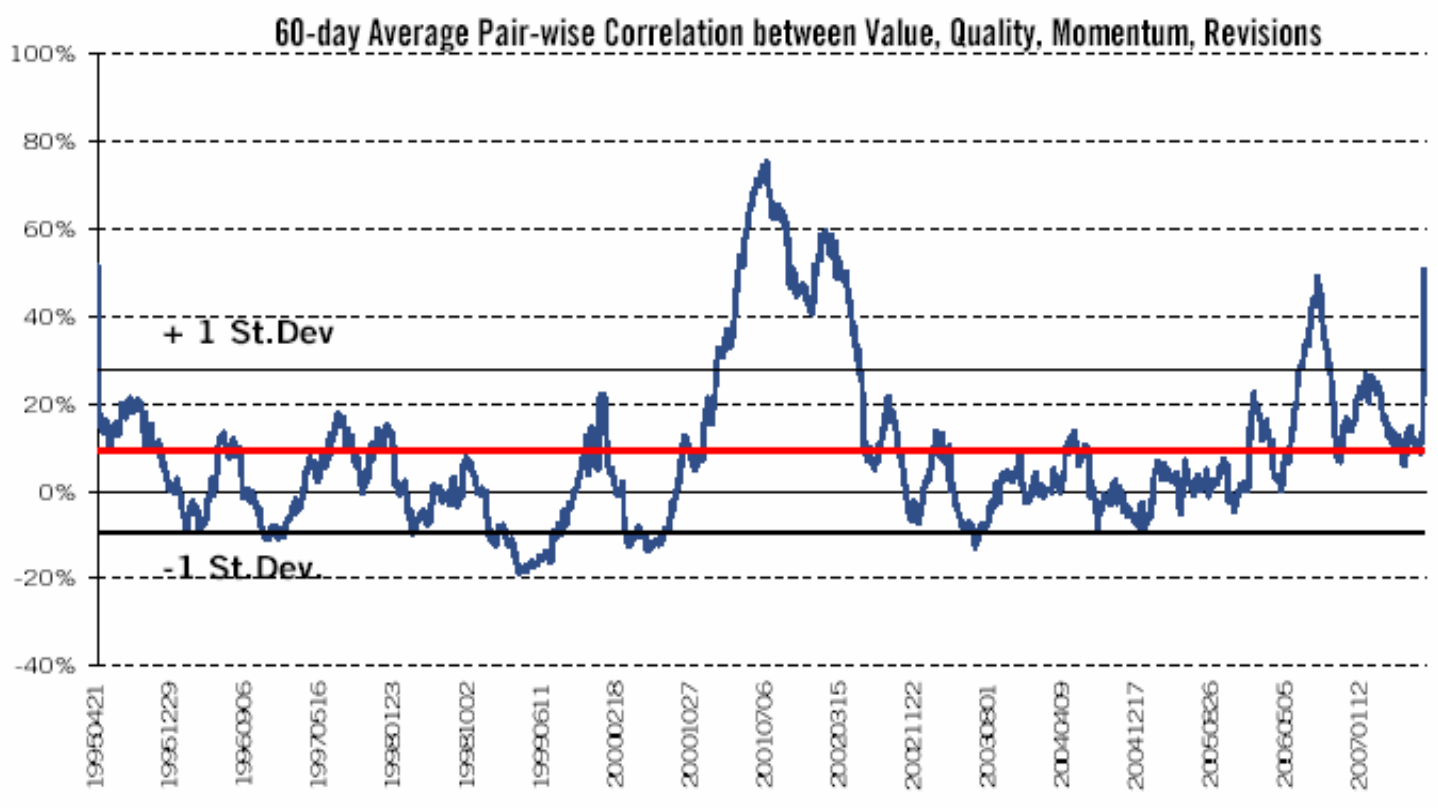
Factor correlations



Source: Citi Investment Research

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Factor volatility

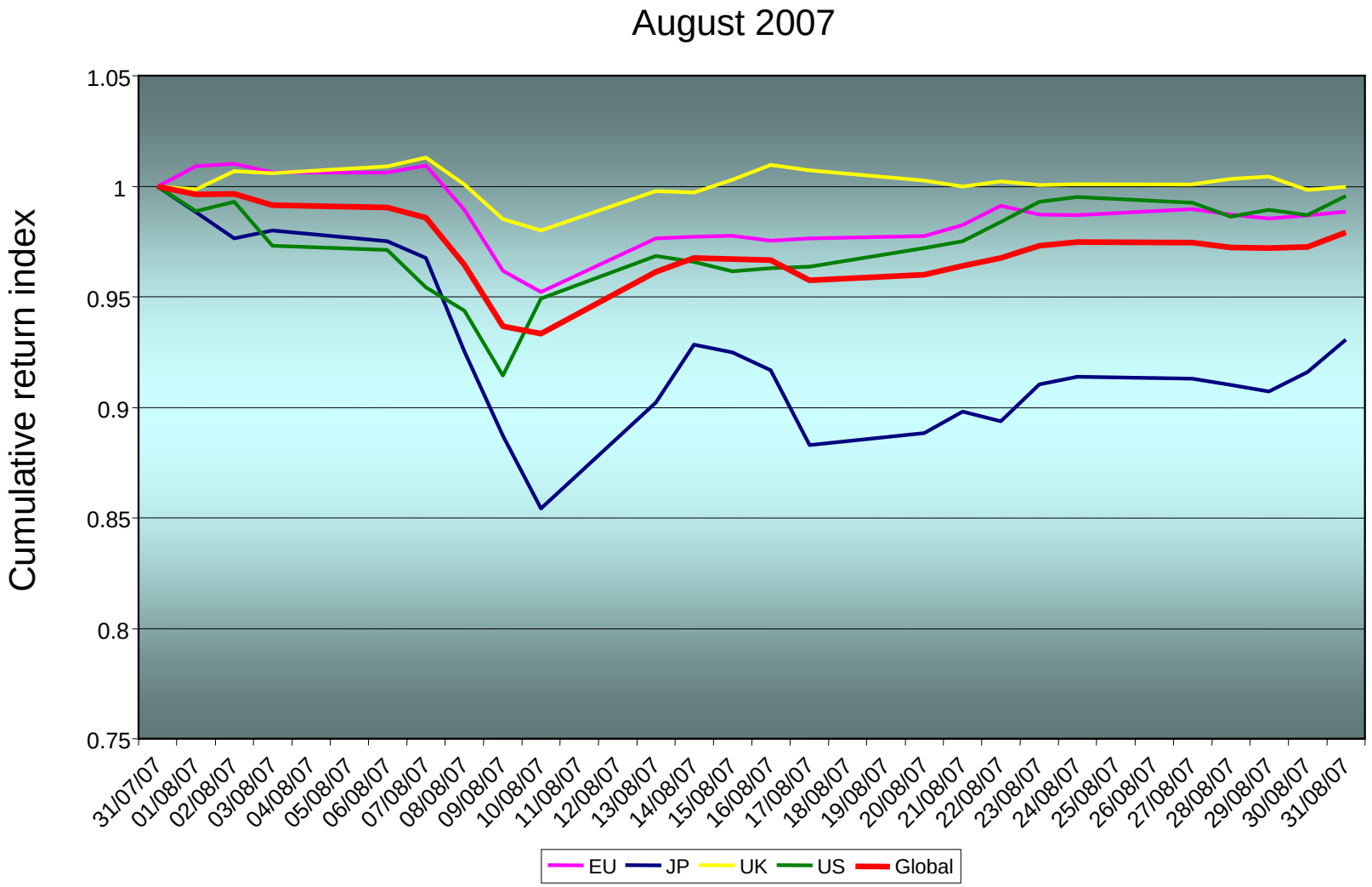
Figure 2. 20-day Volatility for Quant Factor Portfolios

	09-Aug-07	Average (3 Years)	Average (5 Years)	Average Since 95
Earnings Yield - 12 month forward	0.63	0.28	0.39	0.60
Dividend Yield	0.32	0.32	0.40	0.56
Deviation from Fair P/E	0.58	0.26	0.35	0.45
Earnings Quality (Accruals)	0.28	0.24	0.30	0.40
Price Momentum - 12 months	0.53	0.36	0.52	0.60
Earnings Revision	0.45	0.28	0.38	0.39

Source: Citigroup Investment Research

Source: Citi Investment Research

August 2007 – don't blink!



Source: OMAM: GEM Fund ex cash gross of all fees

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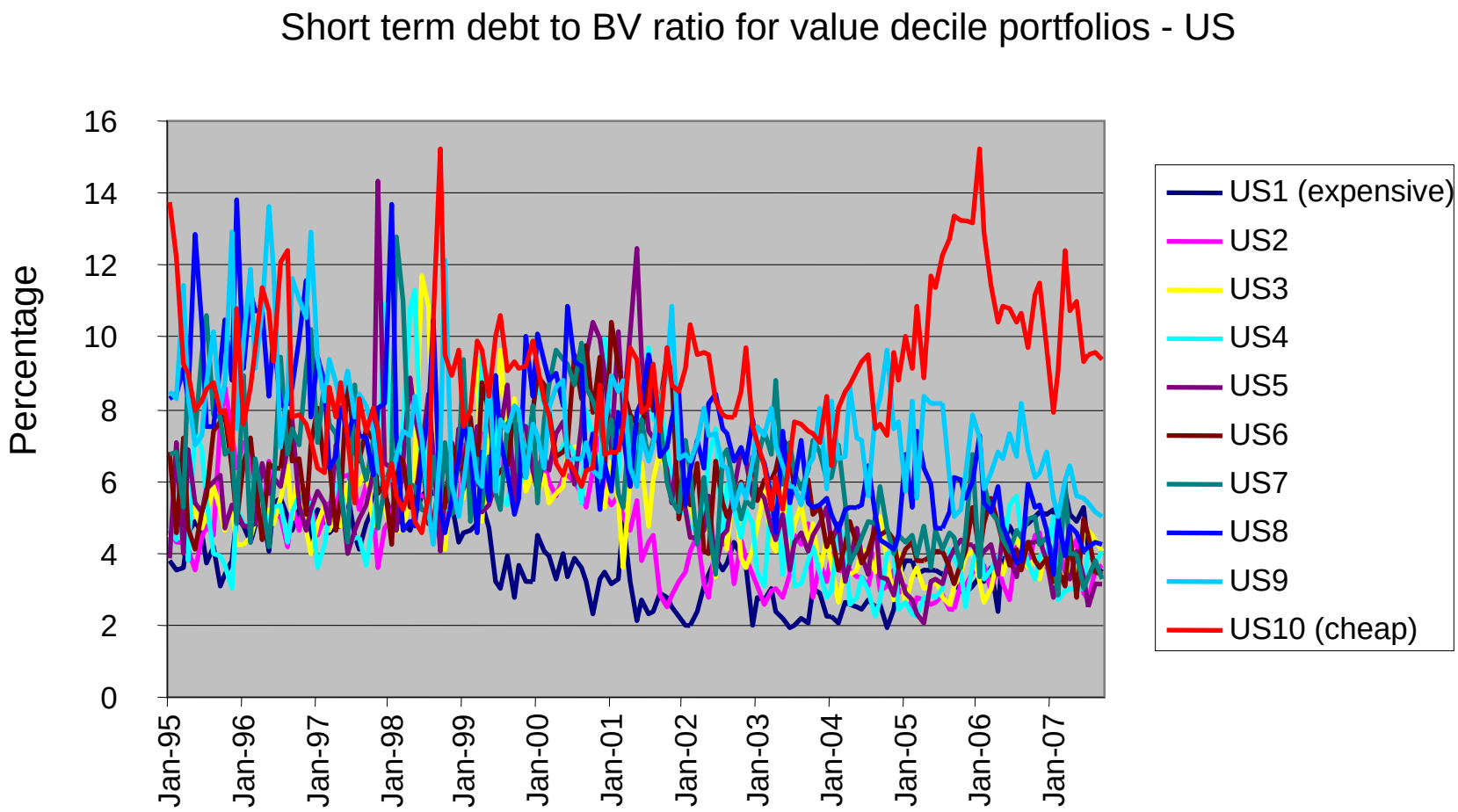
Exposure to credit



Source: OMAM / Factset

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Exposure to credit (cont.)

Figure 15. Percentage of Stocks in the High (low) Momentum Yield Portfolios exposed to Credit Sensitive Stocks

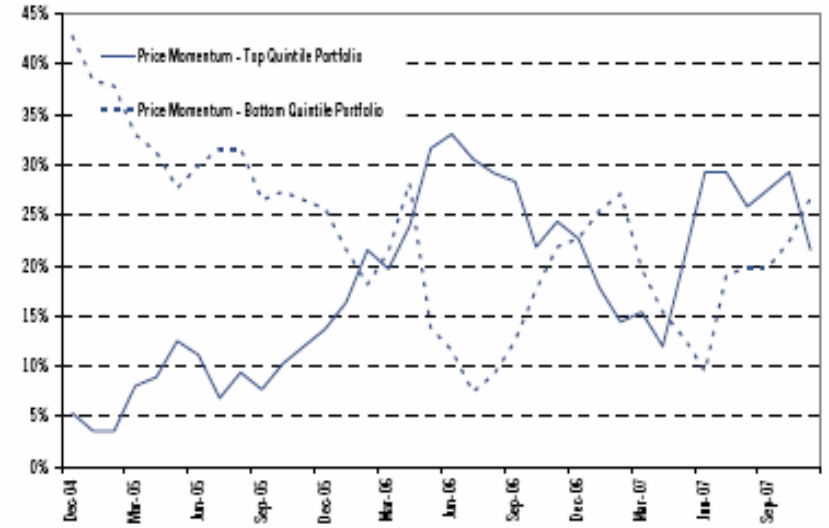
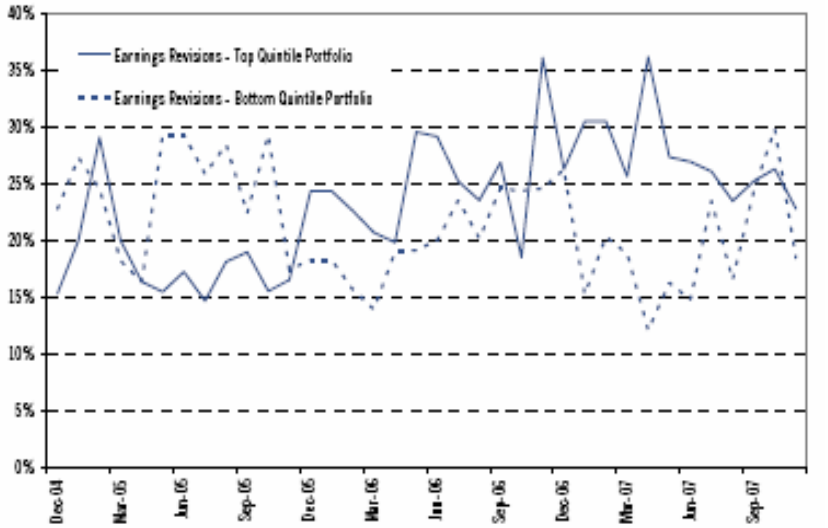


Figure 16. Percentage of Stocks in the High (low) Revisions Yield Portfolios exposed to Credit Sensitive Stocks



Source: Citi Investment Research

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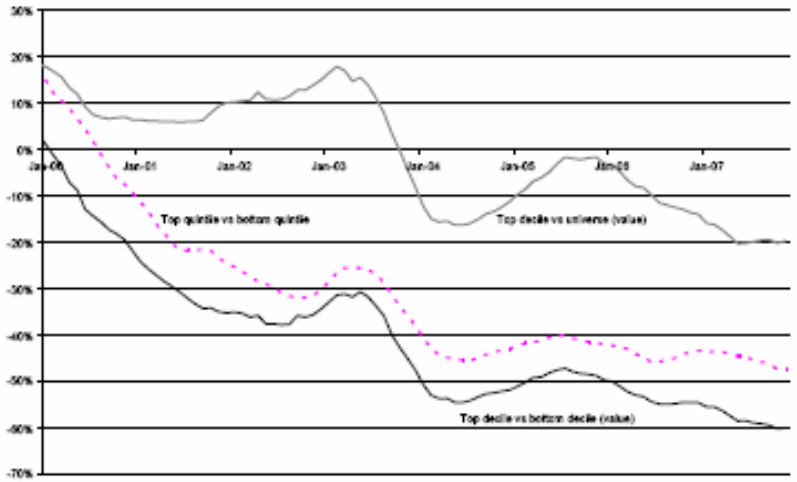
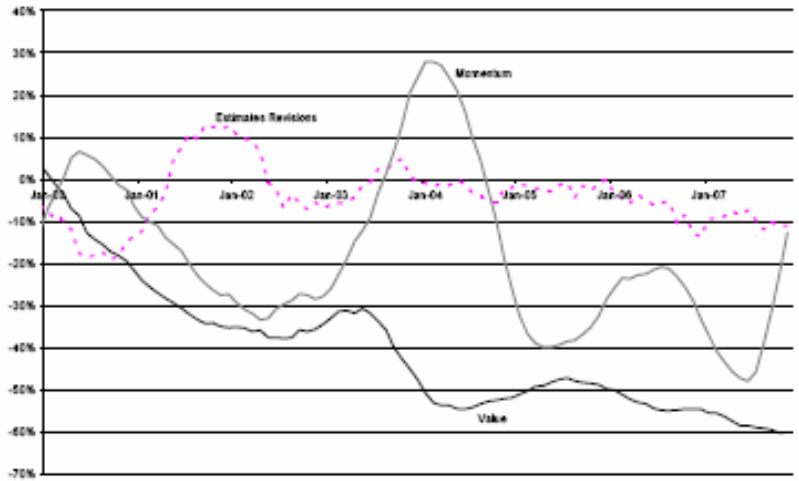
Value and risk model popularity

Figure 28. Idiosyncratic risk discount of high-ranked value stocks over time according to the ERAM risk model (December 2007)



Source: Citi Investment Research

Figure 29. Idiosyncratic risk discount/premium of top-ranked value stocks compared with stocks ranked highly by other factors (using ERAM)

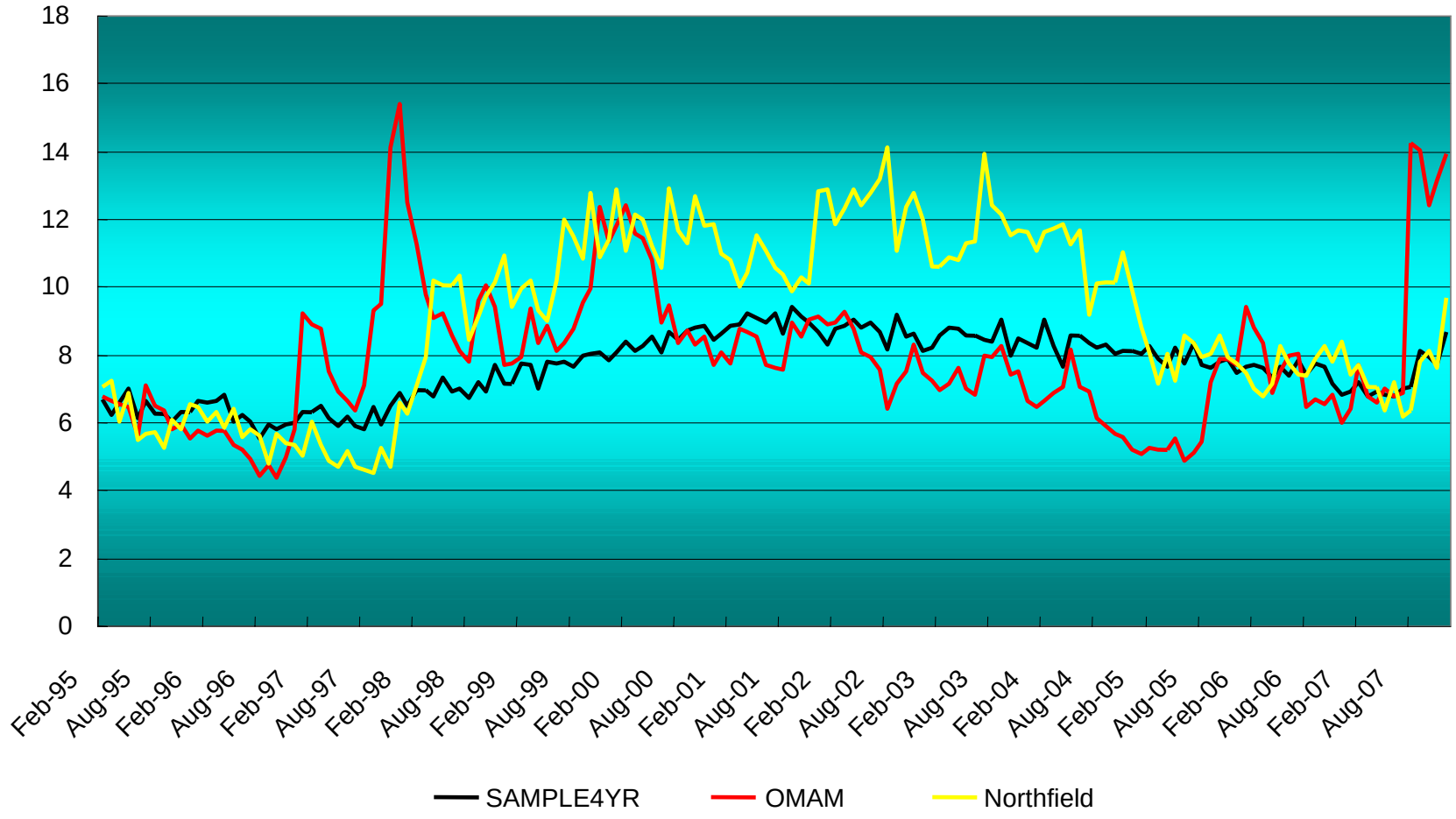


Source: Citi Investment Research

Source: Citi Investment Research

Responsiveness

Ex-ante risk forecast based on Japanese model optimal weights



Source: Datastream / Matlab

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Linear factor models

Traditional approach

- Estimate of risk based on historical data sample
  - Typically expressed in terms of absolute volatility or tracking error
  - Gives statistic based on entire distribution of expected returns
  - Parametric methodology
  - Need for simplification
    - covariance matrix-based models
    - linear algebra
    - mean-variance utility

➡ Linear factor models $R_p = \beta_1 F_1 + \ldots + \beta_N F_N + \varepsilon_p$

Linear factor models

- Intuitively appealing to investment professionals
- “common factors” understood as main drivers of returns
- Desire to constrain portfolios along certain common risk characteristics
- BUT in practice:
  - assumptions are open to question
  - transient factors
  - ever more sophisticated estimation techniques adopted

3 (perhaps 4) basic approaches

- Cross-sectional models
  - factor exposures known, factor returns estimated
- Time series models
  - factor returns known, factor exposures estimated
- Statistical models
  - neither factor exposures or factor returns known
- Hybrid models
  - combination(s) of the above

Advantages and disadvantages

- Cross-sectional models
  - can potentially respond more quickly to addition of new firms
  - will tend to respond more slowly to changes in volatility
  - bias from exposure assumptions
- Time series models
  - do not require unit exposure assumptions in global world
  - portfolio exposures to factors estimated with greater precision
- Statistical models
  - more robust to main types of specification errors
  - make fewer demands of data
  - more difficult to interpret
  - work better for highly correlated systems
- Hybrid models
  - the best of all worlds?
  - increased risk of over-fitting to sample?

LFM summary

- Choice of linear factor model specification should depend on:
  - investment horizon
  - understanding of sample characteristics
  - kind of strategy being implemented
  - nature of risk budget constraints

Tail risks

Event likelihood

> Issues with normality and the likelihood of supposedly improbable events

Probability of a realization > n standard deviations away from mean					
	n=2	3	4	5	6
Chebyshev	1/4	1/9	1/16	1/25	1/36
Bound Same K	1/5	1/27	1/85	1/208	1/432
RV with Same K	1/6	1/33	1/114	1/289	1/614
Normal Dist	1/22	1/370	1/16000	1/1.75 MIL	1/500 MIL

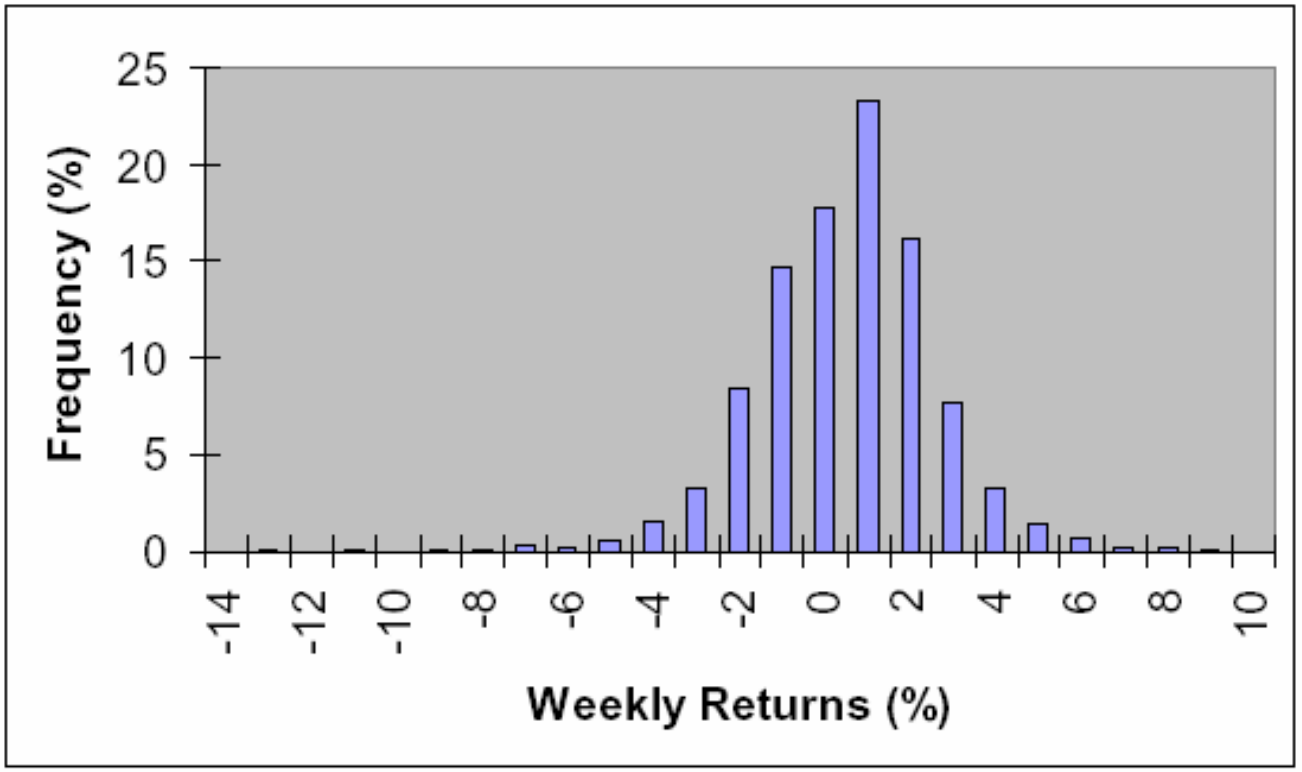
Source: Northfield Information Services

Utility

- Mean-variance
  - portfolio linear co-dependence via correlation
- Higher moments
  - allow for non-linear co-dependence

Non-normality

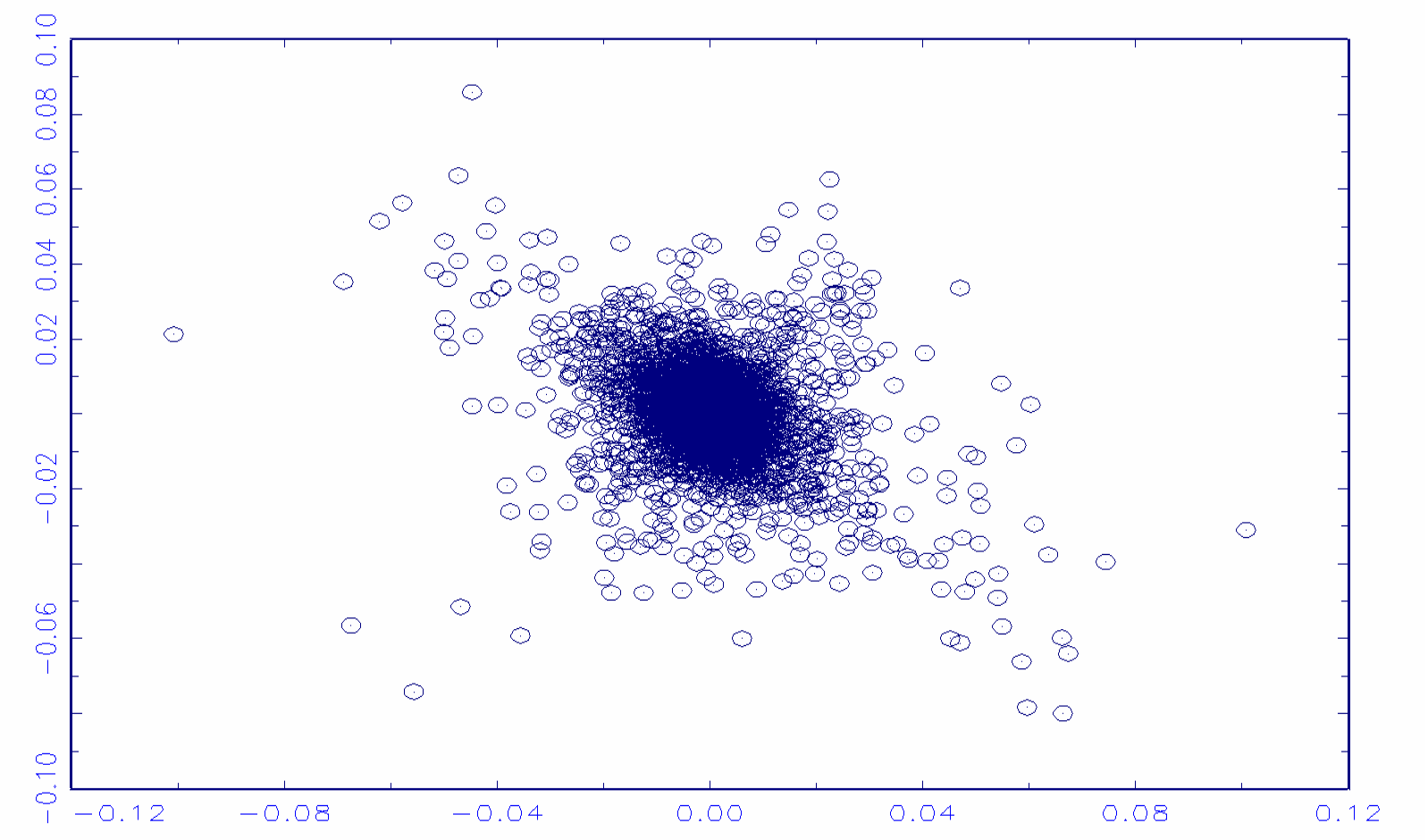
Figure 1: S&P 500 Returns (Dec 1977 – Dec 2007)



Source: Lehman Brothers

Correlation

Correlation of momentum and valuation factor returns: r = -0.31



Source: University of Essex Centre for Computational Finance and Economic Agents (CCFEA)

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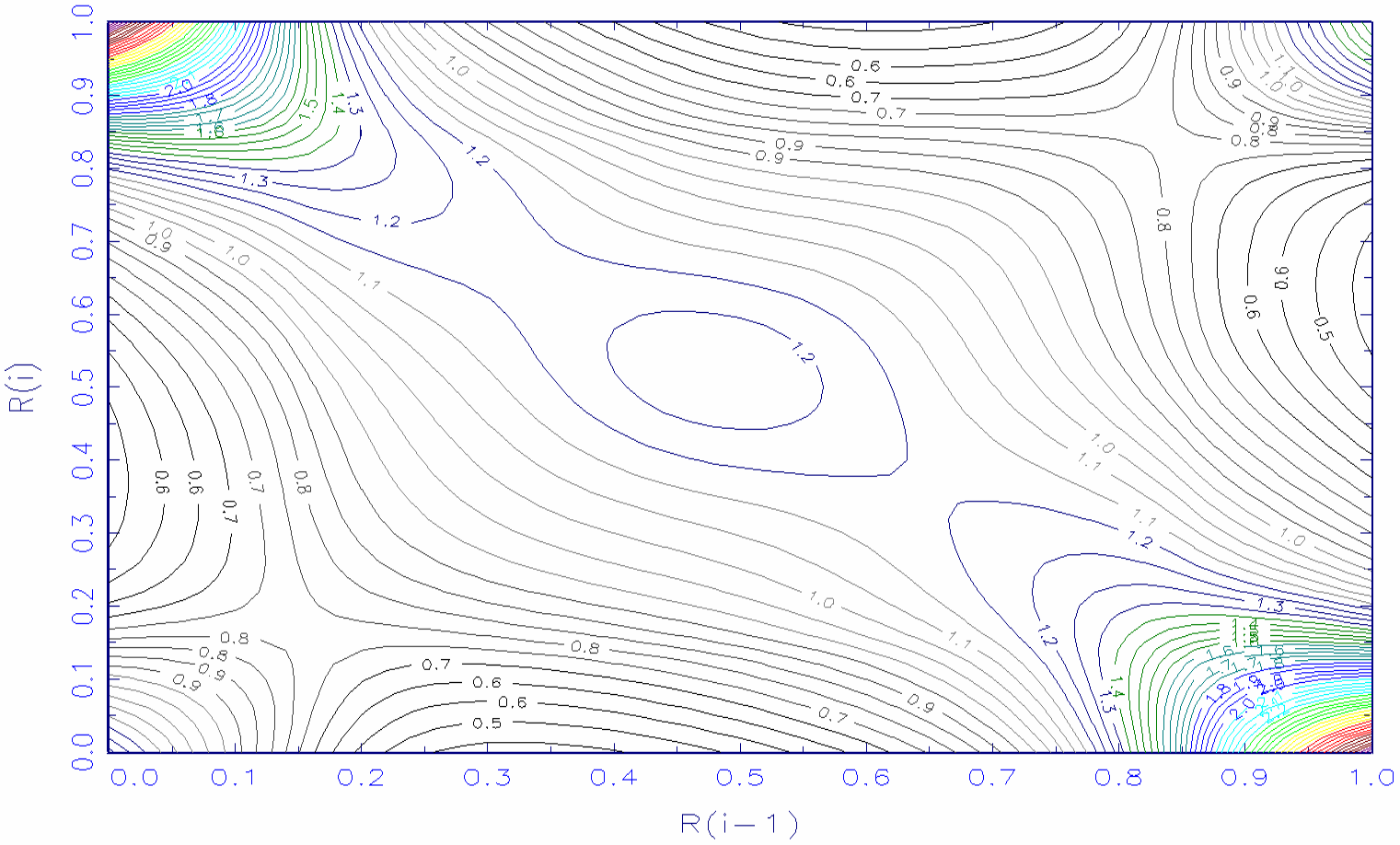
Copulas

Additional depth shown in density function highlights tail risks



Source: University of Essex Centre for Computational Finance and Economic Agents (CCFEA)

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Improved structure

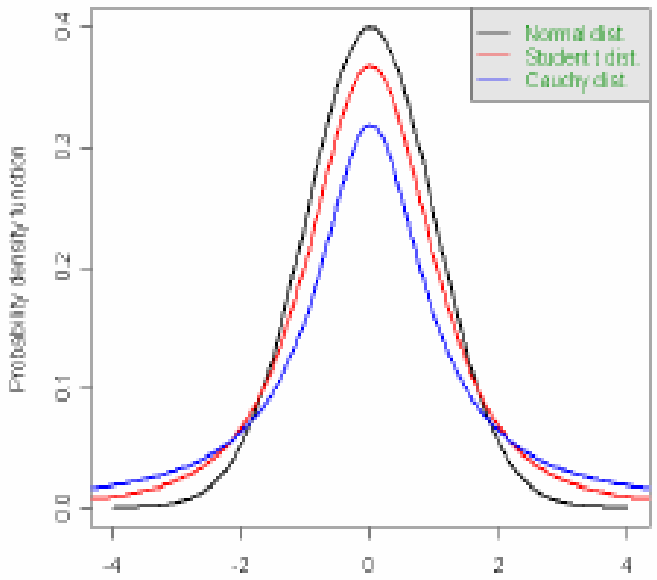
- Copulas provide general structure containing all possible information about inter-dependence

$$C(F_1(x_1), \ldots, F_N(x_N)) = F(x_1, \ldots, x_N)$$

- Copulas are equally applicable to both normal and non-normal situations
- Need marginal distributions for individual factors
- Mix and match different marginal distributions and dependency structures

Distributions

Figure 1. Comparison of tails structure between normal, Student t and Cauchy distributions



Source: Citi Investment Research

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Beyond variance

- Semi-variance better reflects investor utlility
- Tail risk best captured by measures such as Value-at-Risk (VaR) and Expected shortfall (ES)
- VaR provides no information about losses for points on the distribution beyond the specified confidence threshold
  - conditional VaR (CVaR)

Summary

- Risk models come with health warnings for a reason
- Need to understand assumptions and limitations
- LFMs represent a minimum standard
- More sophisticated techniques and metrics available, but they carry their own health warnings too

Risk model evaluation is critical

Important information

The information in this document should not be construed as a solicitation to invest or be relied upon for the purpose of making an investment. The value of an investment and the income from it can go down as well as up and investors may not get back the full amount invested. Past performance is not a guide to future performance. Exchange rate fluctuations can affect both capital and income values.

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