Estimating Capacity for Equity Investment Processes

Stuart Doole
London Research Centre

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AXA Rosenberg
An AXA Investment Managers Company

Overview

- Who are AXA Rosenberg and how do we manage money?
- Why do investment strategies have capacity contraints
- How can you define capacity?
- How can you measure investment capacity?
- Practical signals: demand- versus supply-side indicators
- Approaches in the literature
- Other aspects of capacity for an investment manager

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Who are AXA Rosenberg?

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A Global Investment Firm

- **Founded in U.S. in 1985 to manage specialist equity portfolios**
- **Global presence: San Francisco, London, Tokyo, Hong Kong & Singapore**
- Backing of one of the largest financial Institutions in the world: AXA
- £61.4 billion of assets under management at 31 December 2006

Source: AXA Rosenberg

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Assets Under Management

Assets under management by product/region (31st Dec 2006):

Region	Broad Market £ m	Mid/Small Cap £ m	Enhanced Index £ m	Long/Short £ m	Total £ m
US Equities	3,264	6,201	330	492	10,286
Japanese Equities	1,966	1,437	416	62	3,881
European Equities	16,383	2,869	1,179	140	20,571
Asia Pacific Equities	2,040	375	20	163	2,598
Global Equities	18,674	4,487	458	429	24,048
Total	**42,327**	**15,369**	**2,403**	**1,286**	**61,384**

Assets under management by client domicile (31st Dec 2006):

Client Domicile	£ m
North America	14,027
Europe	37,358
Japan	1,666
Asia Pacific	3,504
Middle East	4,829
Total	**61,384**

Source: AXA Rosenberg

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Not a conventional fund manager

- **Fundamentally based, technologically implemented**

	Conventional Manager	AXA Rosenberg
Opportunity Set Number of stocks researched in detail	*3,000 Globally*	*19,000 Globally*
Diversification Number of stocks held	*70 - 150*	*500+*
Risk Analysis	*Ad hoc*	*Integrated*
Decision Making	*Subjective*	*Objective*

Source: AXA Rosenberg

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Our Investment Philosophy: Earnings Matter!

Valuation Model

Identify most attractively priced stocks in each industry

+

Earnings Forecast Model

Identify companies with superior year-ahead earnings in each industry

=

Company Score

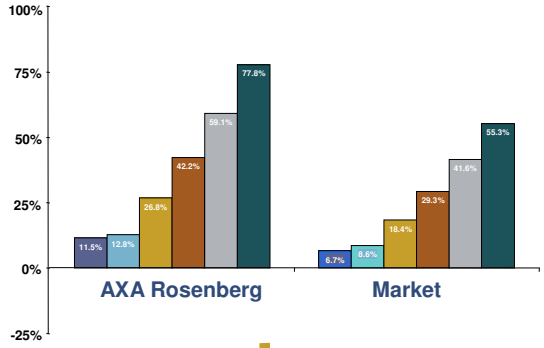
↓

Risk Model

Maximize return with minimum deviation from the benchmark

→

More future earnings…



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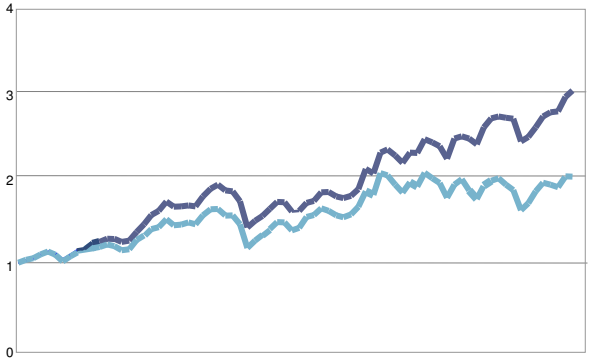
…result in superior performance



Source: AXA Rosenberg

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Valuation Model: An arbitrage/sum-of-parts approach

Property Valuation

Valuation Element	Appraised Value
Square Feet	£ 75,000
Location	**£ 80,000**
Catchment Area	£ 25,000
# Bed/Bathrooms	£ 35,000
Total Property Value	**£215,000**
Current Listed Price	**£180,000**

KEY DRIVER

Company Valuation Based on Financial Statement Analysis

Valuation Element	£ Per Share
Business Line Assets	
Machinery Assets	£17.50
Metal Products Assets	£10.73
Receivables	£ 3.18
Long-Term Debt	£-8.80
Pension Surplus	£ 0.90
AXA Rosenberg's Company Valuation	**£23.51**
Current Stock Price	**£18.50**

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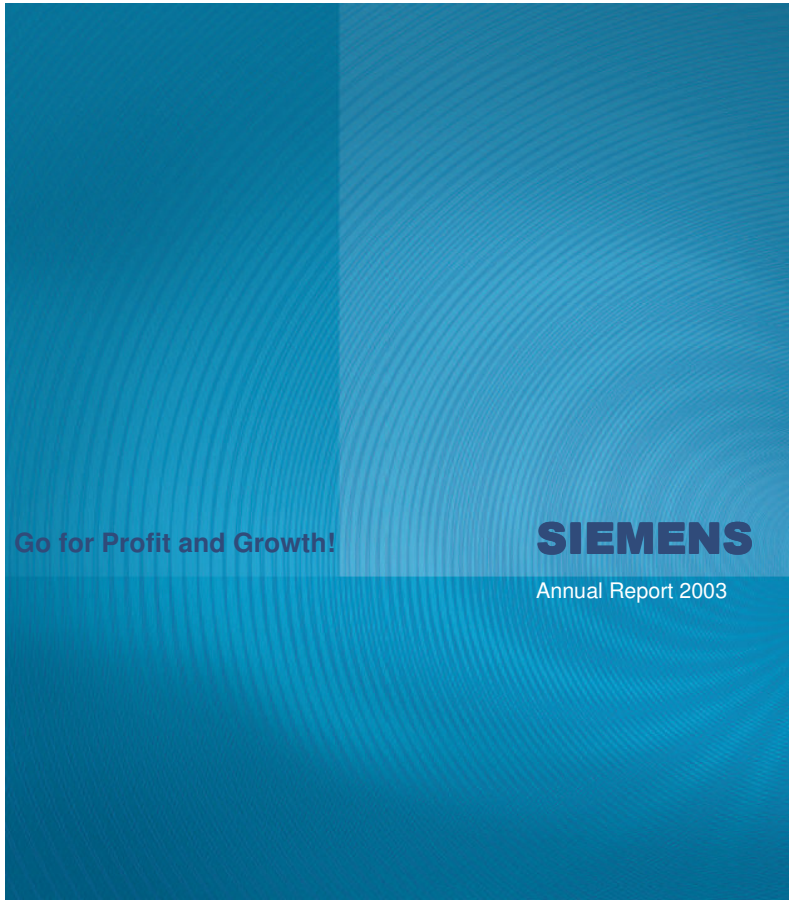
Valuation Model
Example Business Line Breakdown - Siemens



AXA Rosenberg's Breakdown

Electrical Machinery	11%
Medical Instruments	11%
Alarm & Signal Equipment	5%
Electrical Lighting, Lamps	8%
Auto Parts	10%
Programming, Data Processing	14%
Property	13%
Business Credit	28%

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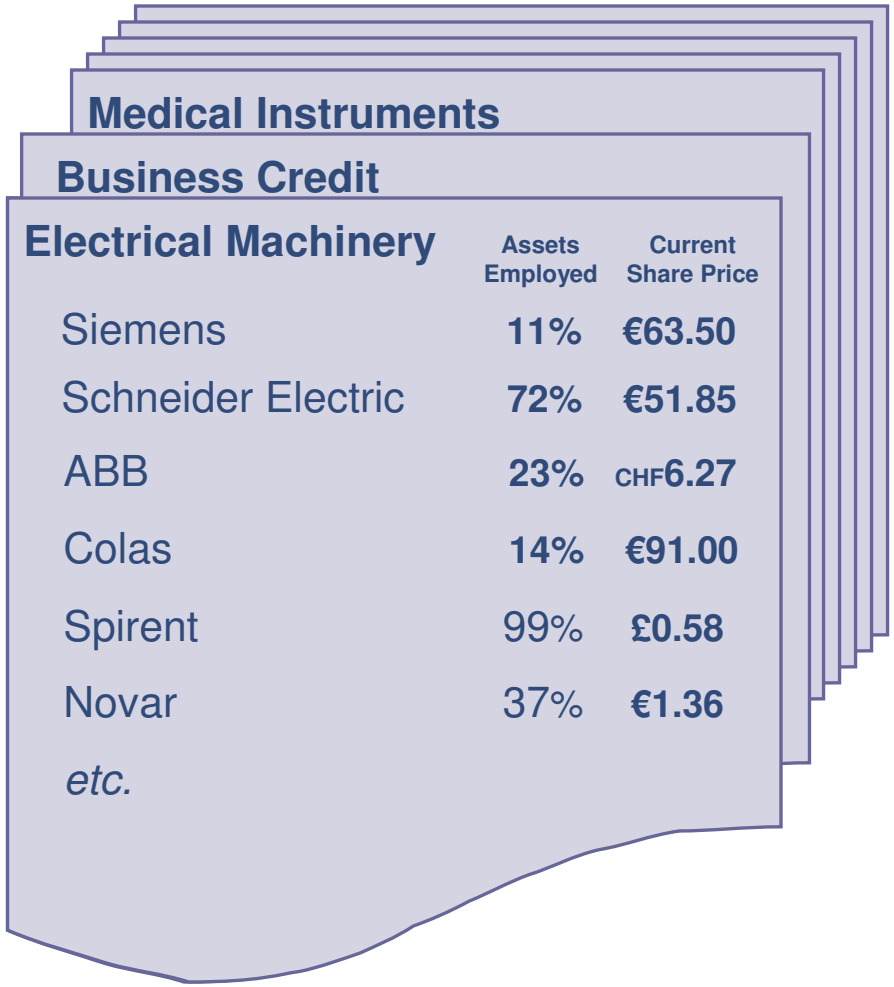
Valuation Model
Example Business Line Breakdown - Siemens



Current Consensus Market Valuation

per unit of assets per share

		€
1.	Electrical Machinery	1.424
2.	Business Credit	1.299
3.	Medical Instruments	2.134
4.	Alarm & Signal Equipment	1.656
5.	Auto Parts	1.083
	↓ ↓ ↓	↓
168.	Development	1.0544
169.	Data Processing	1.5234
170.	Cellular Telephone	1.3123

Source: AXA Rosenberg

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Valuation Model
Building up a Company's Valuation - Siemens

1. **Calculate the valuation of each of the company's business lines**

Balance Sheet Valuation Of Business Lines

Siemens Business Lines	Assets/Share	Market Valuation	Valuation
Electrical Machinery	5.269	1.424	7.503
Medical Instruments	5.269	2.134	11.244
Alarm & Signal Equipment	2.395	1.656	3.966
Electrical Lighting	3.832	1.636	6.269
Auto Parts	4.790	1.083	5.188
Programming, Data Processing	6.706	1.792	12.017
Business Credit	13.412	1.299	17.422
Property	6.227	1.303	8.114

Source: AXA Rosenberg

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Valuation Model
Building up a Company's Valuation - Siemens

Balance Sheet Valuations Of Business Lines

Balance Sheet Adjustments

Balance Sheet Item	EUR/Share	Market Valuation	Adjustment
Cash & Sht Inv	14.07	0.3921	5.5168
Trade Recvble	15.95	(0.0395)	(0.6300)
Goodwill	7.15	0.0932	0.6664
Accounts Payable	9.24	(0.5847)	(5.4026)
Ldbt - Other	12.57	(0.8984)	(11.2929)
Etc…			

1. **Calculate the valuation of each of the company's business lines**

2. **Make an adjustment for Balance Sheet and Profit & Loss Statement and unique revenues and earnings**

Source: AXA Rosenberg

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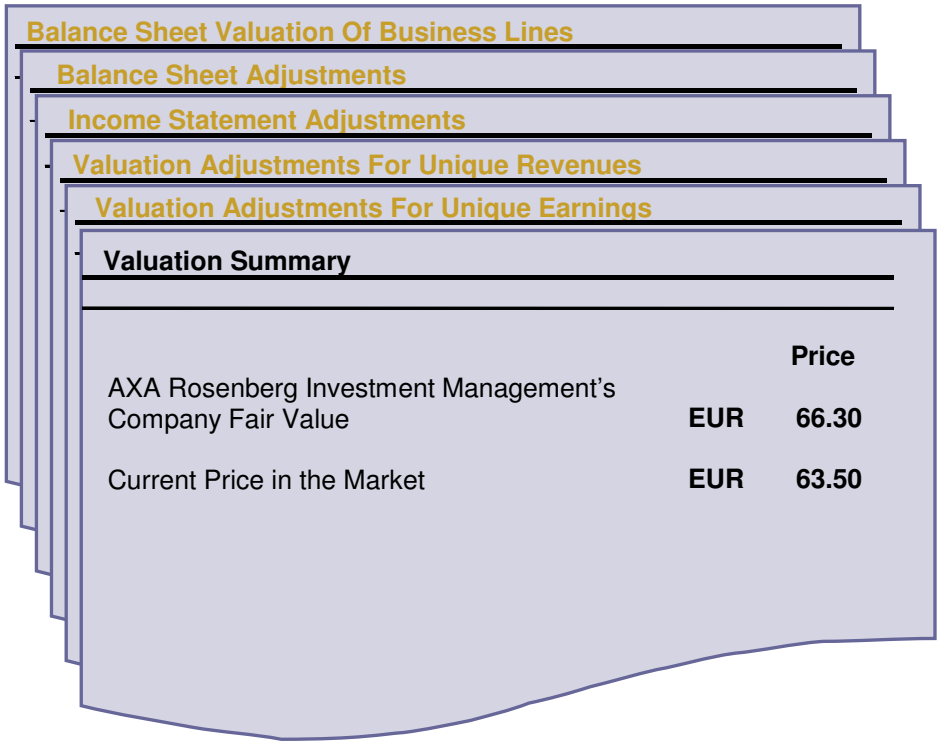
Valuation Model
Building up a Company's Valuation - Siemens



Valuation Summary

- **Adding up the valuations and adjustments gives an assessment of the company's fair value (i.e. the value of the company if the markets were completely rational and consistent)**
- **By comparing the fair value to the current market price, we can identify whether the company is over or undervalued *relative to its peers*.**

Source: AXA Rosenberg

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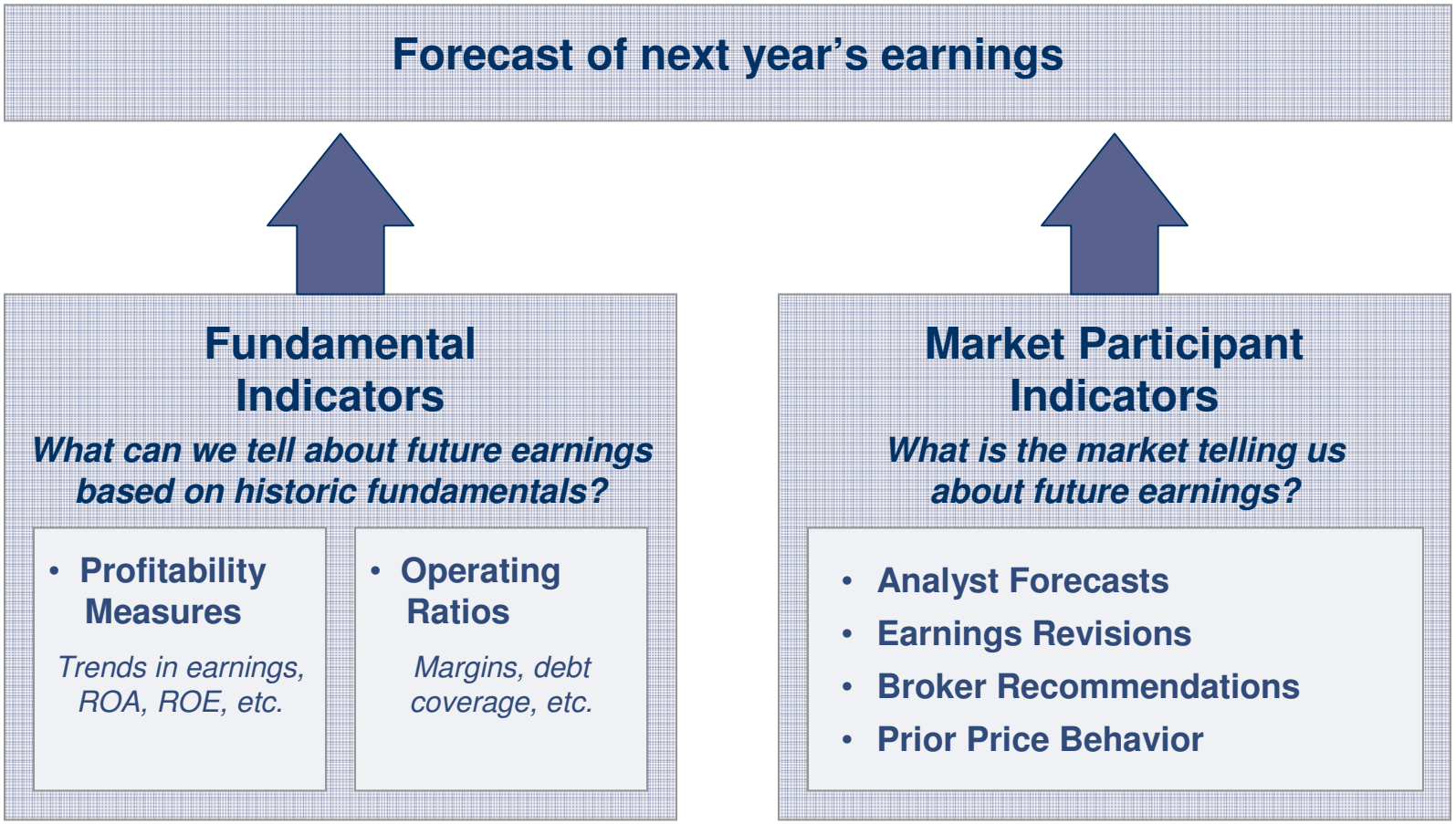
AXA Rosenberg's Earnings Forecast Model

- **Objective: estimate of forward earnings**



Source: AXA Rosenberg

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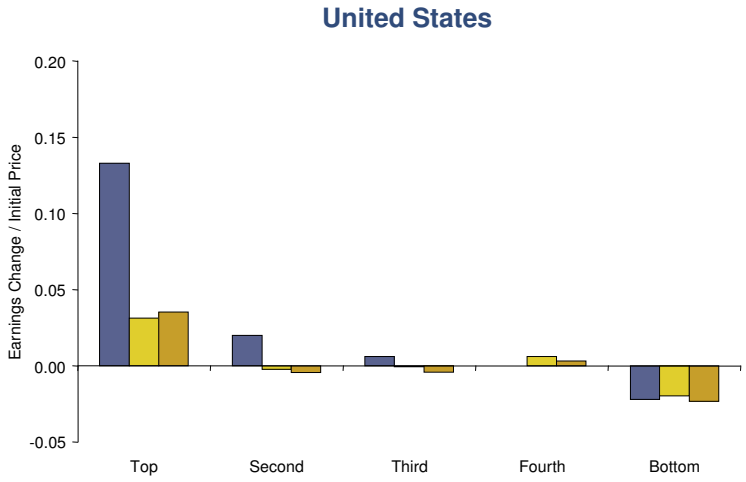
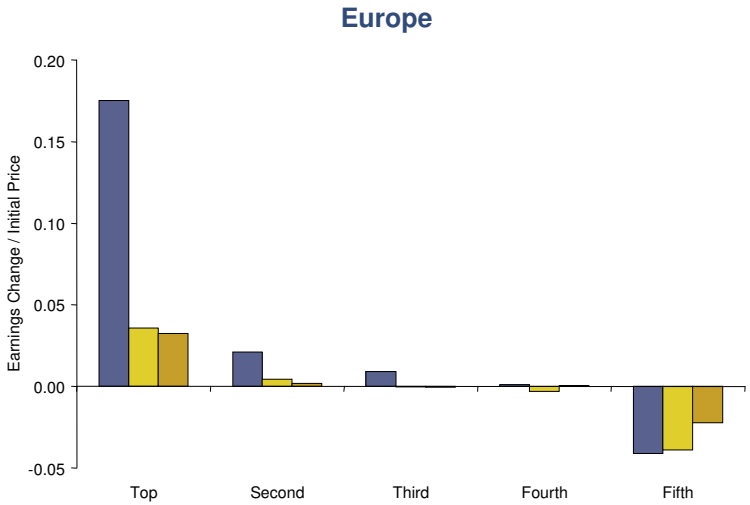
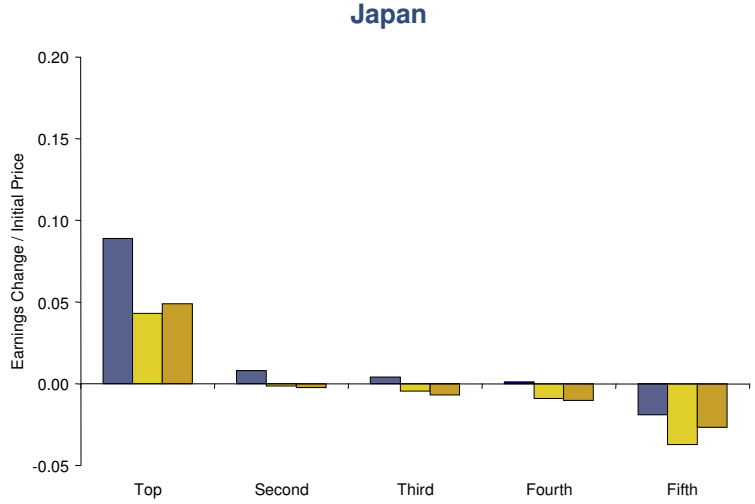
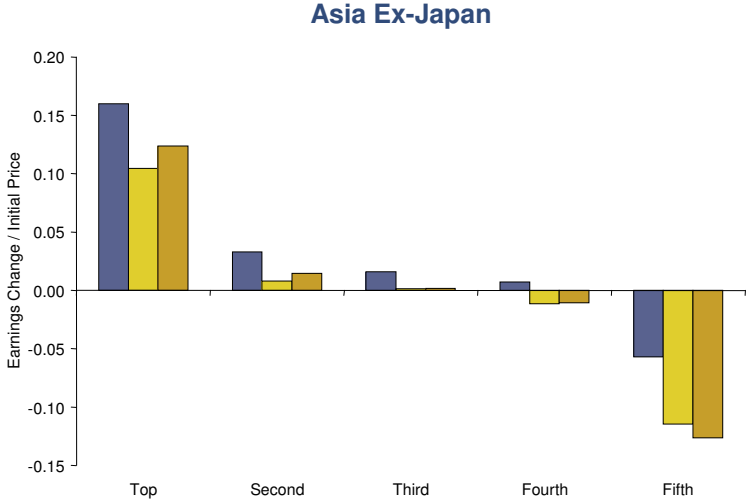
Earnings Forecasts: AXA Rosenberg vs. Consensus





AXA Rosenberg's earnings forecasts have proven to be consistently more conservative and accurate





IBES Forecast **Actual** **AXA Rosenberg**

Source: AXA Rosenberg

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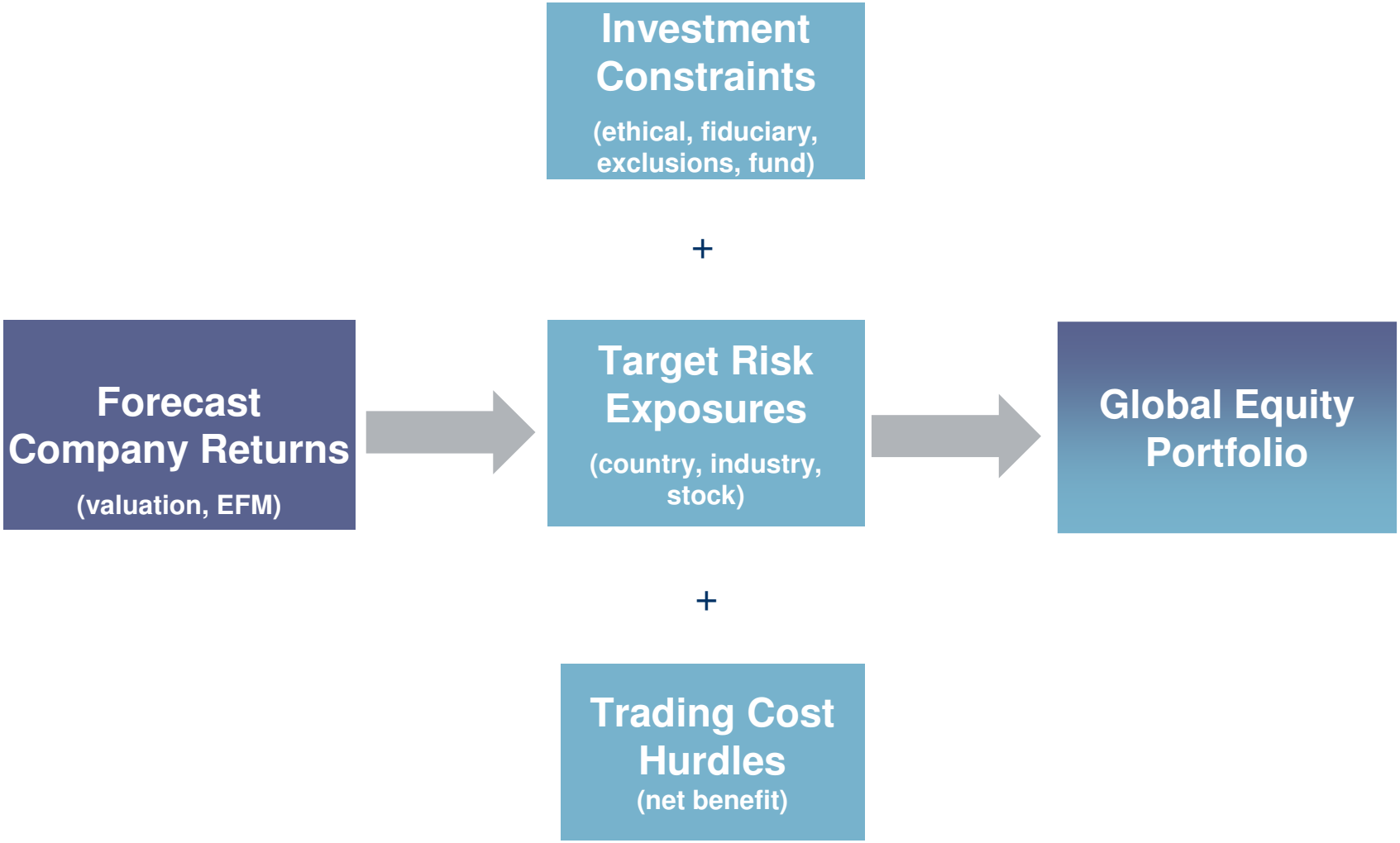
Portfolio Construction
AXA Rosenberg Risk Model



Source: AXA Rosenberg

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Portfolio Construction

December 29, 2006

- **What we expect to see…..**

Risk Factor Exposures

Overweight

- Book/Price
- Earnings/Price
- Relative Strength
- Yield

Underweight

- Size

Stock Exposure

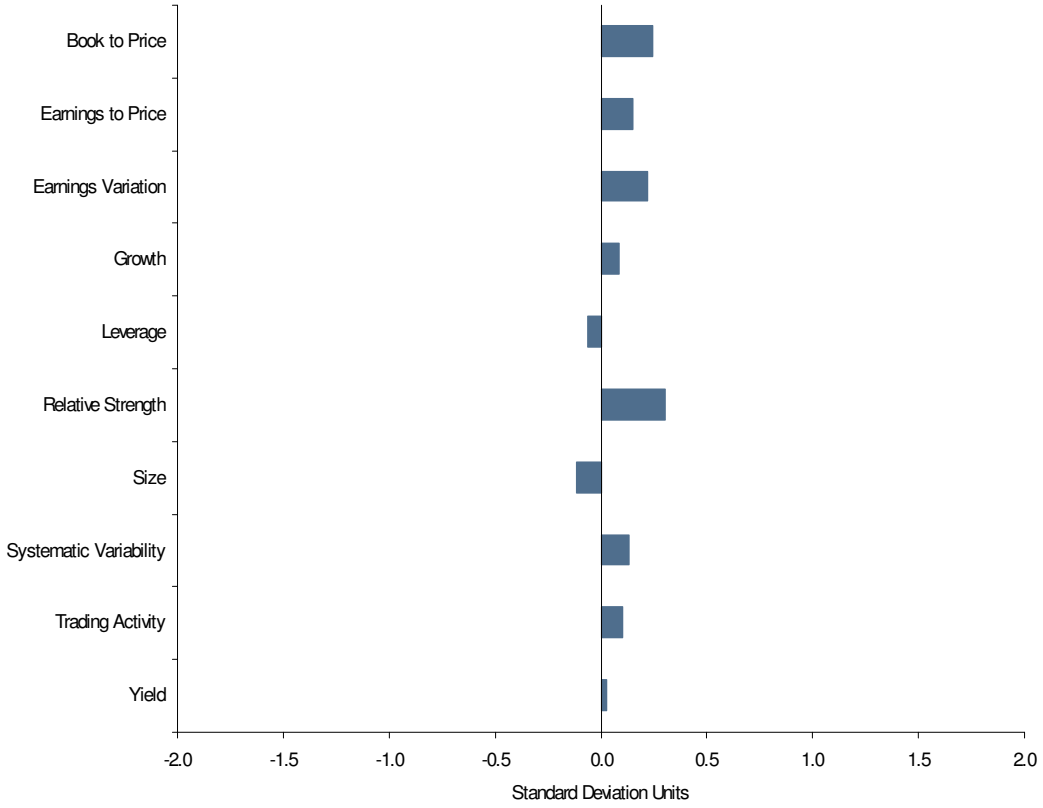
+/- 2%

Industry Exposure

+/- 5% relative to benchmark

Country Exposure

+/- 2% relative to benchmark



Active Exposure =
Portfolio Exposure minus Benchmark Exposure

Source: AXA Rosenberg

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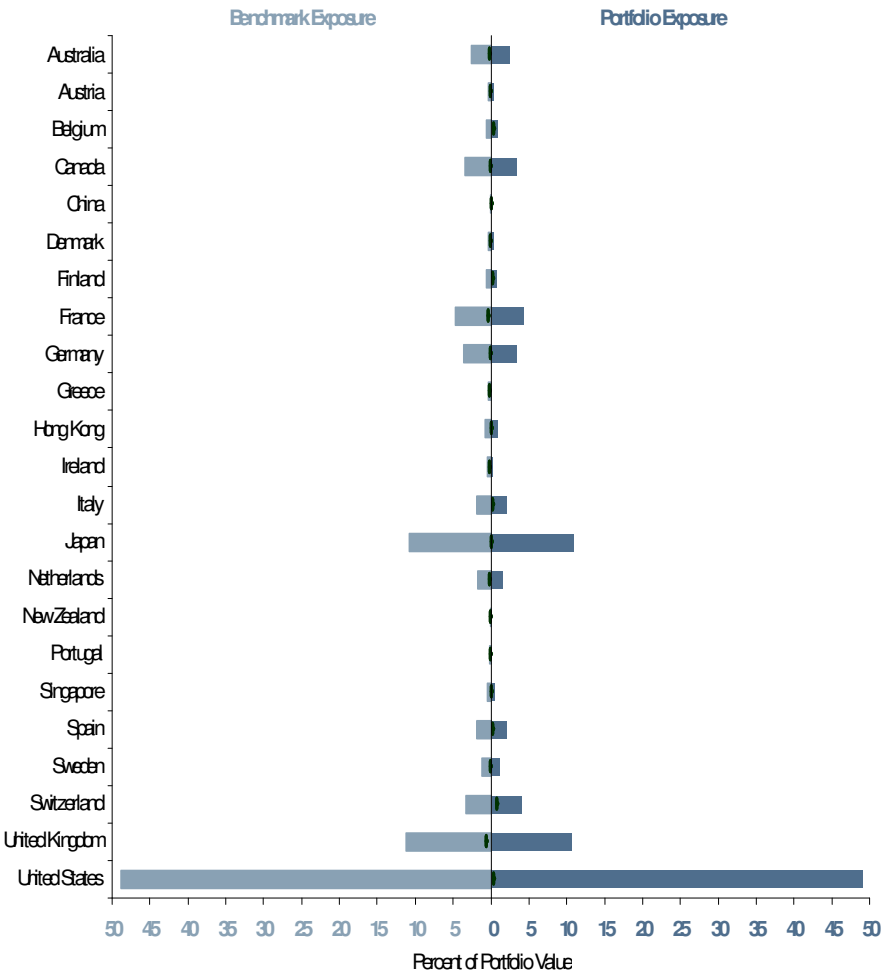
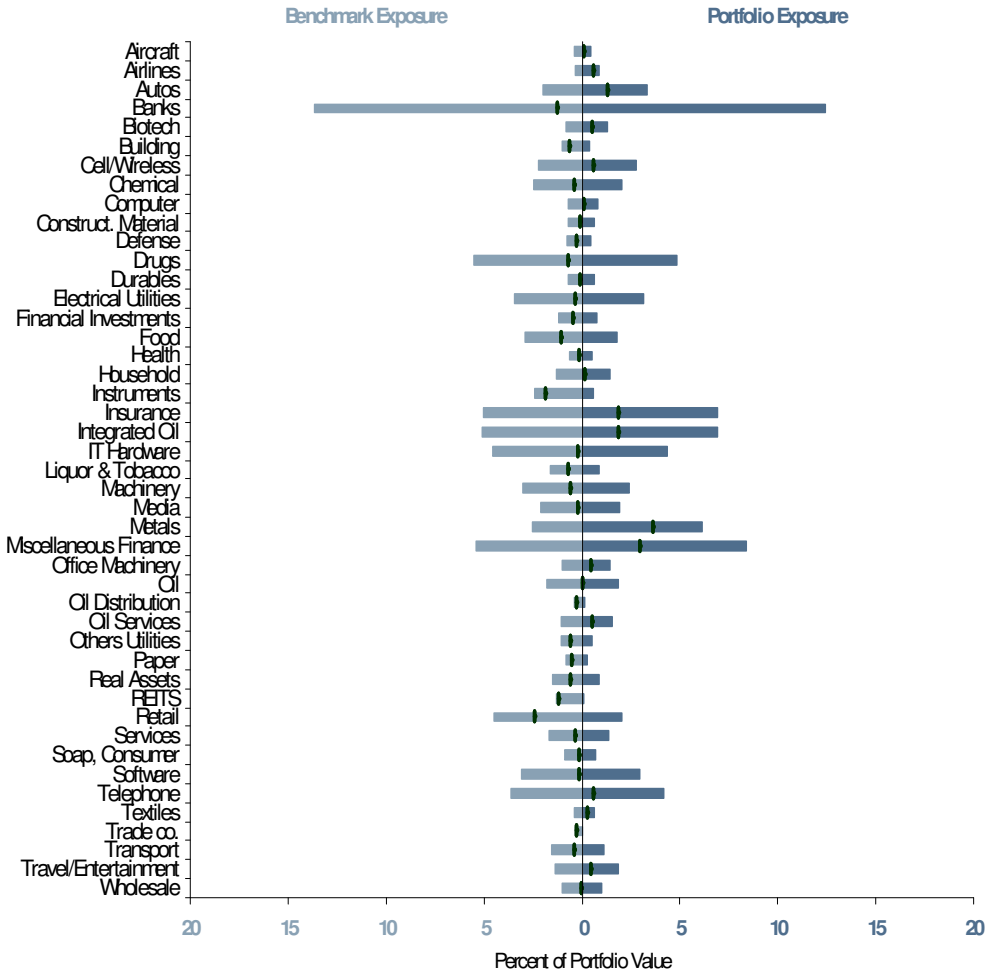
World Broad Market
Country and Industry Active Exposures

December 29, 2006





Source: AXA Rosenberg

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Defining capacity

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Why do investment strategies have a 'capacity'

- **Back-tested strategies often independent of market environment**
- **The reality of investment**
  - Direct and indirect trading costs (include market impact)
  - Information advantage versus the market (perceived, real)
  - Trade-able market volume each day
  - Responsibilities with growing company stakes
  - Cash inflows and outflows
  - Benchmark – the potential to underweight vs. strength of conviction
  - Funds – the potential to overweight vs. (fiduciary) investment constraints
  - And much more!
- **All of these get more problematic as the size of the fund (AUM) increases**

What is capacity: wealth or alpha?

- **The level of AUM that maximises alpha?**
  - No! … then the optimal level of assets is 'zero' *(Perold and Salomon 1991)*
- **How about the level of AUM associated with maximising wealth?...**

- **Vangelisti (2006) proposes a hierarchy of definitions:**
  - *Implementation capacity* – AUM above which dealing efficiencies realised
  - *Threshold capacity* – the AUM beyond which the strategy can not achieve performance (over time) matching its stated return objectives or client expectations
  - *Wealth-maximising capacity* – the AUM that maximises net wealth (AUM times net alpha) for the asset manager (performance fee structures)
  - *Terminal capacity* – the AUM that reduces the net alpha to zero

Capacity: managing client conflicts

- **Without performance fees, no disincentive even to keep AUM below terminal capacity (prior to mandate loss!)**
  - In reality, consultants are much more pro-active
- **Conflict with clients' interests even with net-alpha wealth-maximisation**
  - equal treatment?
  - early investors preferred?
- **Only usable definition: threshold capacity**
- **At 'threshold capacity', client targets only be beaten half the time with a degree of variation driven by our active risk around the benchmark!**
- **So 'effective' capacity can be higher if consultants very 'pro-active'**

Capacity is more than performance

- **Literature concentrates largely on investment performance**
- **Too much emphasis on detailed historical simulations**
- **Other aspects to capacity discussion:**
  - Investment philosophy – investor distress vs. company distress
  - Portfolio construction and liquidity management
  - Turnover management - reducing impact on strategies with excess assets
  - Diversity of strategies or strategy holdings across all portfolios (liquidity, etc)
  - Quality of fund managers
  - Infrastructure issues – technology and interfaces with market
  - Scalability of portfolio management if higher AUM or more mandates
  - Scalability of client and consultant service
  - Client service challenge – explaining the additional dispersion of short-term portfolio performance through pro-active management of capacity
  - Structure of fund 'close' – danger of feeder funds

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Measuring capacity

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Rules of thumb and comparison tests

- **'Capacity is 1% of market size'**
- **'Every active manager with over 2% of market cap has underperformed'**
- **Static analysis:**
  - Calculate % of 'unfilled portfolio positions' as AUM varies based on ADV (average daily volume) and company ownership limits, for example
- **'Quacking-duck' tests – does strategy have metrics that are characteristic of few capacity constraints or major difficulties?**
  - How does cumulative daily turnover compare with the index?
  - How is performance in markets where capacity ought to hurt?
  - Does transaction cost analysis suggest
    - consistent contrarian execution
    - building of positions at or near 'decision prices'?
  - How many days to trade its (active) positions? What % of index and float?
- **For traditional managers, it is hard to do more …**

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Static analysis: a top-down holdings-based approach

Capacity := P x M x C

P = Participation rate by sector (alpha distribution)
(15% - 25%)

M = Max holding per company
(4% - 5% shares outstanding)

C = Universe market cap
(# stocks per sector x average mkt cap)

- ***Calculation by 'size sector' increases sensitivity of estimate***
- ***Product capacity derived from size sector exposure of chosen benchmarks***
- ***Stress-test calculation for market-cap profile by looking at median market cap***
- ***Stress-test participation rate by using bottom-up alpha-hurdle calculations***
- ***Inverted framing: chart 'loss of aggregate portfolio' above holding limit or adv limit as AUM increases***

Source: AXA Rosenberg

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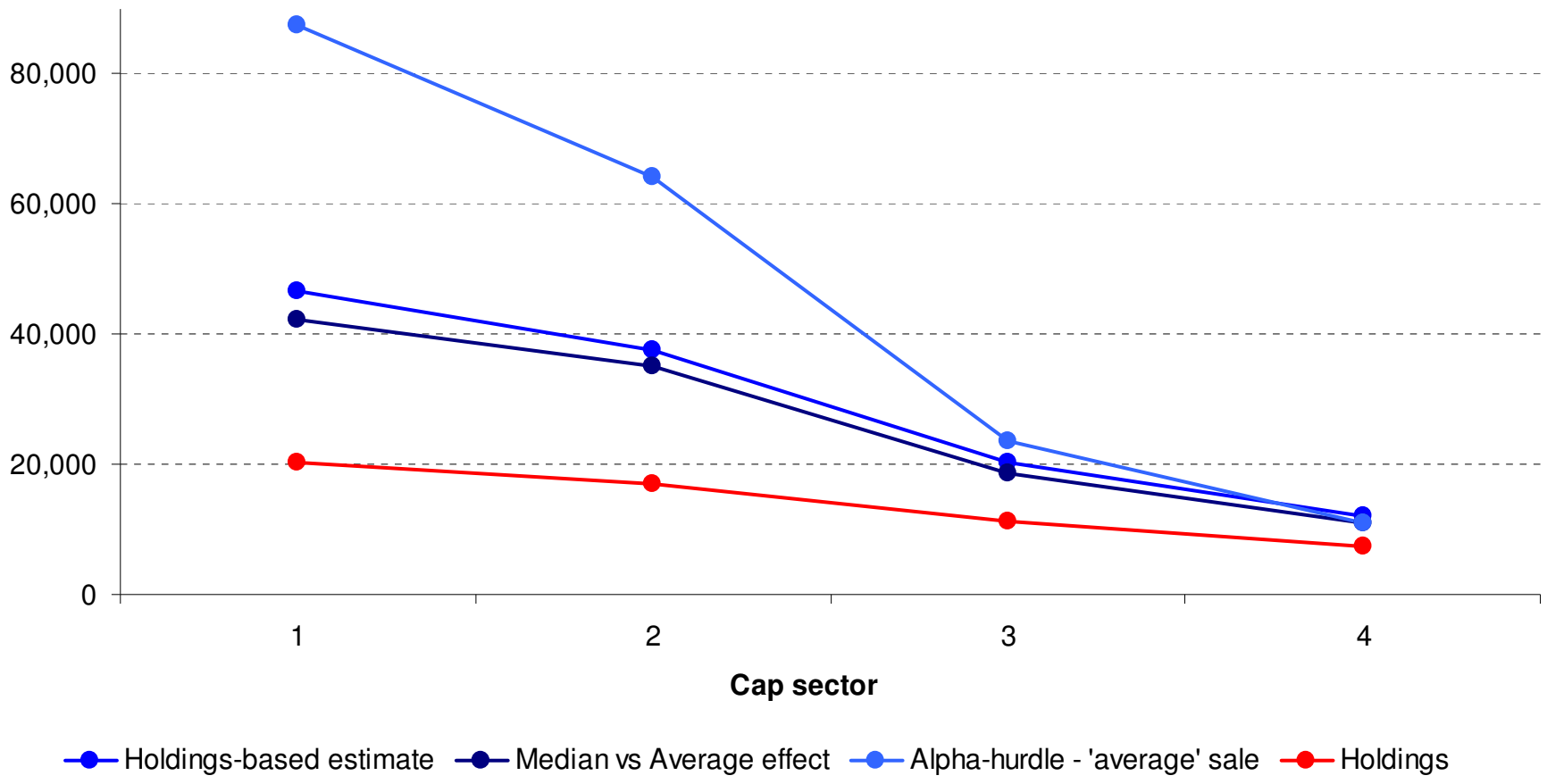
Stress-testing a holdings-based capacity estimate



Source: AXA Rosenberg

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What are some of the pitfalls of this approach?

- **Re-write the formula:**

  participation rate * (typical # of available stks) * max holding * avg mkt cap

- **Problems:**
  - For capacity, investability is key: free-float, liquidity
  - Is the simple average representative (shape of profile)?
  - What is bias/detail of different investment strategies e.g. size?
  - Market cap profile means that the number of stocks to which this 'equal-weighted' analysis is applied is potentially too high
  - Fewer stocks held due to practical limits – lot size, custodian fees
  - This can risk misleading simulations and dispersion of portfolio returns
  - Estimate will vary with market but no 'confidence interval' based on market and trading volume indices over recent years

One possibility: use the ‘effective’ number of stocks

The effective number ñ is

- a standard measure of index concentration - used by FTSE, MSCI, BARRA, etc
- often used as a proxy for the implementation efficiency of an benchmark
- the number of equal-weighted stocks that create a portfolio with the same stock-specific risk as the original portfolio
- equal to original portfolio size n for an equally-weighted index
- Especially useful for small stock market segments

$$\tilde{n} = \frac{1}{\sum_{i=1}^{n} w_i^2}.$$

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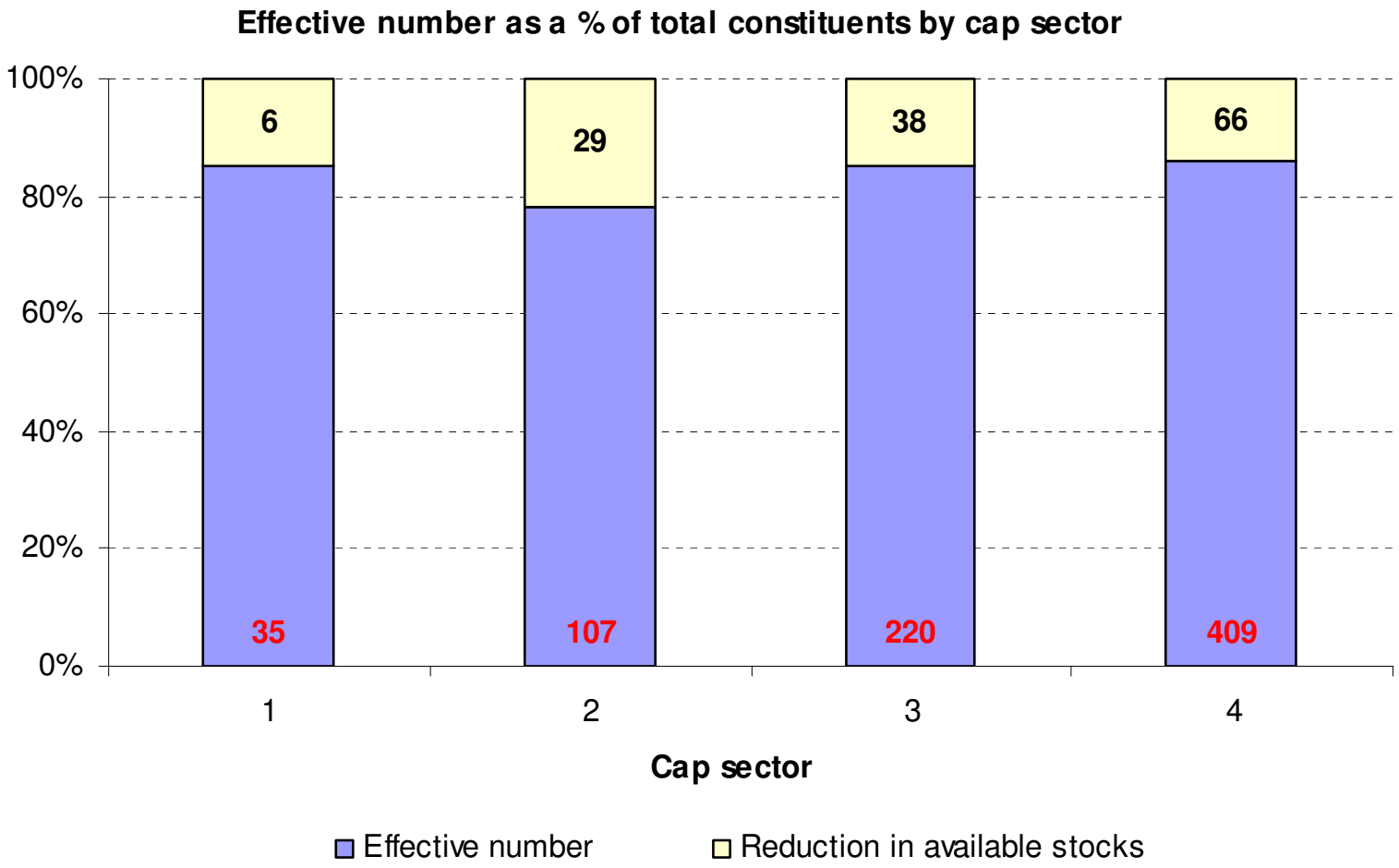
Adjustment to European cap sector size using ‘effective number’



If the cap-sectors were equally-weighted, n = ñ

Source: AXA Rosenberg

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‘Quacking-duck’ tests – transaction cost analysis

- **Index managers are viewed by brokers as usually ‘informationless’…**
- **But active fund managers suffer from broker perception of**
  - the ‘inventory risk’ of the trade they are taking on
  - their ‘adverse selection’ – will they be the wrong side of any events?
- **Do they have the right execution styles to reduce capacity impact?**
- **Check fund manager execution price vs prior day**
  - Does the fund manager suffer a ‘cost of delay’?
  - Does the fund manager build positions into momentum (*low liquidity, high market impact*) or weakness (*high liquidity, low impact*)?
- **Check gap between the manager’s screen decision price and the average execution price**
  - Does the fund manager try to build position too quickly?
  - Does the fund manager get the stock idea into his portfolio at the entry point reflecting his initial expected-alpha?

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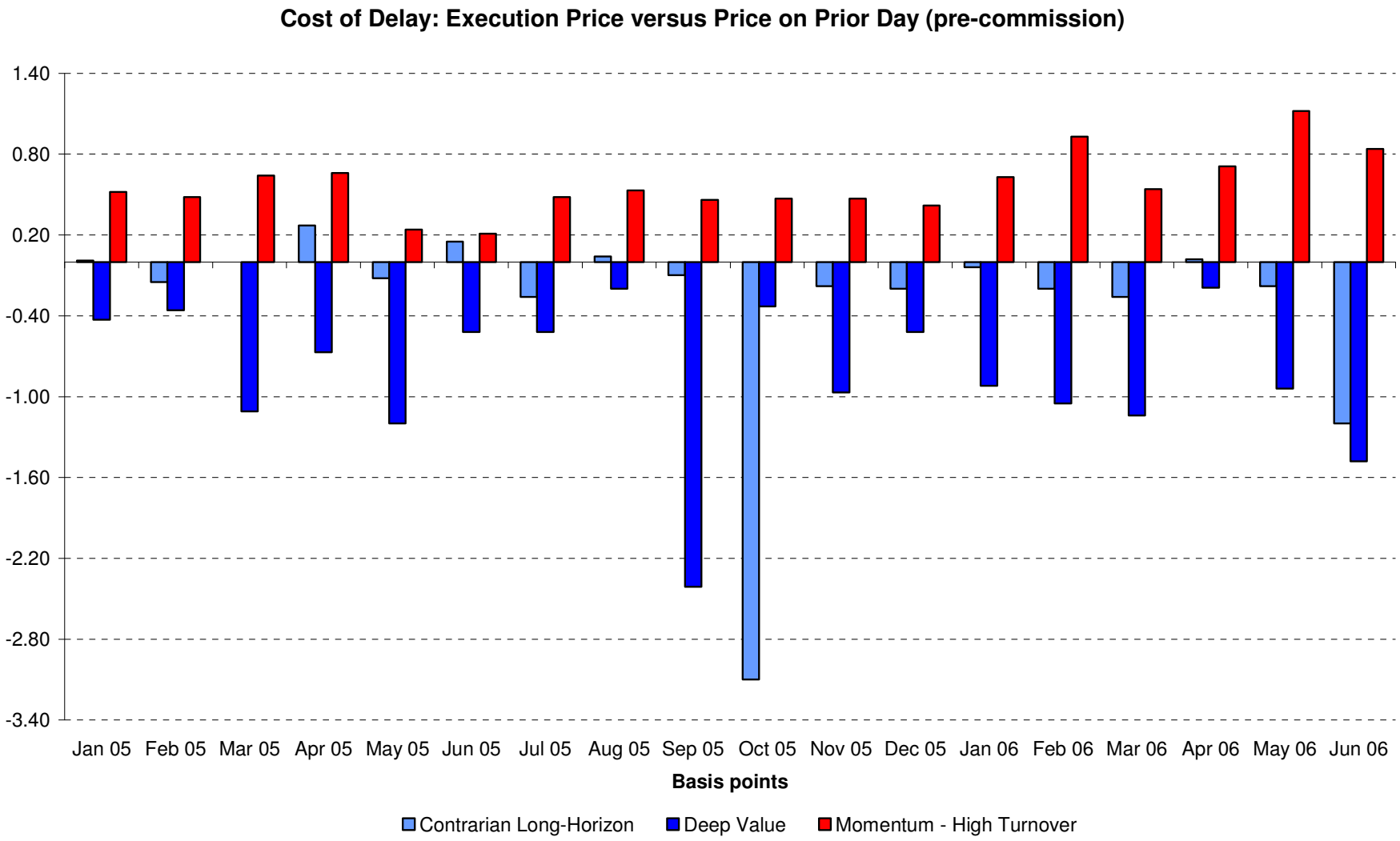
Do fund managers trade well compared to prior levels?



Example charts for anonymized traditional fund managers using ex-post trading cost data

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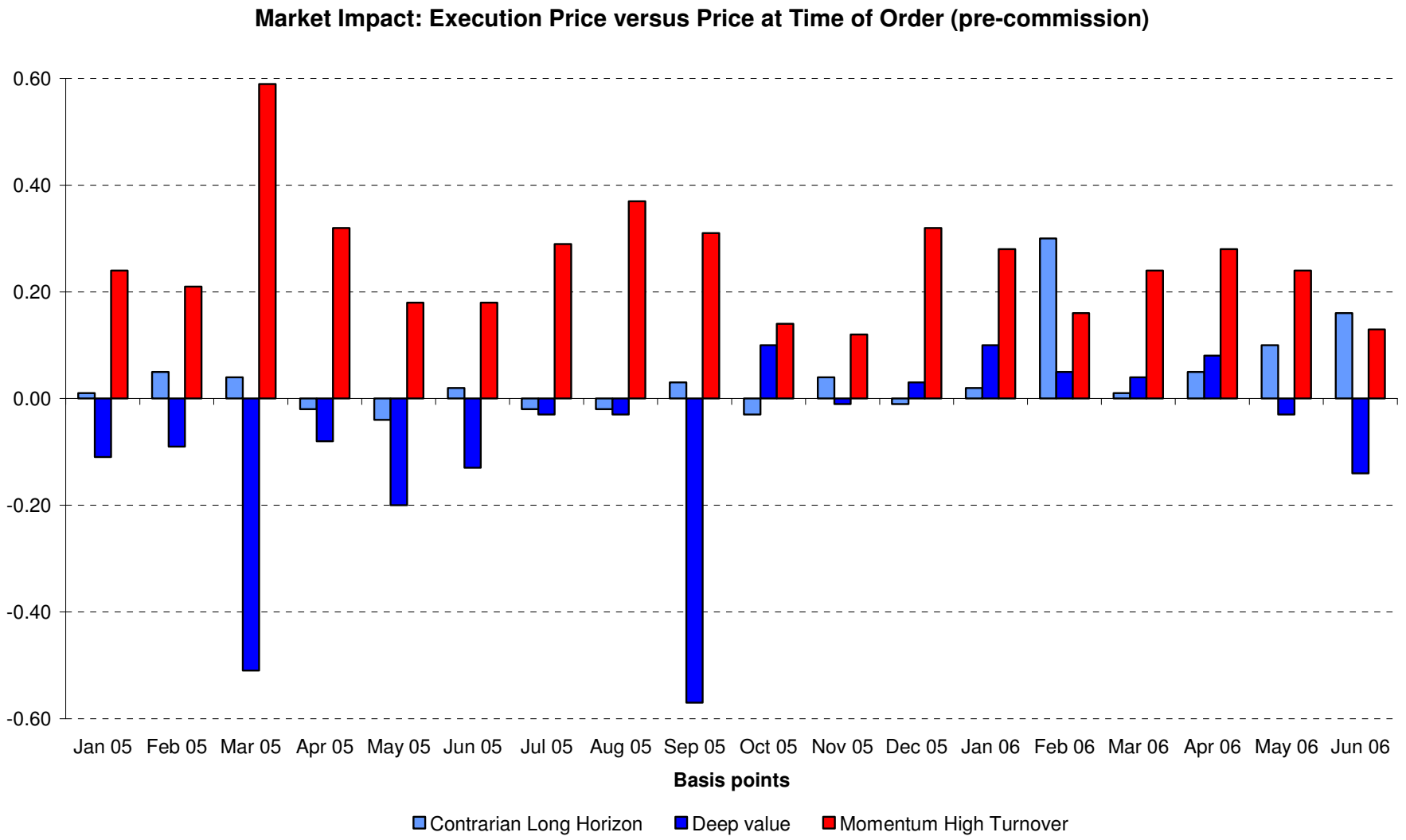
Do managers build portfolios at their 'decision prices?



Example charts for anonymized traditional fund managers using ex-post trading cost data

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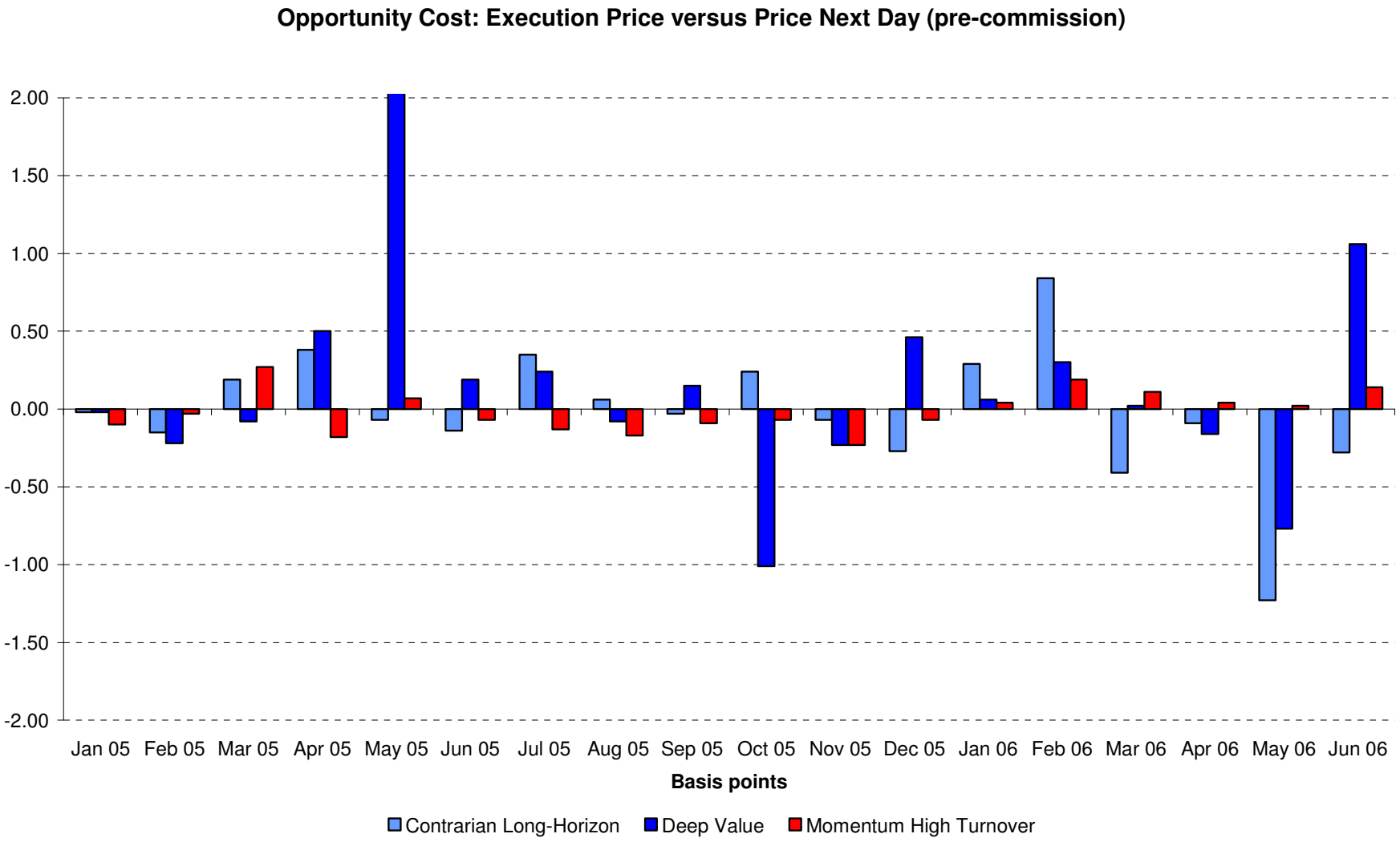
Is execution well-timed? Is money left on the table?



Example charts for anonymized traditional fund managers using ex-post trading cost data

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Supply- vs demand-side - Seasonal trends in alpha and volume

- **Capacity estimates for investment strategy have to be robust**
- **Clients need strategies to perform throughout the year**
- **Investment under stress when desired buys/sells relative to market volume is high**
- **Fundamental valuation models can see marked changes**
  - after quarterly and interim earnings seasons
  - After releases of annual statements
- **Ability to get all of best ideas into portfolios in rapidly is challenged if market volume falls sharply or if more modest fall coincides with spike in alpha changes**
- **April/May : recommendations peak (December year-end companies)**
- **August: market volumes low (holidays)**

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Measuring capacity – the literature

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Measuring capacity more directly and sensitively

- **It is hard!**
- **Cost of implementation increases with AUM but …**
- **Other factors will influence performance e.g. style bias of process**
  - If style bias in favour, you will over-estimate
  - If large caps and higher liquidity stocks are in favour as AUM grow, you will over-estimate
  - Strong positive inflows can mislead on size of alpha
- **Three routes for estimation in literature**
  - Empirical fund performance research (Christopherson et al 2002)
  - Process simulation (Beckers 2001)
  - Simple model with top-down estimated process parameters (Perold 1991)
- **Key points:**
  - Capacity is a range, not a point value
  - Capacity estimates are time-dependent, conditional forecasts

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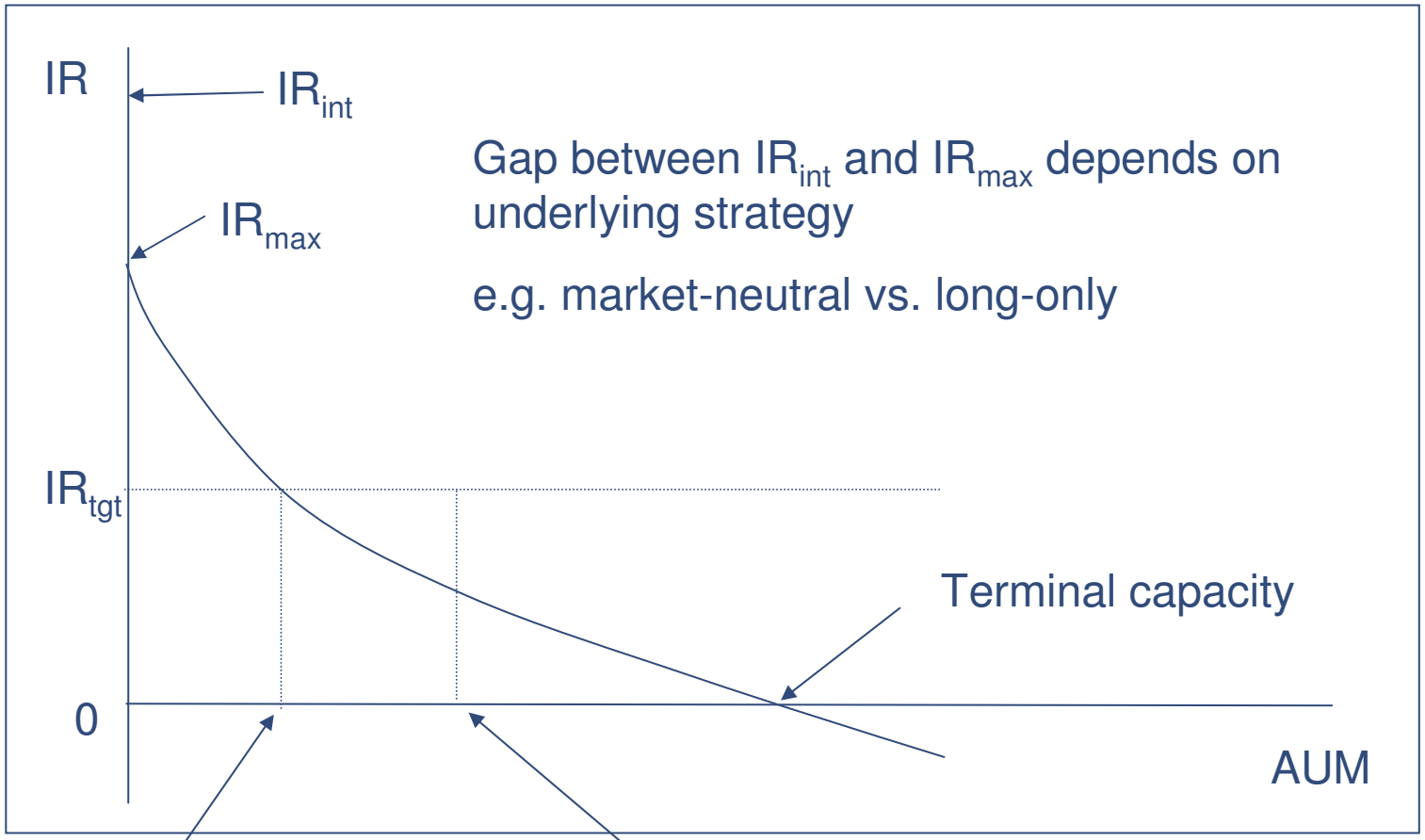
Hybrid approaches to capacity estimation

- **Two recent practitioner papers on capacity estimation have received a lot of attention**
  - The surprisingly small impact of asset growth on expected alpha
    R Kahn, J S Schaffer JPM, pp. 49 – 60, Fall 2005
  - The capacity of an equity strategy
    M Vangelisti JPM, pp. 44 – 50, Winter 2006
- **Both use simulation of portfolios but …**
  - Kahn uses these indirectly to estimate parameters in active investment framework
  - Vangelisti uses simulations with increasing AUM or decreasing 'concentration' (more stocks) to calculate 'slippage rates' for real portfolios
  - Stress variation with market environment and time

A natural framework for capacity estimation



Source: AXA Rosenberg

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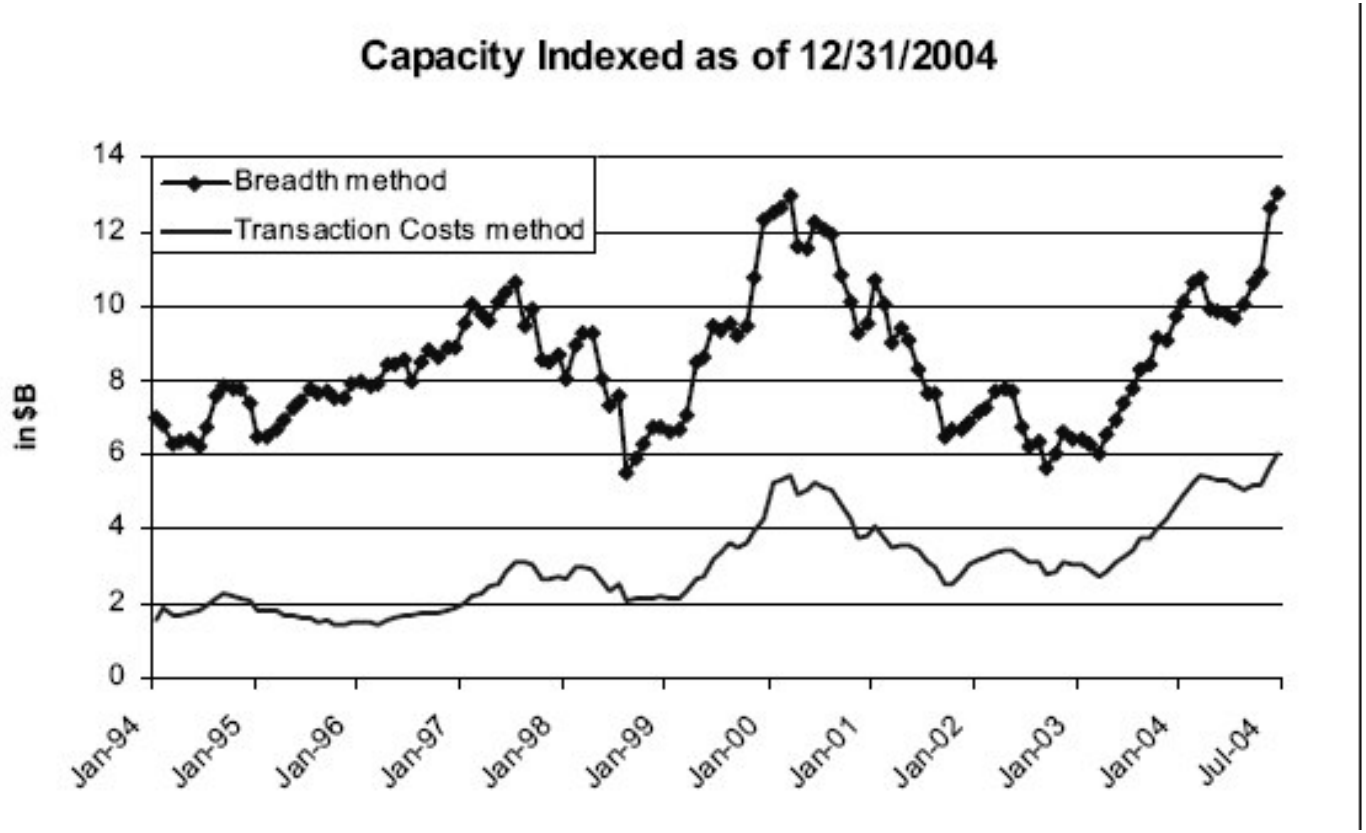
Vangelisti (2006) Two process simulation approaches

- **Approach 1: Transaction cost-driven**
  - Historic alphas and optimised portfolios for varying AUM
  - Penalties for trading and concentrated positions
  - Simple trading-cost rules - fixed commissions, share of ADV
  - Deduces percentage ‘deltas’ to strategy alpha from simulation results and applies these to actual portfolio experience to estimate capacity
- **Approach 2: Portfolio concentration-driven**
  - Defines concentration measure C cf. ‘effective number’
  - Targets a given level of C in simulation
  - Observes simulated net alpha and turnover
  - Obtain capacity estimate depending on max holding as % of free-float
  - Actual capacity estimate again based on ‘slippage’ in simulation, not levels

Results - Wide range for GMO GEM strategy

- **Time-dependence based on macro environment, market volumes and level of issuance *relative to strategy's investment universe***



Source: Vangelisti 2006

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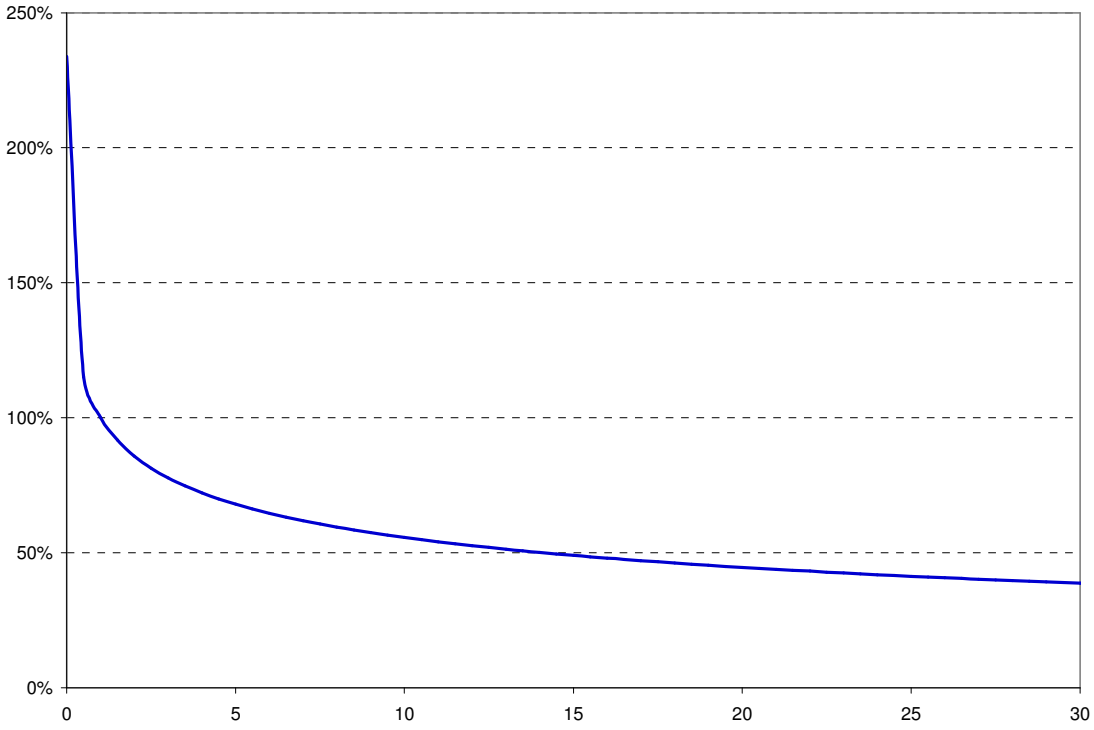
Kahn (2005) – model with estimated parameters

- **Net alpha = IR_{int} * ω * e(τ) – τ * TC(A, τ)**
  - τ is annual turnover
  - e(τ) is implementation efficiency or transfer coefficient – index and strategy dependent (Clarke et al 2002, Strongin 1999, Grinold & Kahn 2000)
  - ω is the expected or desired level of active risk
  - No history: IR_{int} ~ skill * √breadth (fundamental law of active management)
- **Uses backtests to estimate parameters in postulated efficiency, turnover and cost functions (not directly for performance)**
  - Drop first year of 3-year simulation to avoid immature portfolios
- **Estimates 'threshold capacity'**
- **Capacity estimate ~ 'confidence in ability to take on 20% more AUM'**
- **Tightness of capacity range generated depends on the height of the client alpha hurdle**
- **Low sensitivity of forecast alpha to capacity estimate with lower hurdles**

Kahn (2005) – process style and parameters

- **Maximum transfer coefficient will depend on index and strategy (0.2 - 0.8)**
- **Coefficients in efficiency function depend on speed of alpha decay and range of forecast horizons (strategy and zone dependence)**
- **TC follows standard market impact models TC = a + b * $\sqrt{(A\ \tau)}$**
- **Given A, choose turnover τ so net alpha maximised**
  - Optimal turnover falls as AUM increase



Source: AXA Rosenberg

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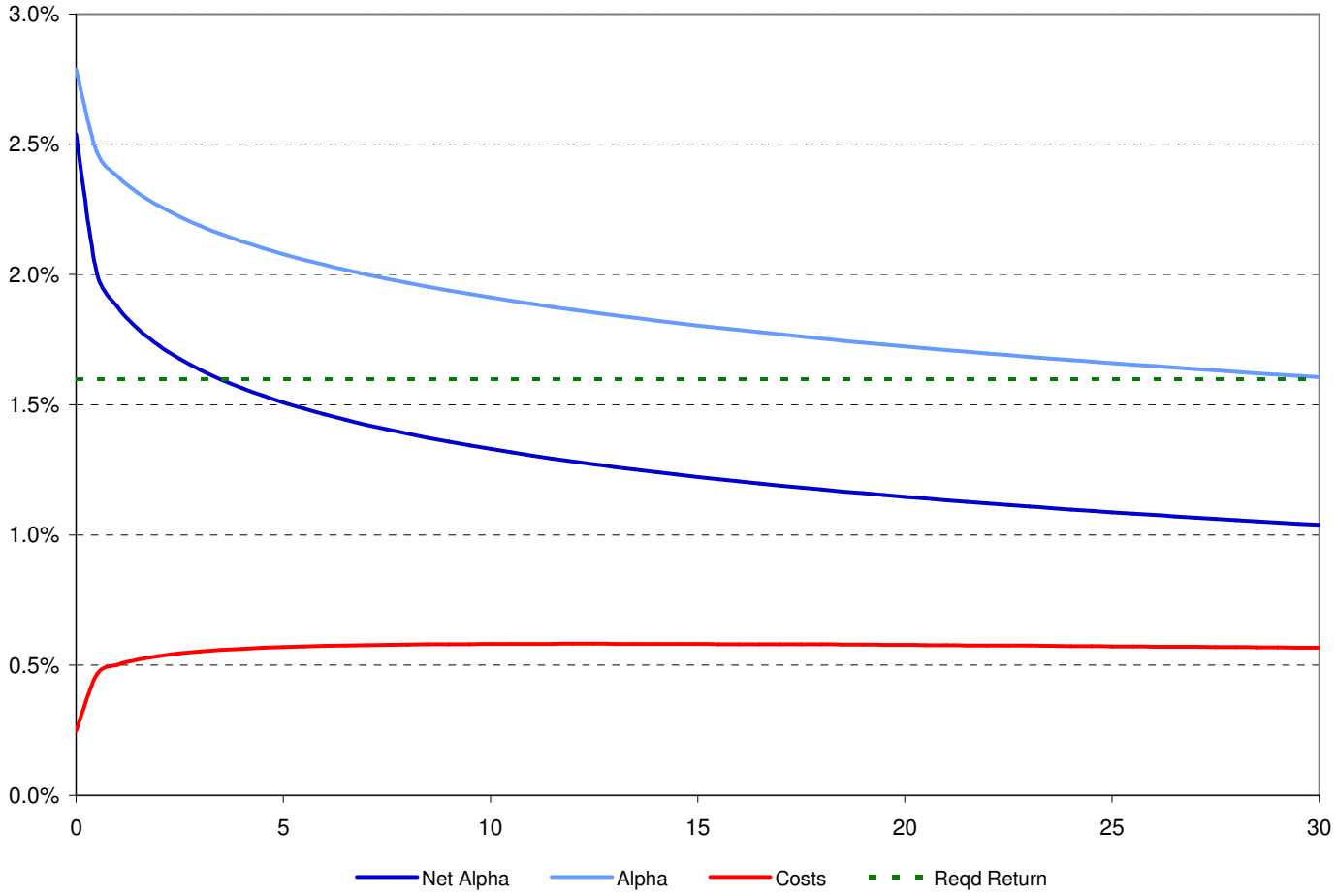
Kahn (2005) – estimating capacity with optimal turnover

- Alpha net of costs decays slows once reach higher asset levels
- Costs change little as assets increase *providing turnover is managed*



Source: AXA Rosenberg

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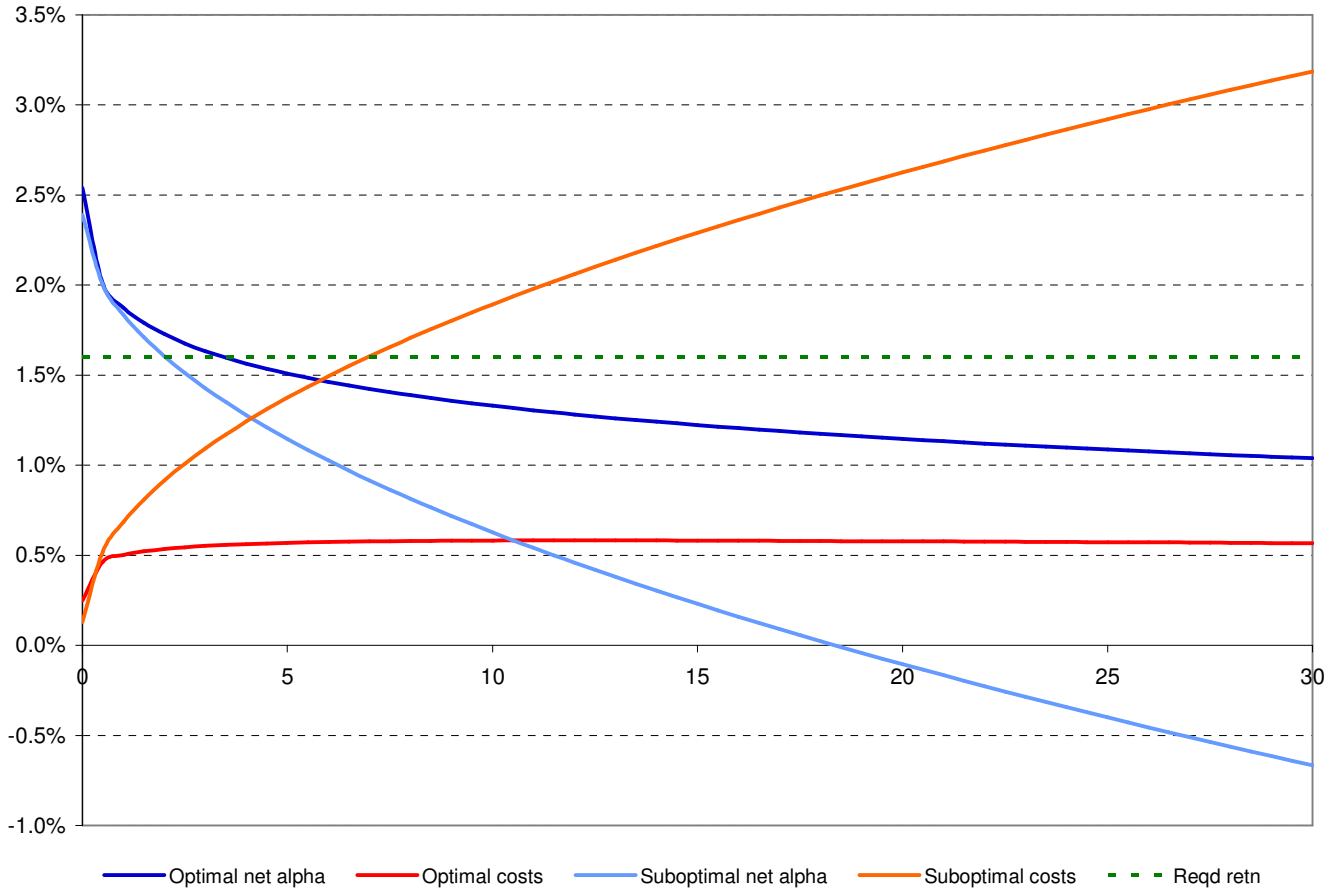
Kahn (2005) – lower capacity without turnover management

- At low AUM levels, stable turnover is too low to get alpha in portfolio
- At high AUM levels, fixed turnover generates too much cost
- Examine input parameter sensitivities to generate range forecast



Source: AXA Rosenberg

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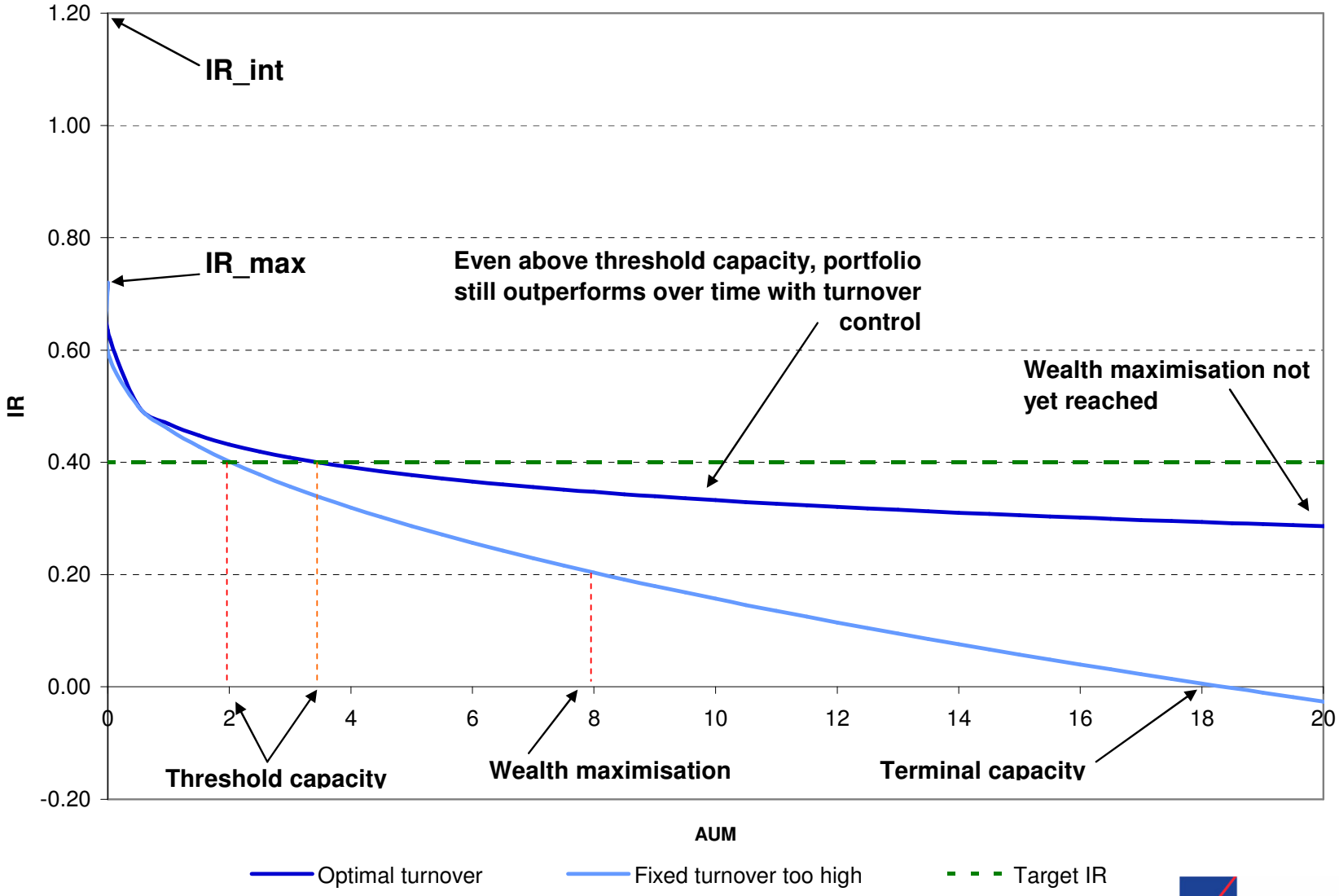
Kahn (2005) – example within the IR framework



Source: AXA Rosenberg

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Capacity estimation - shortcomings

- **Trading cost models break down when volumes hit high % of ADV**
  - Trades will no longer complete … capacity over-estimated
- **Long-short or 130/30 - capacity includes ability to borrow stock**
- **Increased information content of trading when holdings are high**
- **Stakeholder and take-over issues important at high holding levels**
- **Impact of competitors following similar strategy**
  - Reduces intrinsic information ratio
  - Include other in-house portfolios
- **Inability to reach risk target at high AUM**
  - TCs too high to build and maintain positions fast enough
- **Non-optimal portfolio construction will lower capacity**

Other capacity monitors

- **Performance?**
  - Assets above capacity will erode alpha but shouldn't turn negative unless management is truly sub-optimal or no skill!
- **Realized transaction costs?**
  - Helps identify non-optimal management o/w TCs fairly constant
- **Monitor levels of unfilled trades**
- **Risk attribution – how much of active risk is in liquid segments**
- **Trends in active risk – can we spend our risk budget?**
  - Hard in low volatility environment; monitor TE versus 'active money'
- **Turnover management and trends**
- **Longer portfolio – trends in number and sector weights**
- **Is capacity higher or lower for 'trad' managers vs 'quant shop'?**

  Better portfolio construction, more alpha opportunities

  vs. Bias to smaller less-liquid stocks? (Zhao)

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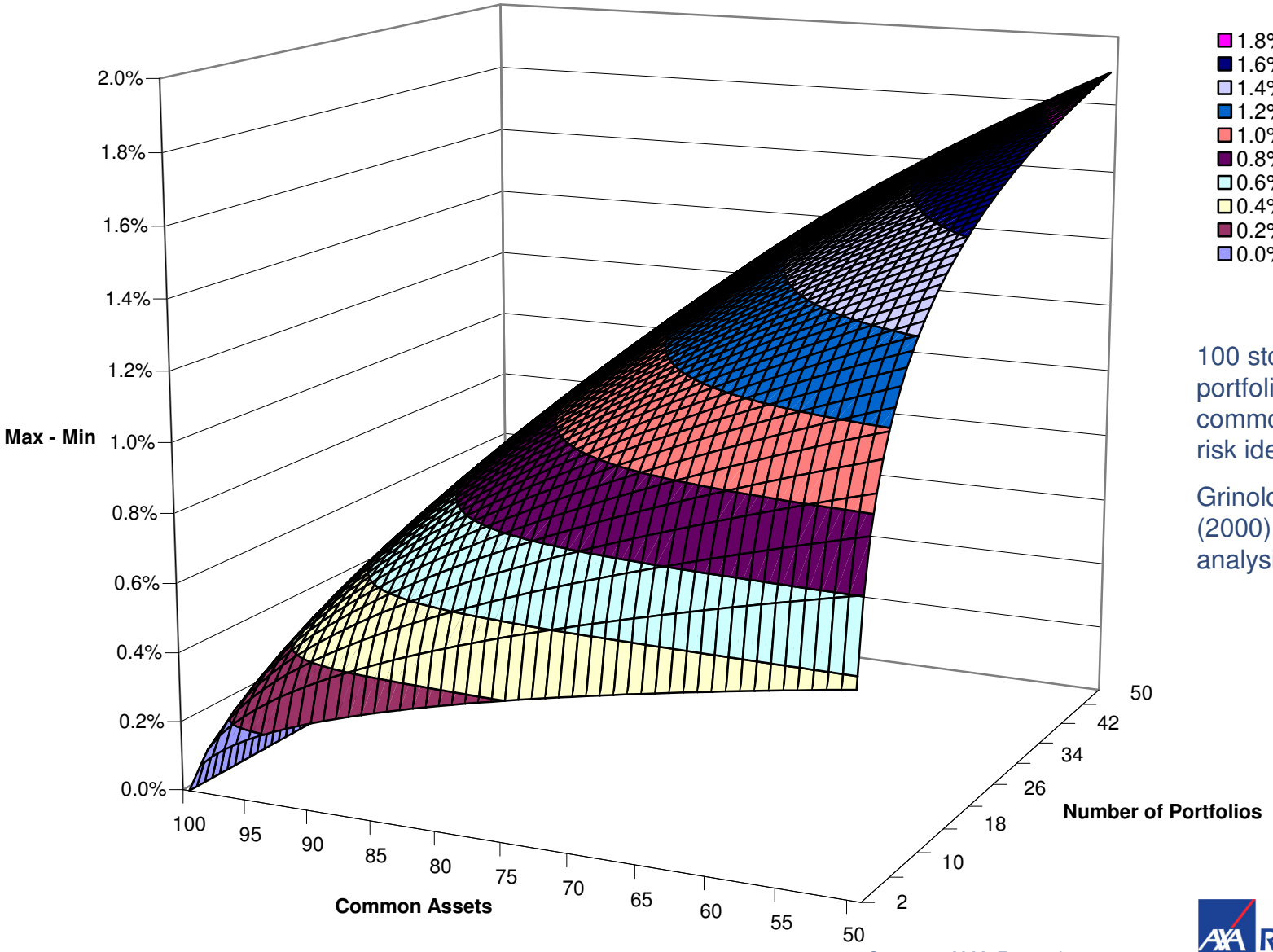
Capacity management: Risk of portfolio dispersion!



100 stock portfolios, all common factor risk identical

Grinold & Kahn (2000) type analysis

Source: AXA Rosenberg

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Conclusions

- **'Threshold' capacity is the key definition for an investment manager**
- **Activist consultants mean that funds must close before capacity is hit**
- **Traditional fund managers have to rely on static and supply-side measures**
- **Quantitative fund managers (or ones who can back-test in detail)**
  - have more options
  - but can be deceived by simulations
- **Remember:**
  - Capacity is a range, not a point value
  - Capacity estimates are time-dependent, conditional forecasts
- **Non-performance related issues are key in practice**
- **Portfolio dispersion can be as big a client issue as capacity concerns**

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Some references

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Appendix

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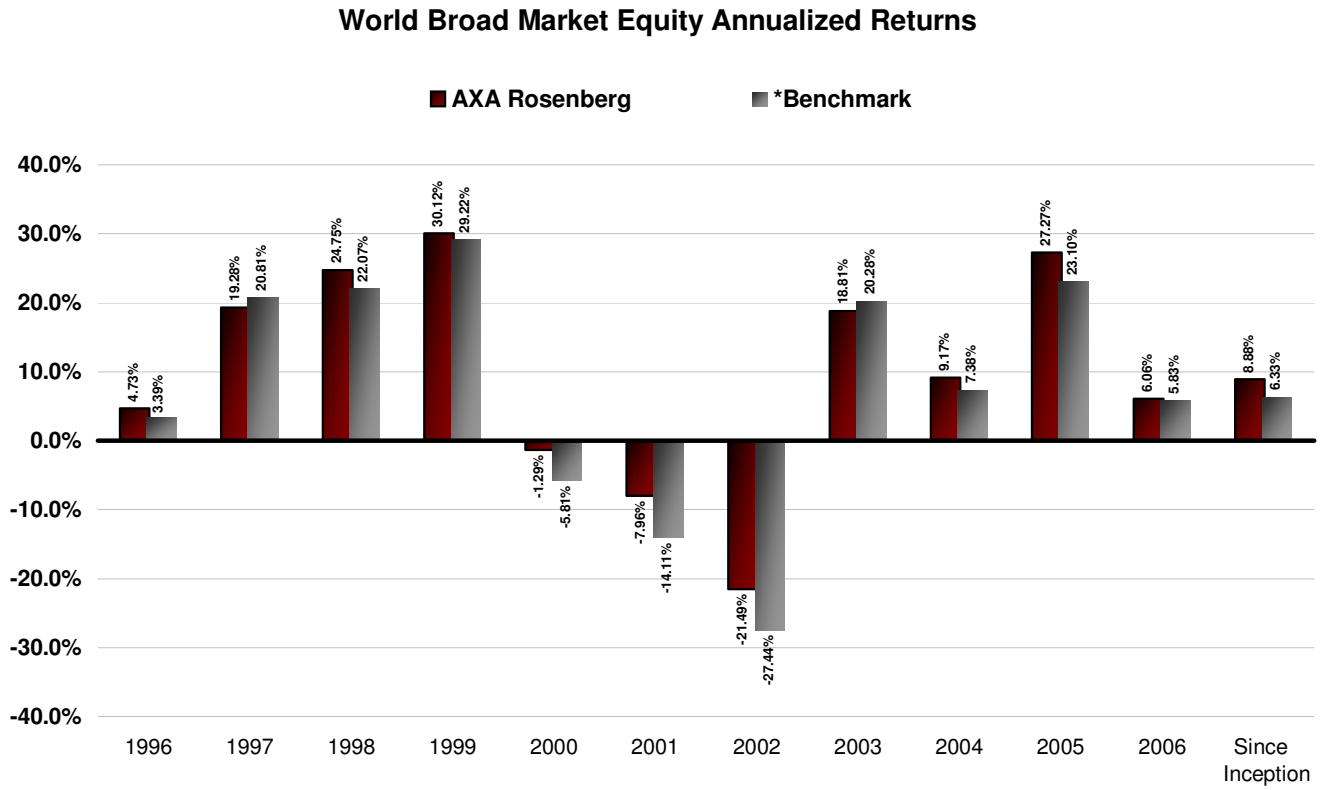
World Broad Market Performance



GBP Denominated Annualized Returns Since Inception
Dec 95 - Dec 06

AXA Rosenberg	8.88%
*Benchmark	6.33%
Outperformance	**2.55%**
Tracking Error	**3.55%**

* The benchmark is a value-weighted composite of the indices selected by each client for comparison purposes. The country weights of the portfolios are plus or minus 4% of the country weights of the clients' designated benchmarks. Benchmark weights as of 12/1/2006 are: 79.99% MSCI World, 7.10% MSCI World-ex Singapore, 1.12% MSCI World ex-Norway, 9.61% MSCI World ex-Australia, 2.19% MSCI World ex-Switzerland. These weights are recalculated monthly. Benchmarks are gross of withholding taxes.

(Source: AXA Rosenberg's fully compliant World Broad Market Equity presentation, which is available on request.)

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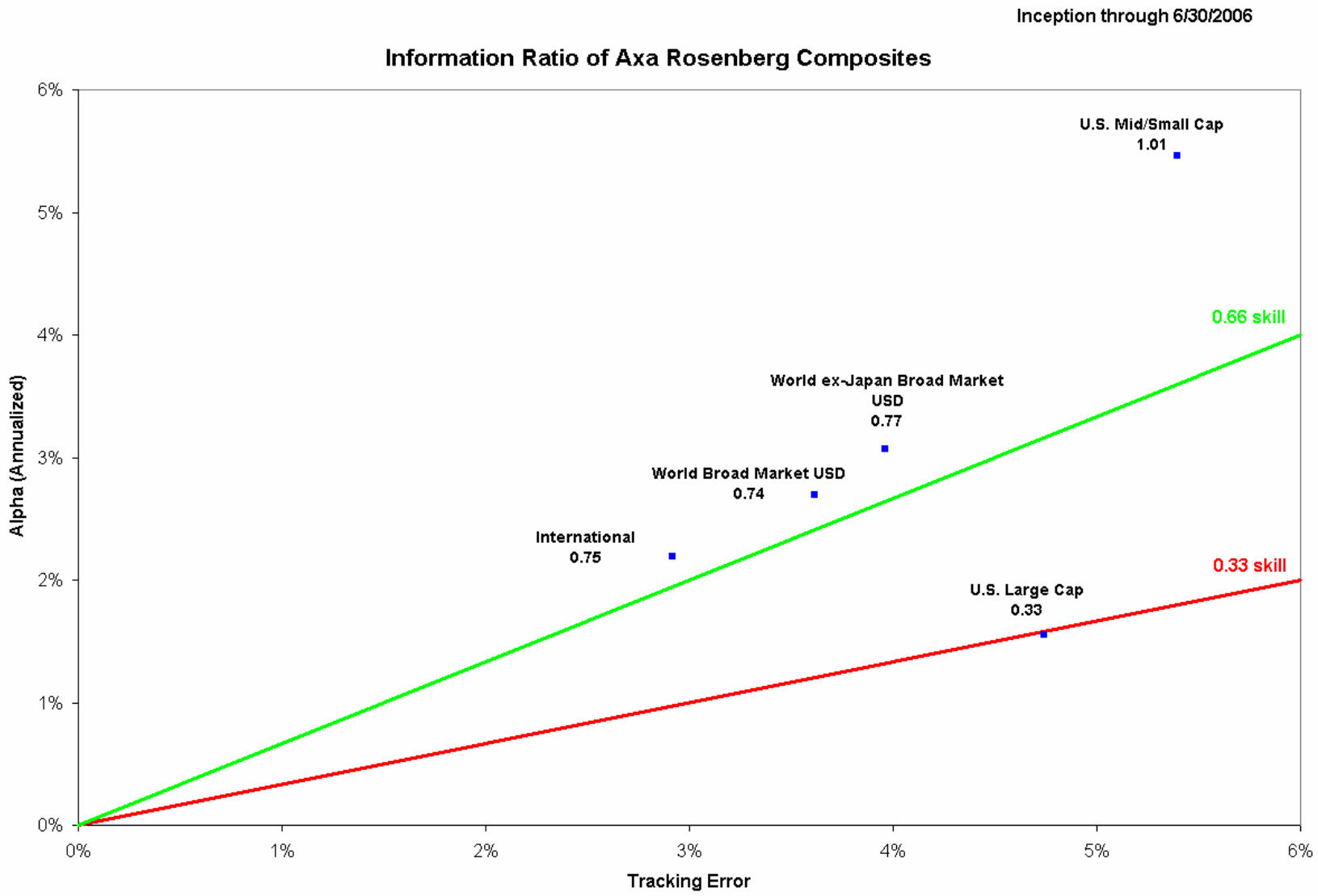
Evidence of Active Skill: Large Cap



Source: AXA Rosenberg

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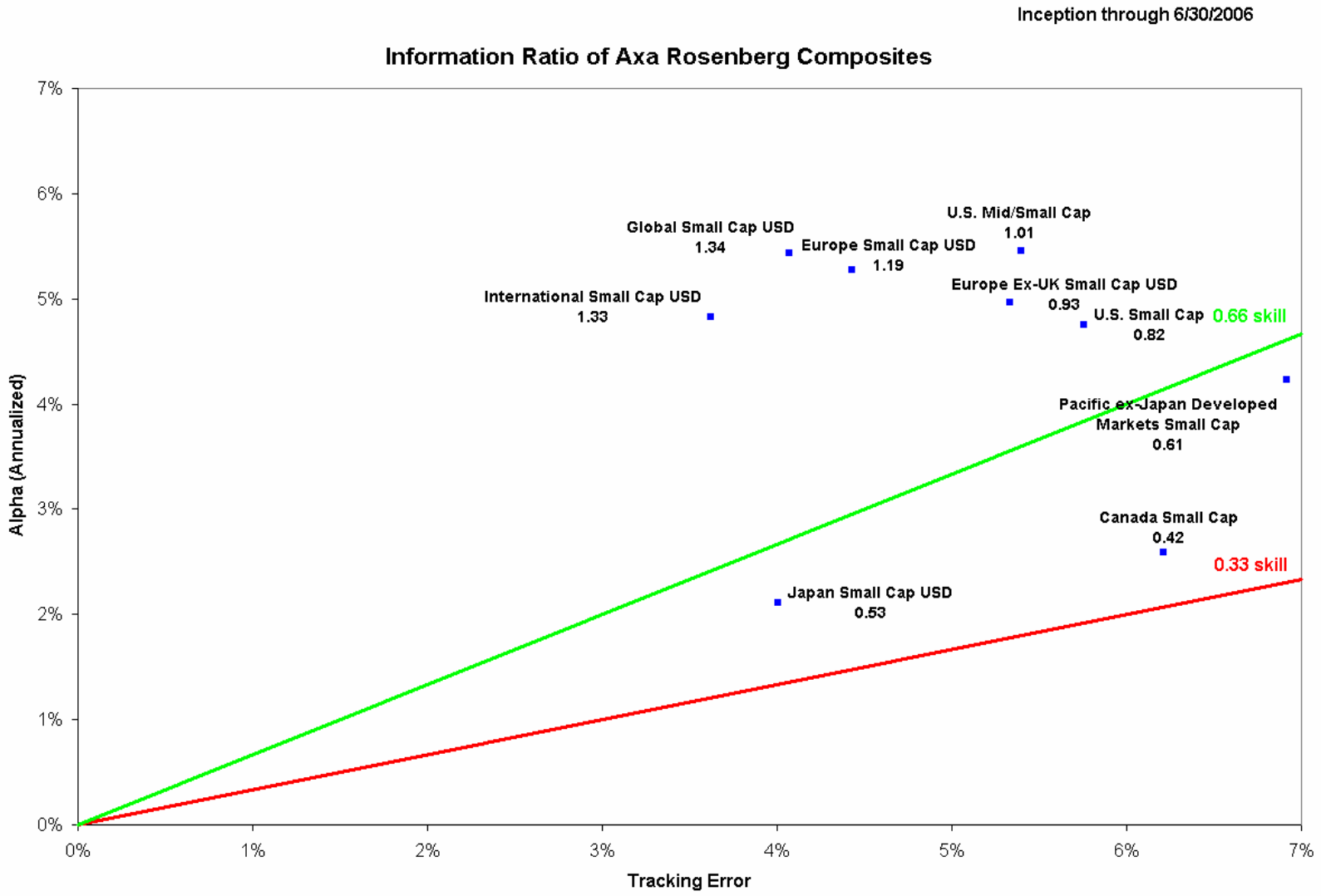
Evidence of Active Skill: Small Cap



Source: AXA Rosenberg

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