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Quantitative Investments

An equity investor's perspective

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Outline

- Quants and Quantitative Investments
- A Little About History
- What Fills A Day At A Quant Fund
- New Area of Growth

Quants and Quantitative Investments

- Quants: anyone who toys with numbers
  - Inside one's brain – heuristics
  - With a ruler – chartists
  - With a calculator – fundamental
  - With a super computer – canonical quants

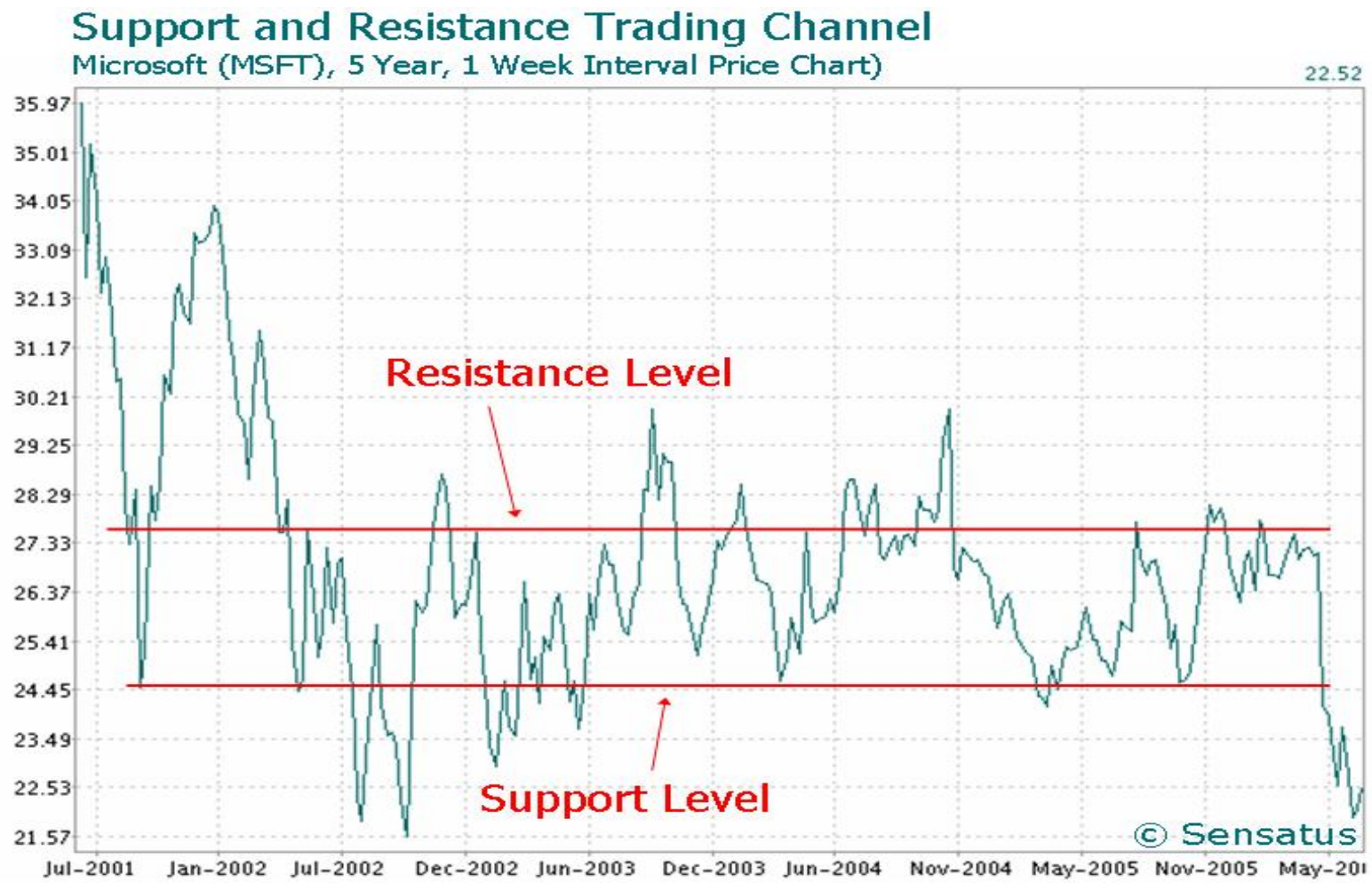
Heuristics, System 1, Experience, Guts or by any other names

- Heuristics: simple, efficient, learned rules
  - “Sell in may, go away”: some evidence to support that: June through August average return 4.3% p.a., other months 11.5% p.a.
  - Financial Firms are riskier than others: seems to be supported by 2008/2009 crises
  - “Cheap Companies Ultimately Outperform”: survivorship bias
- Innate vs. sum of experiences
  - Some we are born with
  - Some we acquire:
    - Hearsays;
    - Mental accounting: we are all secret “frequentists”

Biases: a case against intuition

- Confirmation Bias: consciously or unconsciously seeking evidence to confirm one's heuristics;
  - "My success must imply I have done something right, and let me numerate…"
- Anchoring: our tendency to attach our thinking to a reference point;
  - Chart reading: arbitrary support/resistance levels;
- Survivorship Bias: we acknowledge what survive and ignore those that didn't;
  - Value investing: it does work however people underestimates the risk involved;
- Substitution: we answer questions easier than the ones being asked
- Herd Behavior: agree *and* do what your brethren do, by shared euphoria or pessimism
  - Tech Bubble: 1997 – 2003
  - Housing Bubble: 2003 – 2007
  - Safety Bubble: ongoing

Biases: an example of anchoring (from Wikipedia)



Biases: a case for intuition

- Instinctive response usually are the best starting point of an analysis;
  - "What will be President's rating in 6-month?"
- Instincts are the best to deals with fast change in circumstance
  - No prior history or little history: very "rare" event"
    - Ignore it?
    - Deal with it?
  - Waiting for evidence could mean extinction: meteor

Biases: will quant do differently?

- Confirmation By Statistics: different sort of bias afflicting quants
  - Correlation vs. Causality: “drivers”
  - Statistics vs. Dynamics: does statistics ever tell you anything you don’t know?
- Anchoring: our tendency to attach our thinking to a reference point;
  - Model selection: a model that have described the history is the only one I care
  - Criticism: No model is perfect; What’s outside the model?
- Quants herd too!
  - Quant crises of 2007

Invest with a ruler: technical analysis

- Core Beliefs:
  - Price Discovery incorporate all information: truism “market knows better”
  - Past trading pattern repeats
- Typical stuff: there really are only two strategies out there
  - Trend Following: channels, breakouts, MACD
  - Mean-reversion: stochastic oscillators, “head and shoulders”, “double top”

Invest with a ruler: criticism, criticism of criticism

- Criticism:
  - Efficient Market Hypothesis (weak form)
  - Arbitrariness: more an aesthetic differences
- Criticism of criticism
  - Efficiency in the eyes of beholder: short-term inefficiencies
  - Flow and liquidity do matter in the short to medium term in price discovery: pattern as indicators
  - Evidence: turtle traders 1980s, $250K - $2 MM each to $175 MM profit within 5 years

Invest with a calculator: fundamental analysis

- Core beliefs:
  - Fundamentals read tables (as opposed to technicals read charts)
  - Financial statements contain accurate and sufficient information about a firm
  - Such information is predictive of stock price movements
- Typical stuff: there really are only two strategies out there
  - Trend Following: momentum, sentiments
  - Mean-reversion: valuation (P/E, P/S, P/Cash Flows)

Invest with a calculator: criticism, criticism of criticism

- Criticism:
  - Efficient Market Hypothesis (strong form)
  - Herding in analysts' opinions: followers vs. leader
  - Financial Statement Manipulations
- Criticism of criticism
  - Efficiency in the eyes of beholder: intellectually appealing but impractical
  - Near equilibrium: behavior biases, macro overhang
  - Evidence: "Value Investing" Graham and Dodd; Franklin Templeton Value Fund

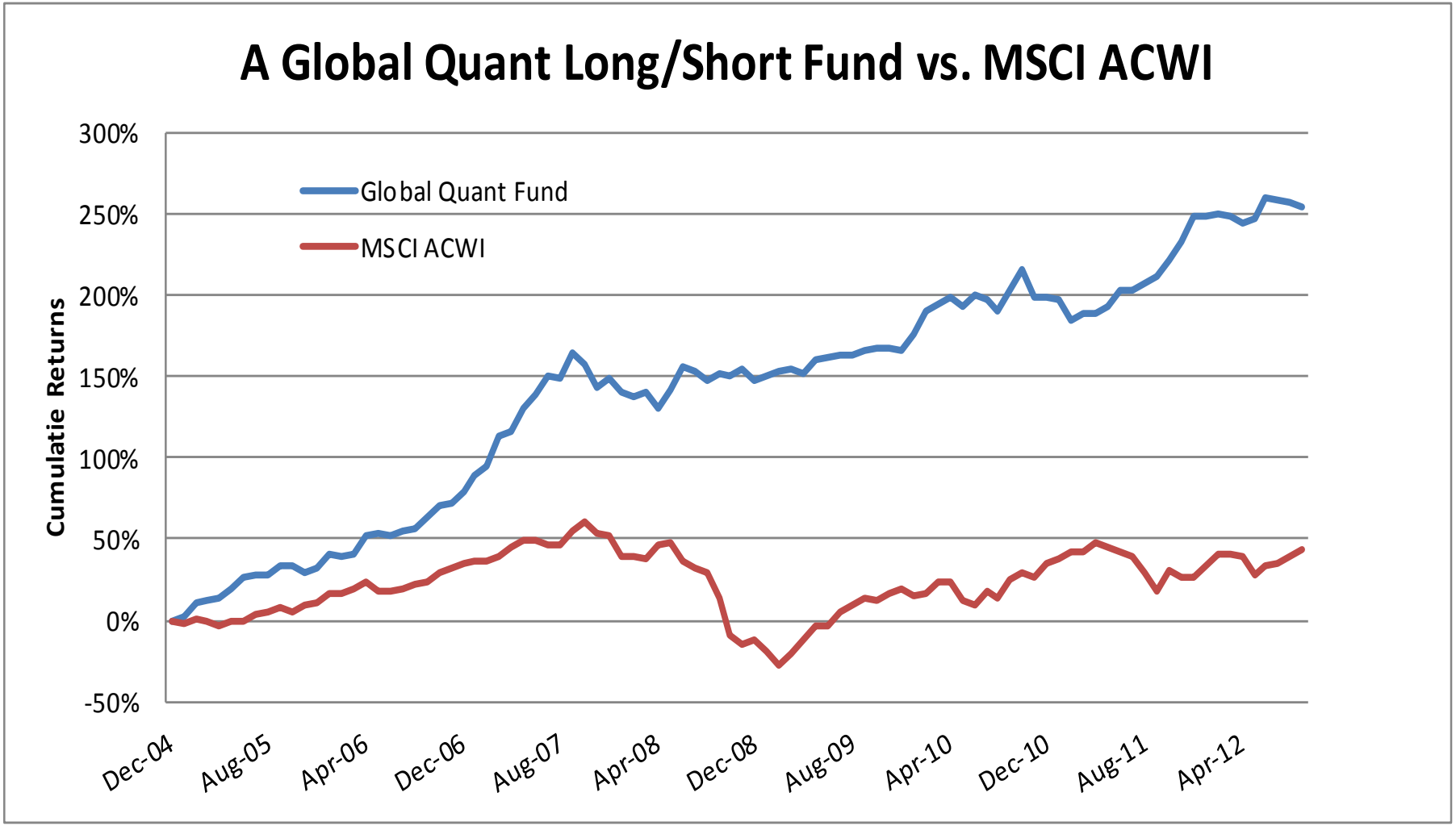
Invest with a super computer: quants

- Core beliefs:
  - “Quant understands risk better”
  - Statistics based: against human biases
  - Broader reach, higher efficiency
- Typical stuff: there really are only two strategies out there
  - Trend Following: momentum, sentiments
  - Mean-reversion: valuation (P/E, P/S, P/Cash Flows)

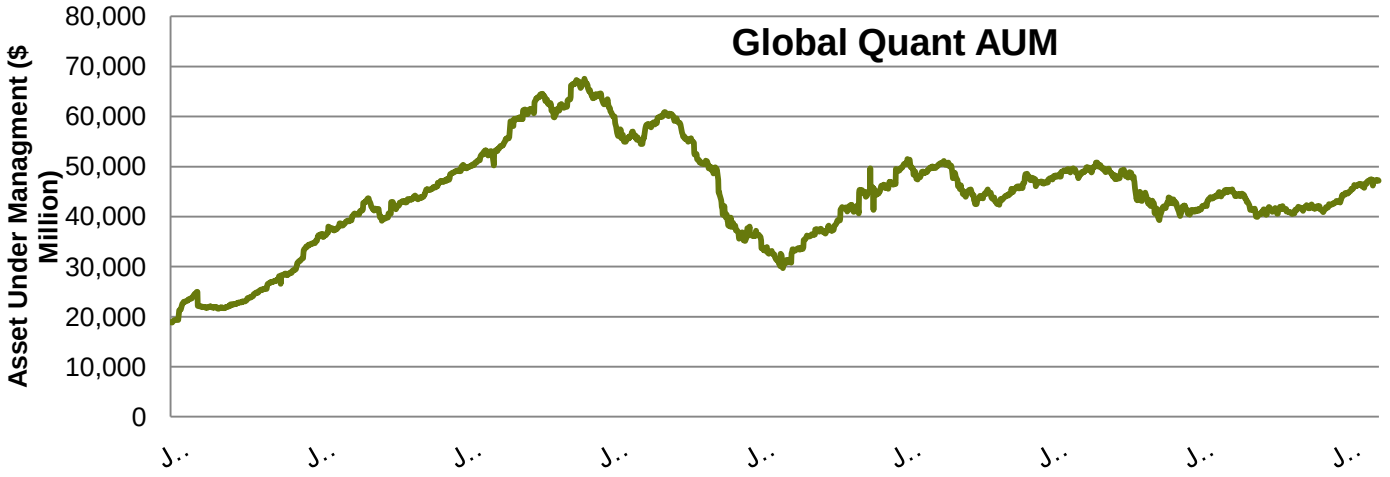
Invest with a super computer: criticism, criticism of criticism

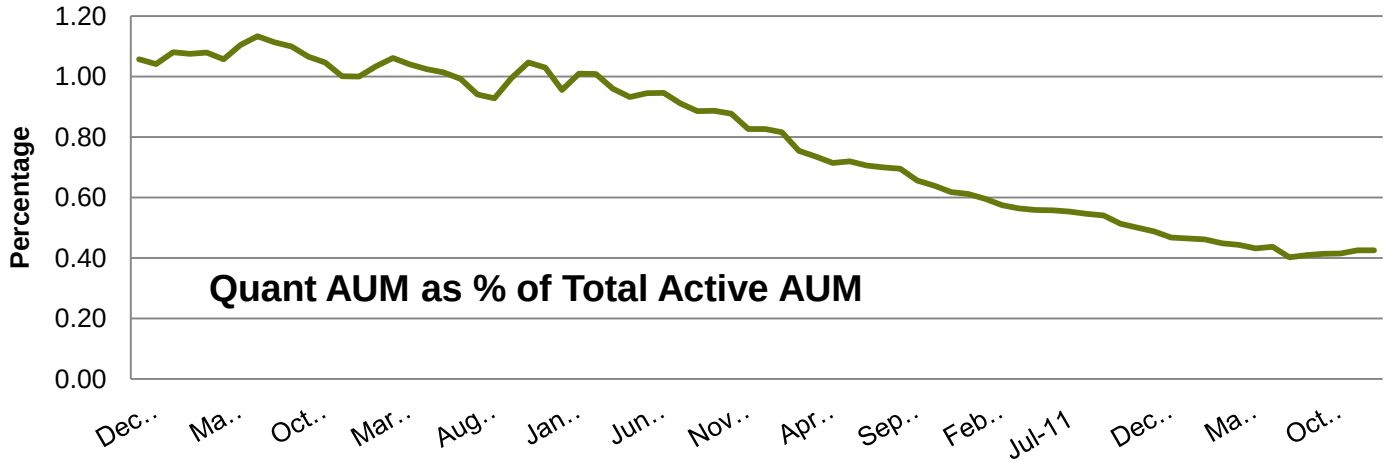
- Criticism:
  - Efficient Market Hypothesis (strong form)
  - Biases or blind spots of quants: pretend things outside models do no harm;
  - Confusing correlation with causality: ignoring underlying dynamics;
- Criticism of criticism
  - Efficiency in the eyes of beholder: intellectually appealing but impractical
  - Near equilibrium: behavior biases, macro overhang
  - Evidence: quant fund success from late 90s to mid to late 2000s

Quant does work in general

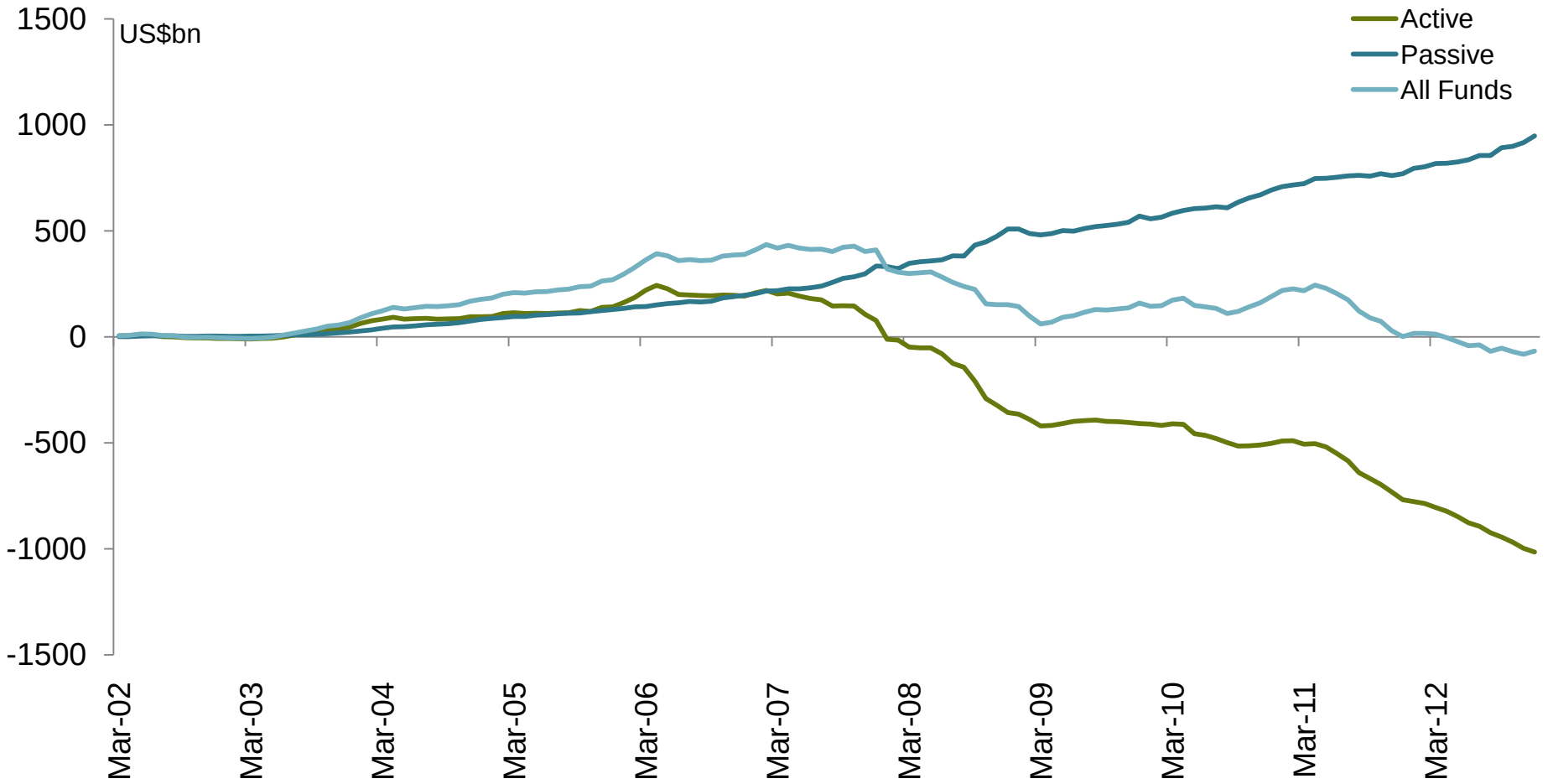


Asset Under Managements by Quants





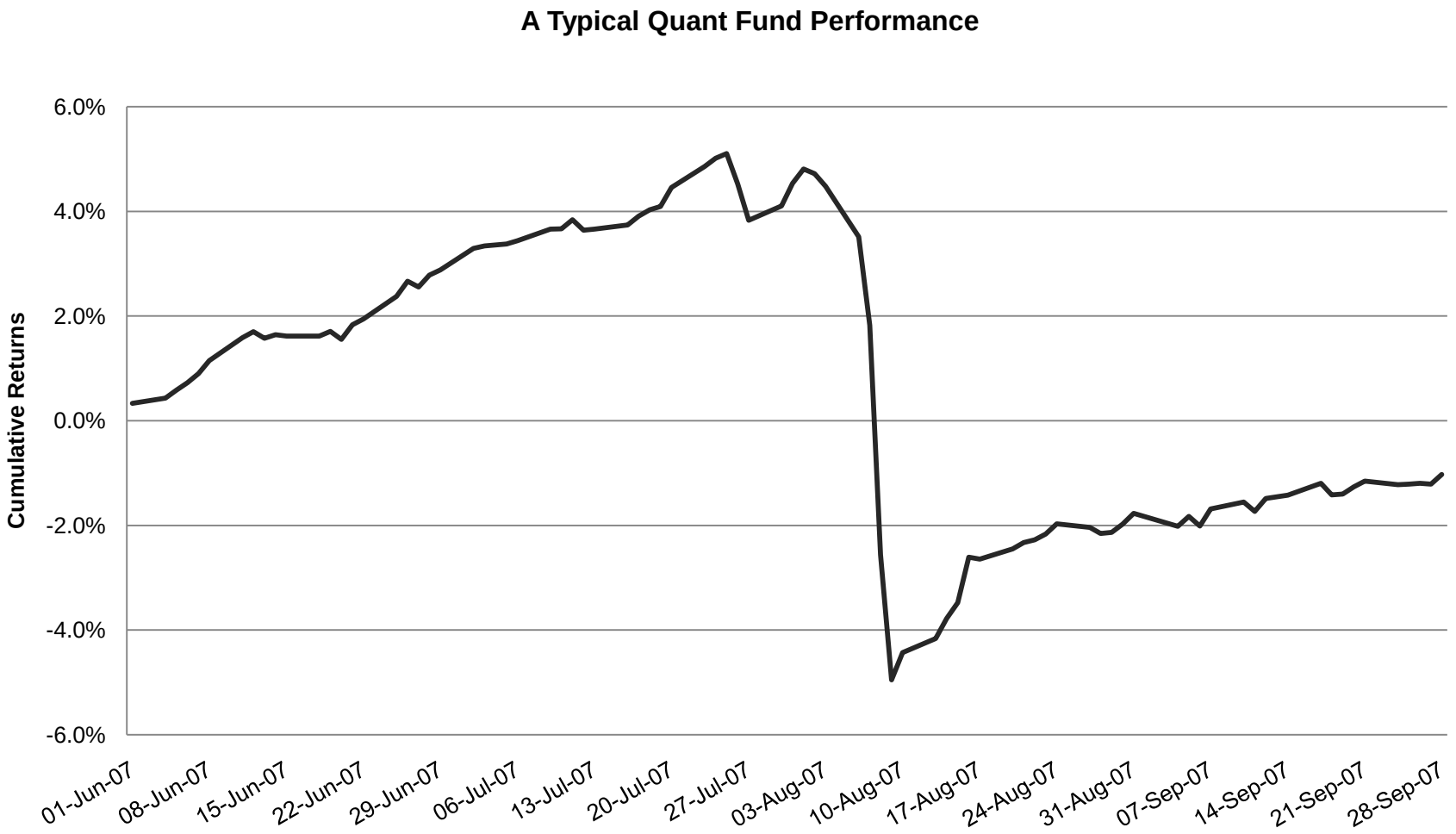
Struggles post housing bubbles



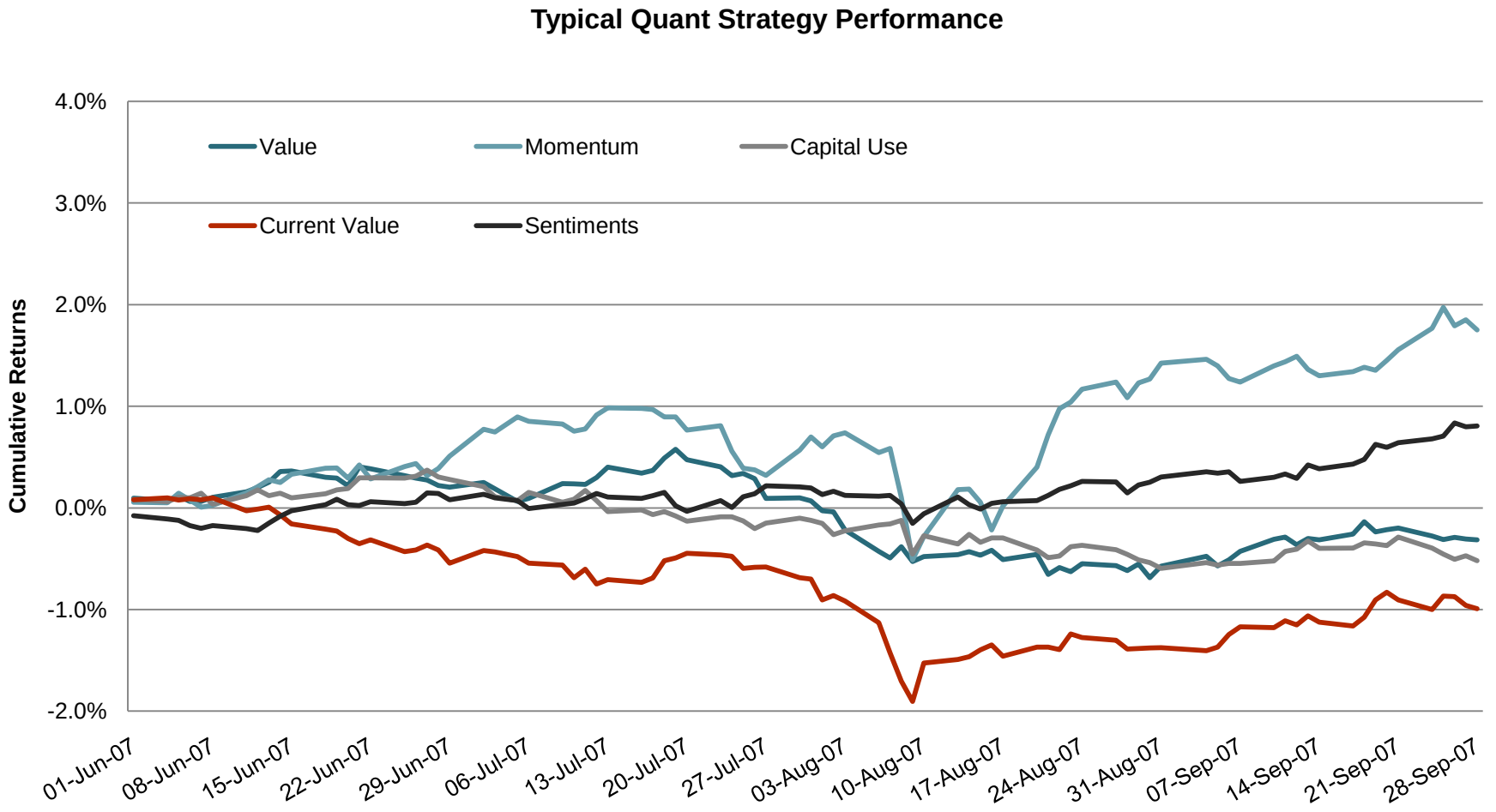
Quant Crises of August, 2007

- What happened?
  - Simultaneous underperforming almost all strategies: “10 sigma event” (?!!)
- Possible Causes
  - Model Similarities
  - Liquidity Crises
  - Sub-prime

Quant Crises of August, 2007: ~ 10 times risk estimates suggests



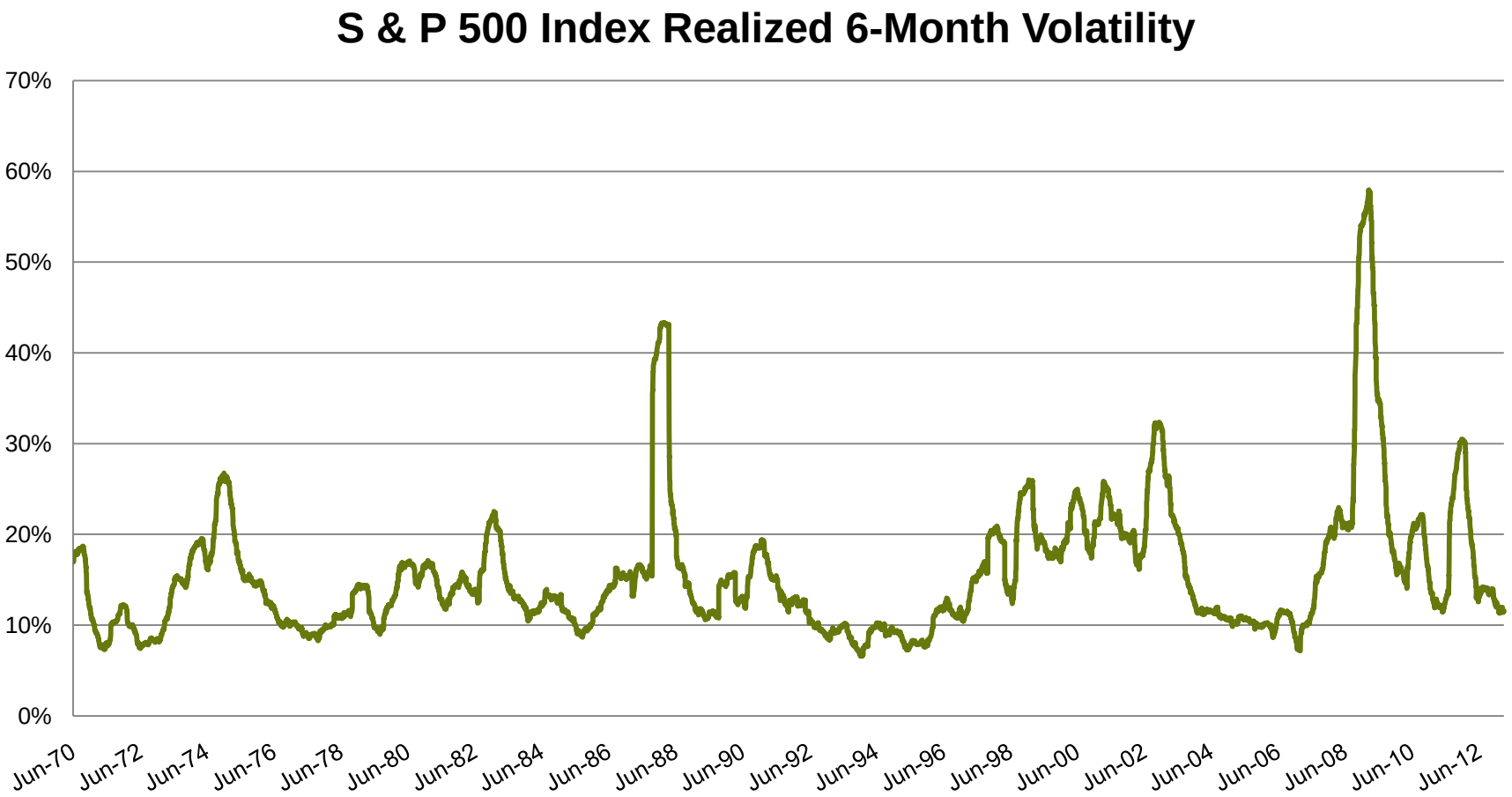
Quant Crises of August, 2007: almost all quant "drivers" at bottom of historical range



What is a day job for a quant at a quant fund

- Risk forecast: volatility and correlation
- Return forecast: key strategies and assembly of strategies
- Portfolio Construction: transaction cost, round-lots, liquidity
- Performance Attribution: how and why funds out/under-performed
- Research:
  - Risk forecasting
  - Return
  - Implementation

Risk Forecasting: S & P 500 Index Volatility



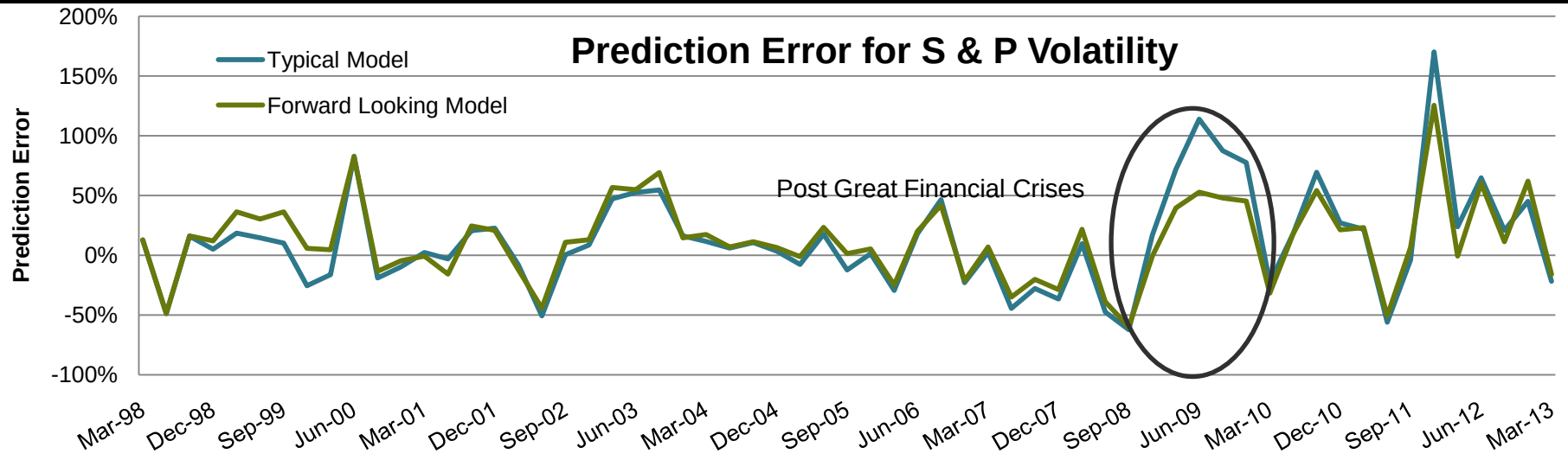
Risk Estimation

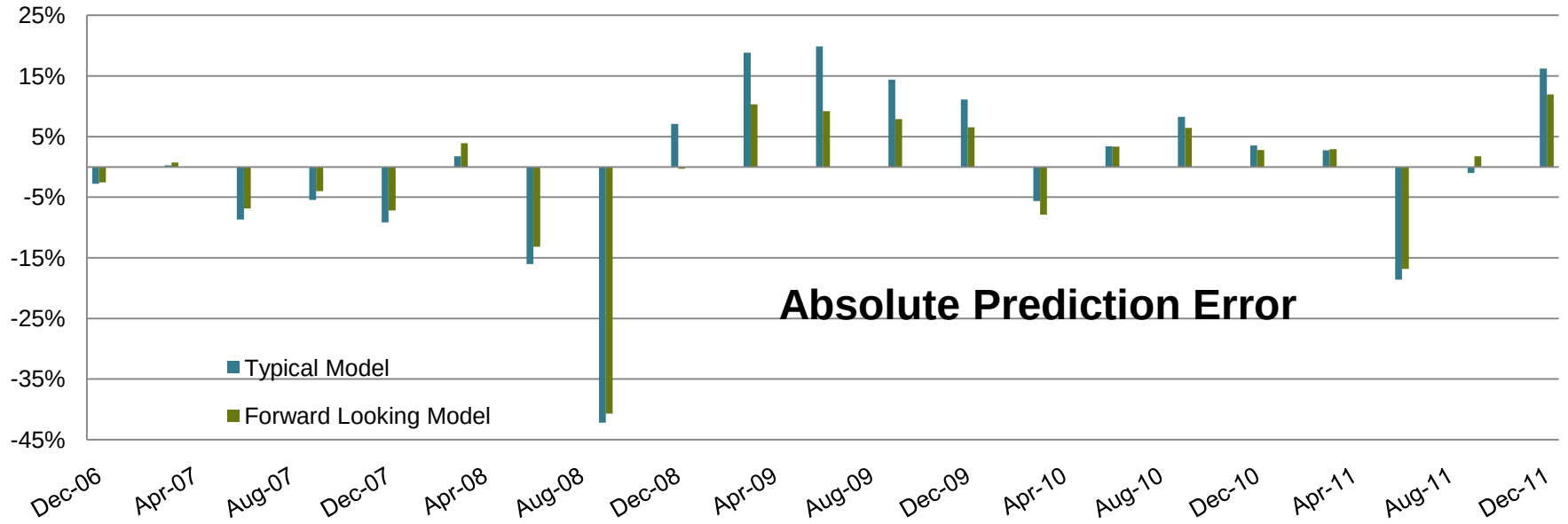
- Clustering: high vol begets low vol, *"autoregressive"*
- Sensitive to outliers: quadratic nature
- Time-varying: duh!
- Non-stationary: *"heteroskedasticity"*
- GARCH-type: "generalized autoregressive conditional heteroskedasticity"
  - Example: IGARCH Model, "integrated generalized autoregressive…."
  - Loosely speaking: IGARC(1,1) : Sigma^2(t) = (1 – a) x r^2 + a x Sigma^2(t – 1)
  - Equivalent of exponential weighting: time-decay concept
- DCC: "Dynamic Conditional Correlation"
  - Individually analyze pairs of returns

Risk Forecasting

- Principal component analysis
  - Covariance matrix: positive semi-definite
  - Cholesky Decomposition: A = L D L*
  - Stochastic Factors
- Fundamental/factor based: Barra, Axioma
  - Regression
  - Factor Covariance and Residual Variance
- Biases around turning points
  - Mostly history-based
  - Undershoot going into a crises
  - Overshoot coming out of a crises

Risk Forecasting: Adding forward looking element improves accuracy

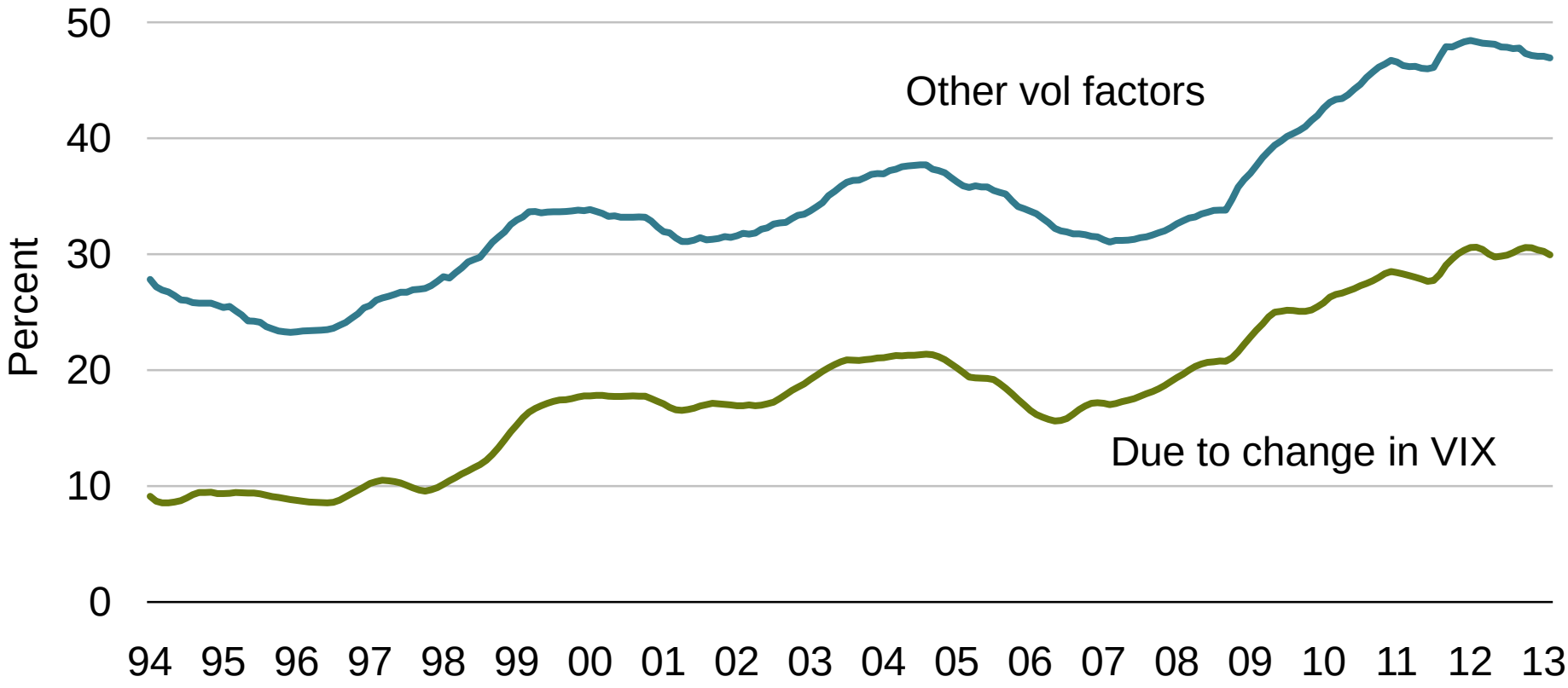




Risk Forecasting: The Risk On/Risk Off world we live in

Explanatory Power of Systematic Risk Characteristics

Top 1,500 Stocks, Through February 2013



Return Forecasting

- Individual signals
- How to assess individual signals
- Time horizons
- Alpha Models

Typical Factors

	Theme	Representative Metric	What It Measures
Alpha Factors	**Deep Value**	P / Book	Measures attractiveness under “mean reversion” in fundamentals
	Current Value	P / Earnings	Measures attractiveness of a stock on current earnings
	Capital Use	Dividend Yield	Measure of shareholder “friendliness”
	Quality	Accruals	Measures earnings quality, accounting
	Profitability	ROE	Measures “internal” rate of growth, pricing power
	Momentum	Price Momentum	Measures investor reaction, fund flows, sentiment feedback
Control Factors	**Beta**	Beta	Measures predicted beta estimated by risk model
	Size	Market Cap	Measures magnitude of “size bias”
	Risk	Residuals	Measures possible embedded risk that can not be controlled

Deep Value: liquidation value

- Typical Definition: P / B = Market Cap / Book Equity
- Market Cap = Price x Shares Outstanding
- Book Equity = Total Asset – Total Liability
- Liquidation Value
- “Buy low, Sell High”

Deep Value: Should I long MS and short KKR?

Company	Market Cap	P/B	ROE
JPMORGAN CHASE & CO	$ 178,992,250,000	0.9	11%
CITIGROUP INC	$ 137,021,780,000	0.7	7%
BANK OF AMERICA CORP	$ 126,188,950,000	0.5	2%
GOLDMAN SACHS GROUP INC	$ 66,609,500,000	0.9	10%
BLACKROCK INC	$ 43,504,790,000	1.7	10%
MORGAN STANLEY	$ 40,348,800,000	0.7	0%
BANK OF NEW YORK MELLON CORP	$ 31,361,080,000	0.9	8%
STATE STREET CORP	$ 26,010,240,000	1.3	10%
BLACKSTONE GROUP LP/THE	$ 22,959,130,000	4.3	4%
SCHWAB (CHARLES) CORP	$ 20,946,190,000	2.2	9%
CME GROUP INC	$ 19,684,590,000	0.9	4%
T ROWE PRICE GROUP INC	$ 19,285,390,000	5.0	23%
AMERIPRISE FINANCIAL INC	$ 14,686,610,000	1.6	12%
KKR & Co LP	$ 13,551,990,000	6.9	29%
NORTHERN TRUST CORP	$ 12,560,100,000	1.7	9%
TD AMERITRADE HOLDING CORP	$ 10,586,770,000	2.4	14%

Deep Value: Should I long SU and short EPD?

Company	Market Cap	P / B	ROE
EXXON MOBIL CORP	$ 391,815,310,000	2.3	24%
CHEVRON CORP	$ 225,158,670,000	1.7	19%
CONOCOPHILLIPS	$ 70,194,880,000	1.5	17%
OCCIDENTAL PETROLEUM CORP	$ 64,137,230,000	1.6	12%
ENTERPRISE PRODUCTS PARTNERS	$ 55,502,900,000	4.2	18%
SUNCOR ENERGY INC	$ 41,666,910,000	1.1	11%
ANADARKO PETROLEUM CORP	$ 40,650,740,000	2.0	5%
KINDER MORGAN INC	$ 40,256,450,000	2.9	8%
Phillips 66	$ 35,870,160,000	1.7	19%
KINDER MORGAN ENERGY PRTNRS	$ 32,485,110,000	2.8	18%
EOG RESOURCES INC	$ 30,844,760,000	2.4	4%

Deep Value: Not quite! Some are cheap for good reasons

- What's in a firm's Value?
  - DDM: a firm's value is equal to sum of all future discounted dividends
  - Residual Income Model: current invested capital + present value of net income excess of cost of equity
- DDM:
  - $\text{Value} = \sum_{k=1}^{\infty} \frac{D_k}{(1+r)^k}$
- Stable Growth Company ("Gordon Growth Model"): assuming constant dividend growth rate g and cost of equity r
  - $\text{Value} = \frac{D_1}{(r-g)}$
- Where does growth come from:
  - Improving efficiency: increasing ROE (episodic, trends to zero as a firm matures)
  - Re-invesment

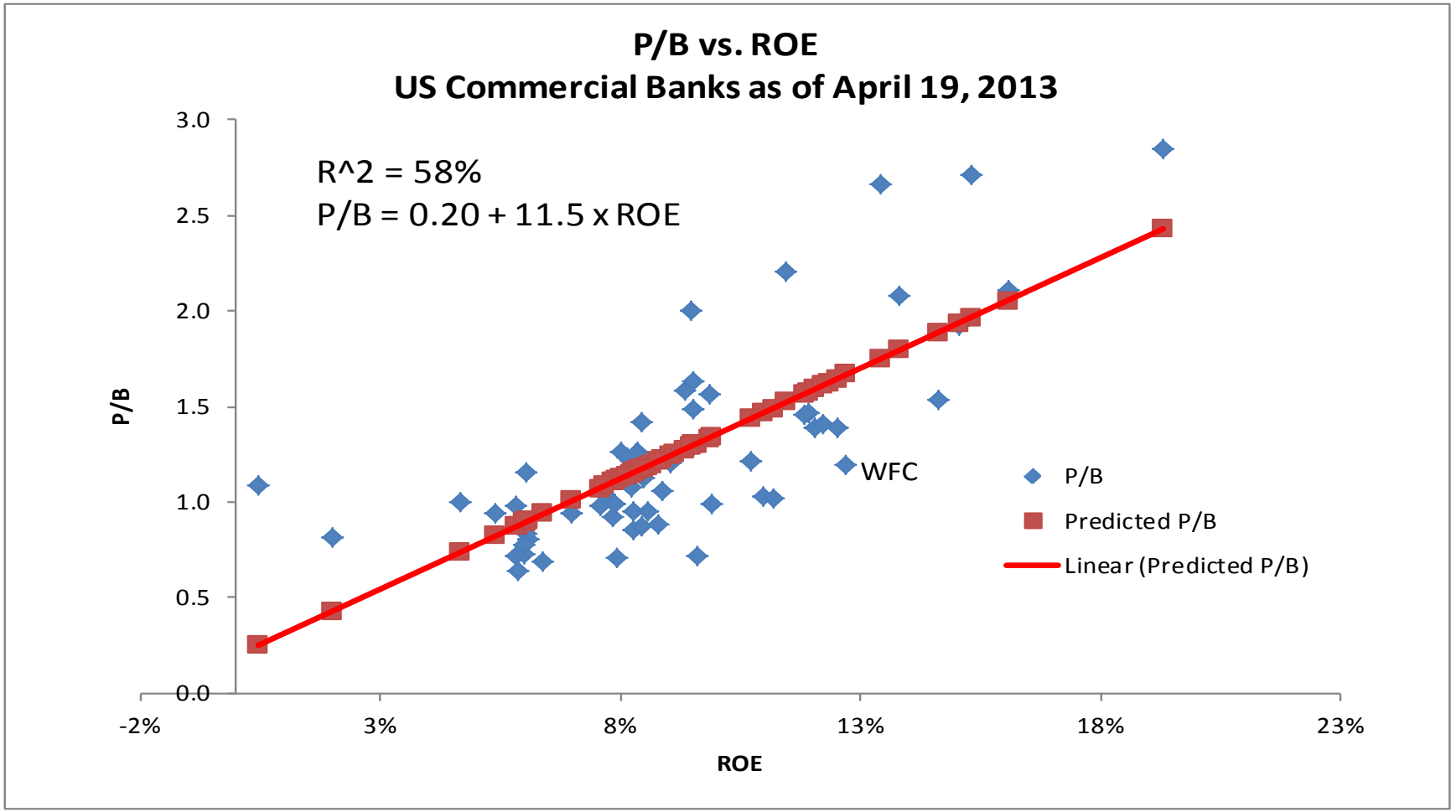
Deep Value: Not quite! Some are cheap for good reason

- Growth is closely linked to dividend payout ratio and ROE
  - $g = ROE_t \times (1 - payout\ ratio) + \frac{ROE_{t+1} - ROE_t}{ROE_t}$
- As firm matures
  - $g = ROE_t \times (1 - payout\ ratio)$
- So how much dividend a firm can pay depends on earnings growth and efficiency
  - $payout\ ratio = 1 - \frac{g}{ROE}$
  - $dividend = net\ income \times payout\ ratio = Book\ Equity \times ROE \times \left(1 - \frac{g}{ROE}\right)$
- Putting them all together
  - $Firm\ Value = Book\ Equity \times \frac{ROE - g}{r - g}$

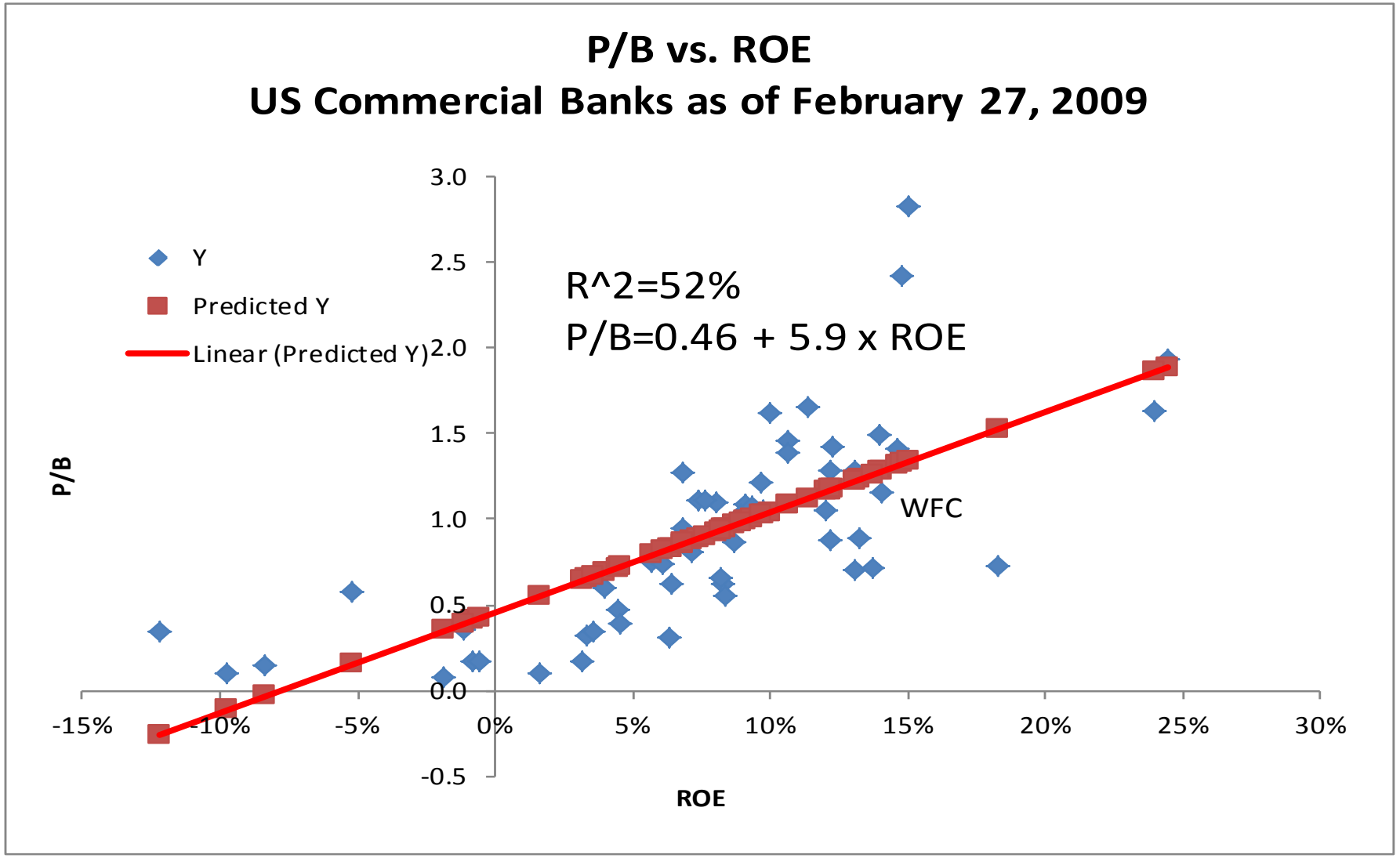
Deep Value: Not quite! Some are cheap for good reason

- If market is fair
  - $\frac{P}{B} \propto \frac{ROE-g}{r-g}$
- What's in r?
  - r is "cost of equity"
  - From CAPM model: $r = r_{free} + \beta \times r_{equity}$
- What do all these mean?
  - P/B is proportional to ROE
  - P/B is inversely proportional to β

Case Study: US Commercial Banks, as of April 19, 2013



Case Study: US Commercial Banks, as of February 27, 2009



Case Study: US Commercial Banks – Market is quite rational

- Regress P/B against ROE (April 19, 2013)
  - $\frac{P}{B} = 0.2 + 11.5 \times ROE$
  - $R^2 = 57\%$
  - F-statistics: 81
- Adding impact of "cost of equity" (April 19, 2013)
  - $\frac{P}{B} = 0.8 + 10 \times ROE - 0.5 \times \beta$
  - $R^2 = 62\%$
  - F-statistics:47

Implications for deep value investors

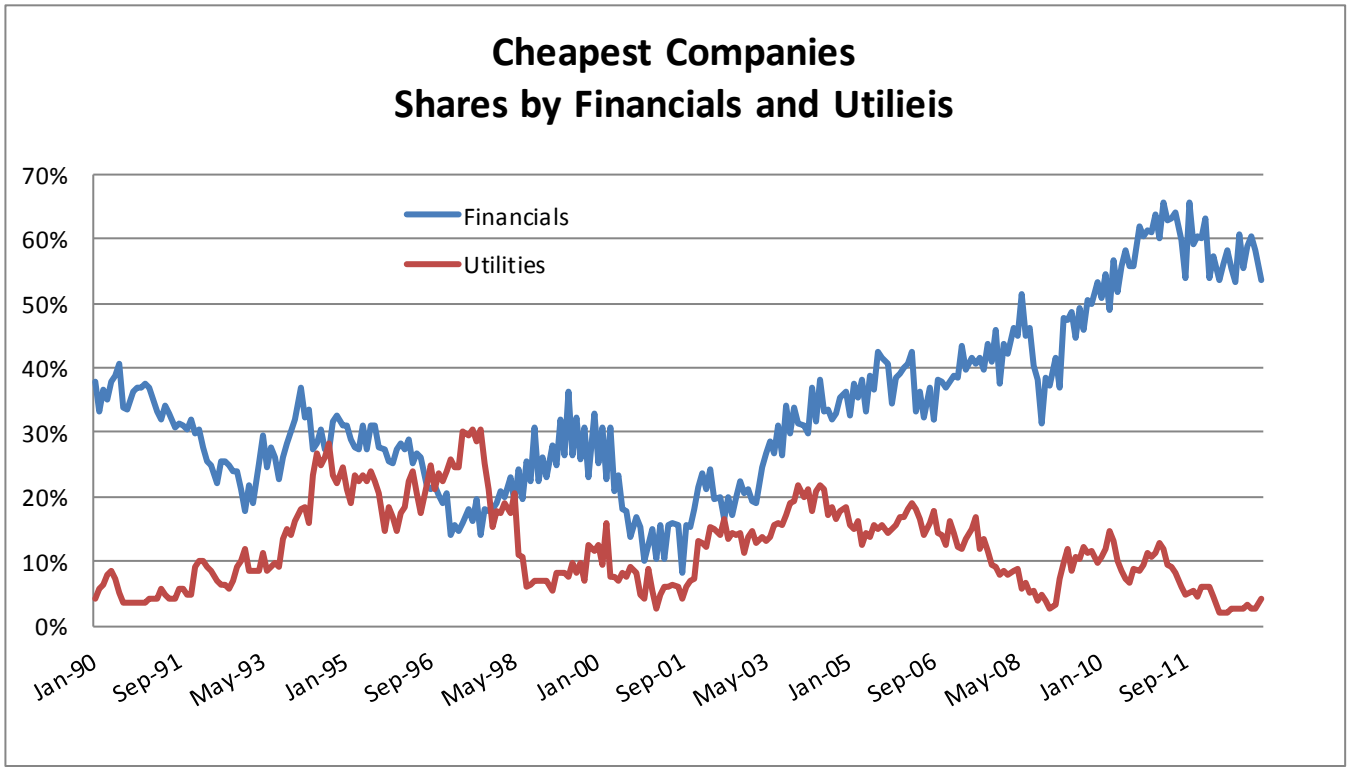
- P/B is mainly an express opinion on the a firm's ROE
  - Investors pay up for high profitability, more importantly, sustainability of such profitability;
  - Investors pay fraction of book value when they believe the profitability of a company, or even an industry is permanently damaged;
- Other factors complicate the value proposition by P/B
  - Beta: higher beta → higher cost of equity → lower P/B, when all else being equal
  - Sector biases: more often than not, disbelief in sustainability of profitability isn't isolated to just one firm but the entire industry ("Investment Banks" a case in point)

Two ways to skin the Value

- Naïve implementation
  - Given a universe of stocks
  - Sort these stocks by their price to book ratio;
  - Pick the cheapest decile or quintile to go long;
  - Pick the most expensive decile or quintile to go short (in case of L/S implementation);
- Pure Value – Value Done Right
  - Assign each stock given an exposures to “value” (and beta, and other stuff);
  - Estimate Covariance Matrix of these stocks;
  - Construct a long only (or long/short) portfolio with maximal exposure to value
  - While minimizing overall risk, and
  - Exposures to all other factors
  - Similar to *orthogonalization* process in linear algebra

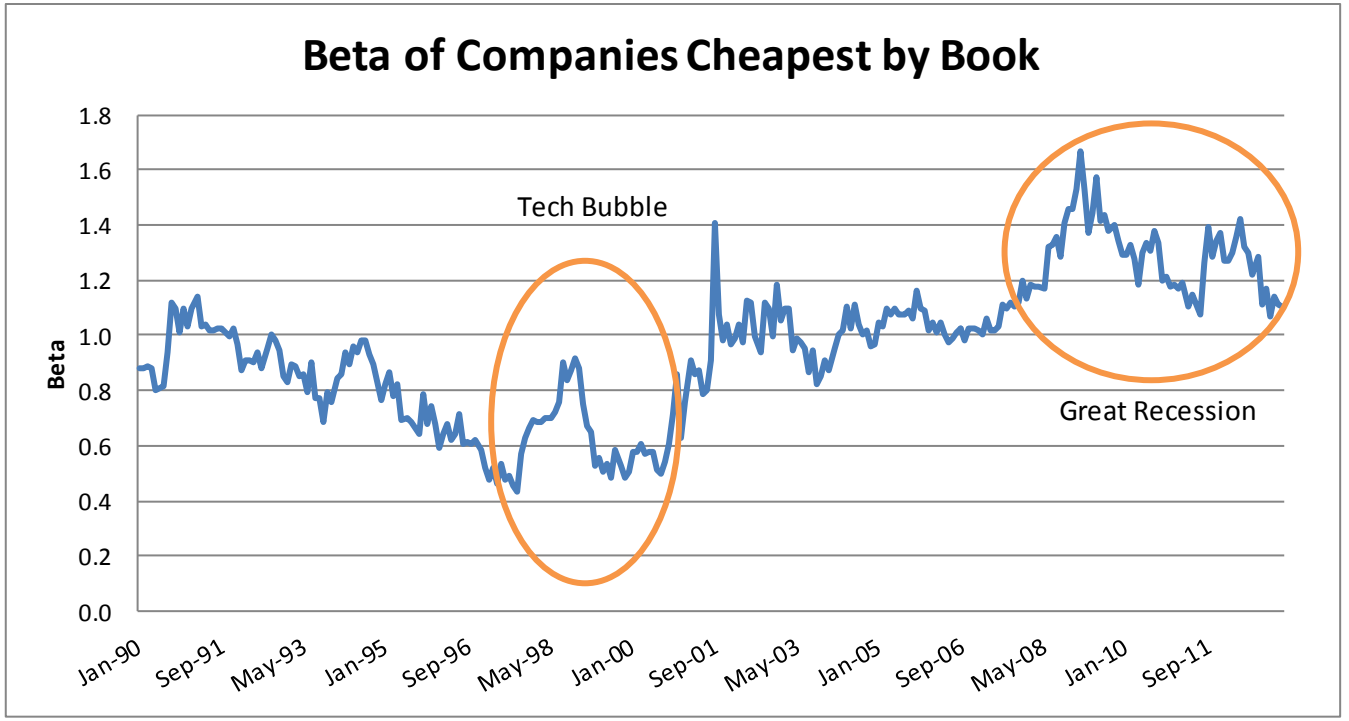
Naïve Implementation leads to unintended exposures and consequences

- Significant Sector Bets
  - In tech bubble, deep value means utilities/staples
  - Post 2008/2009 crises, deep value means financials

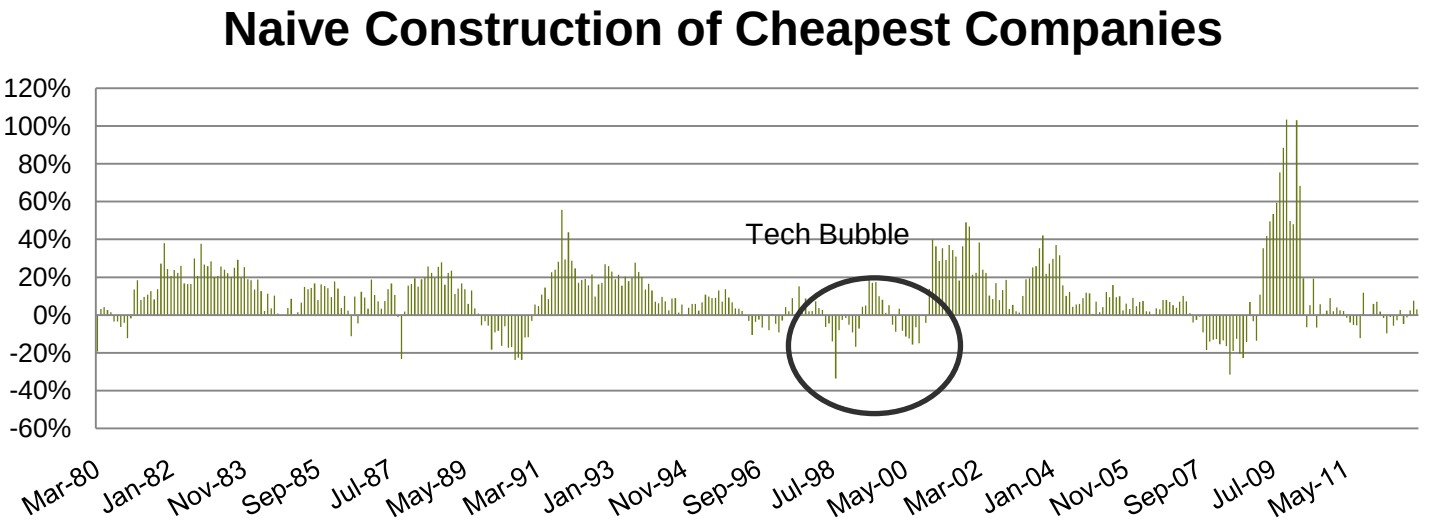


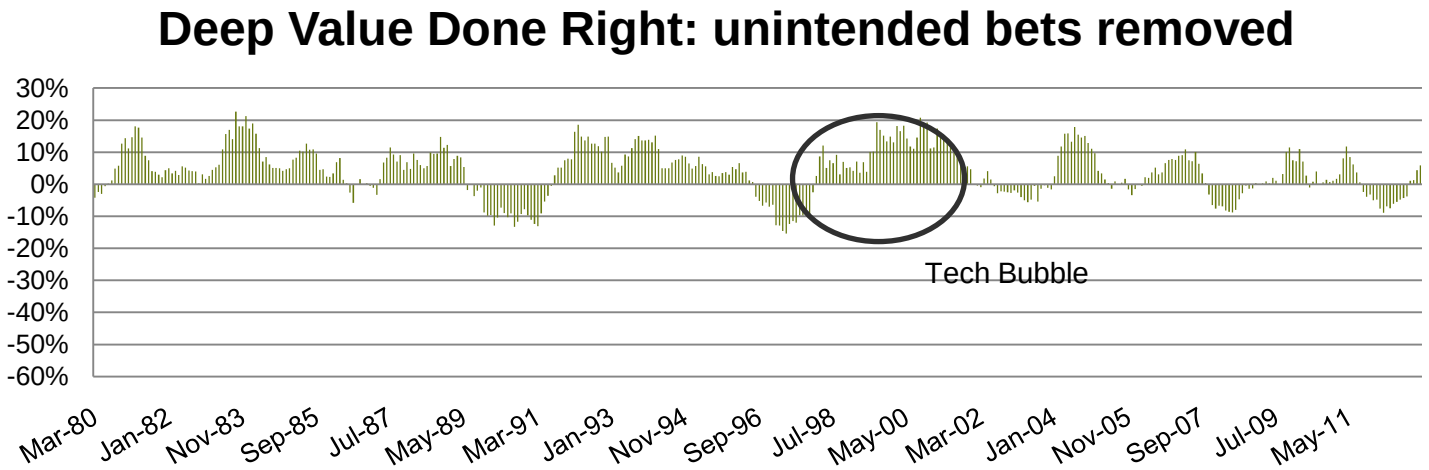
Naïve Implementation leads to unintened exposures and consequences

- Significant Market Beta
  - In tech bubble, lower beta nature leads to significant underperformance
  - Post 2008/2009 crises, deep value means early cyclicals, i.e. financials



Compare “naïve value” and “value done right”: rolling 12-month excess returns





Compare “naïve value” and “value done right”

- Naïve Style has more oomph but behave badly
  - Can outperform the market north of 100% over a 12-month period;
  - Can provide large and persistent underperformance from unintended exposures;
- Pure Value offers more direct and better behaving value exposure
  - Monthly drawdowns are limited;
  - Far higher efficient use of risk budget;

	Naïve	Pure Value
Annual Excess Return	3.1%	3.9%
Tracking Error	10.1%	5.8%
Information Ratio	0.3	**0.7**
Maximum Monthly Drawdown (Excess Return)	-14%	-5%
Beta	1.1	1
Skewness	2.5	0.4
Kurtosis	19.9	1.2

Cyclicality of Deep Value

- Cheap can get cheaper
  - Deep Value necessitates an expectation of return to historical ROE
  - Macro environment deteriorates → shrinking risk appetite
  - Spread continue to widen until the Fed cuts rates or resolution of some systemic risk
- Cheap can take a bid
  - Market anticipates recovery 6-12 months on average → re-pricing of risk
  - Cheapest, most beaten shares are also the least owned
  - Cheapest also has the lowest liquidity (least amount of shares trades)
  - Though re-risking leads to all boat floats, least liquid and cheapest bump up the most;
  - It takes the brave to dip toe in this; One month to early could be disastrous;

Business Regimes	Excess Return	Tracking Error	Information Ratio
Expansion, Intensifying	7%	6%	1.2
Expansion, Moderating	**6%**	**4%**	**1.5**
Contraction, Intensifying	2%	7%	0.2
Contraction, Moderating	4%	5%	0.8

Other Factors – Current Value

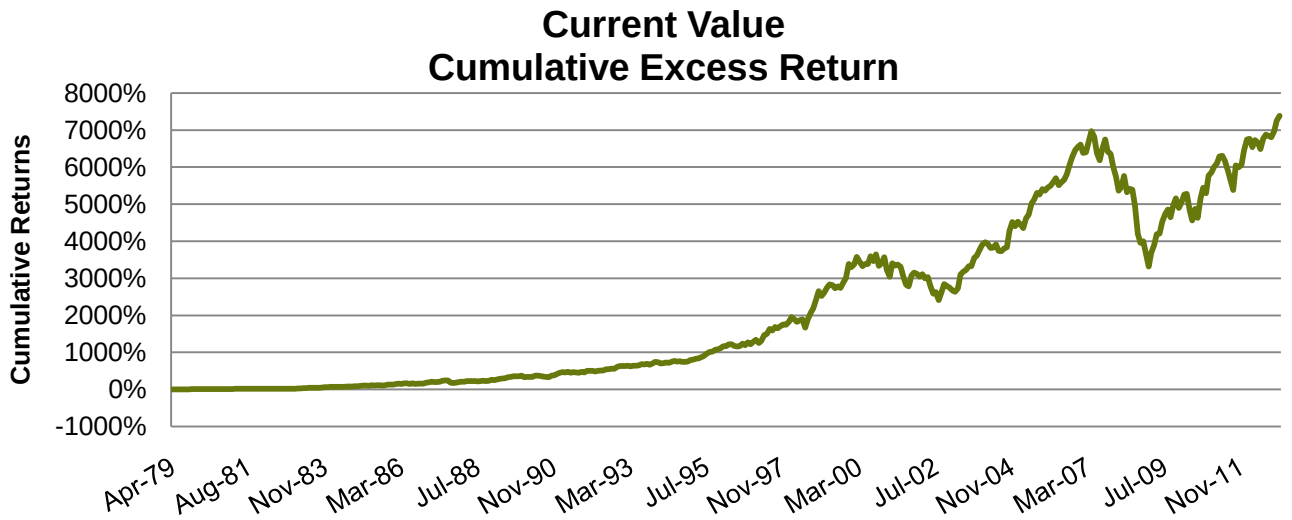
- P / E, P / Cash Flow Multiples
  - Go long firms with cheapest P / E multiples
  - Initiate short in firms with the highest P / E multiples, *within the same sector*
  - Fundamentally mean reversion strategy
  - Not applicable to all sectors: companies with lumpy earnings, or unpredictable cash flows or cash flows are ill-defined such as banks;

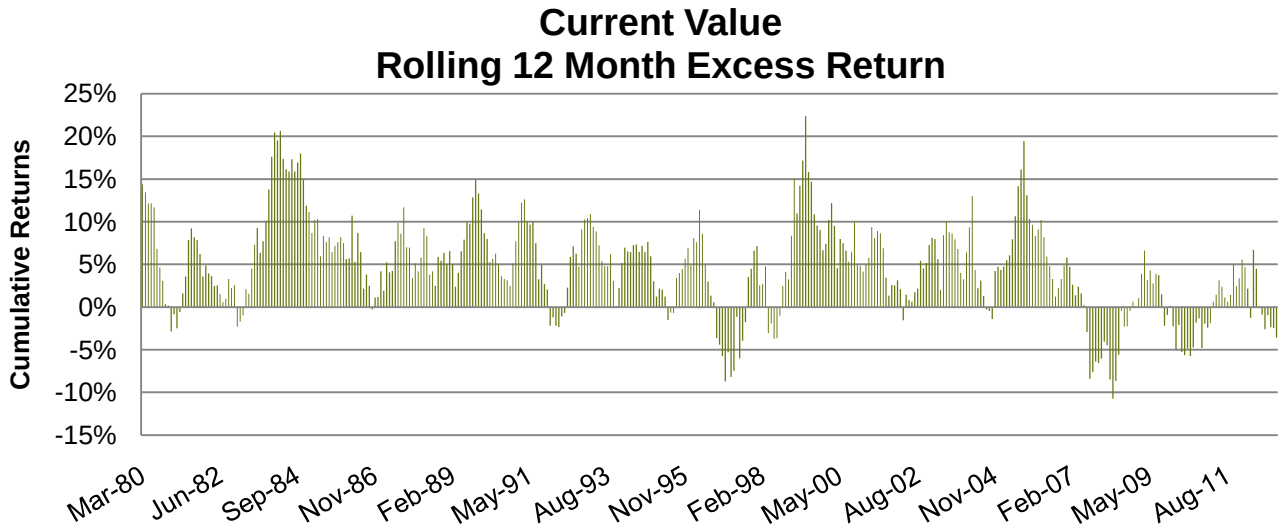
- Effectiveness
  - Annual Excess Return: 5%
  - Tracking Error: 5%
  - Information Ratio: 1.0

- Cyclicality: late expansion strategy

Business Regimes	Excess Return	Tracking Error	Information Ratio
Expansion, Intensifying	3%	4%	0.8
Expansion, Moderating	**6%**	**4%**	**1.6**
Contraction, Intensifying	4%	4%	1.0
Contraction, Moderating	4%	4%	1.0

Other Factors – Current Value



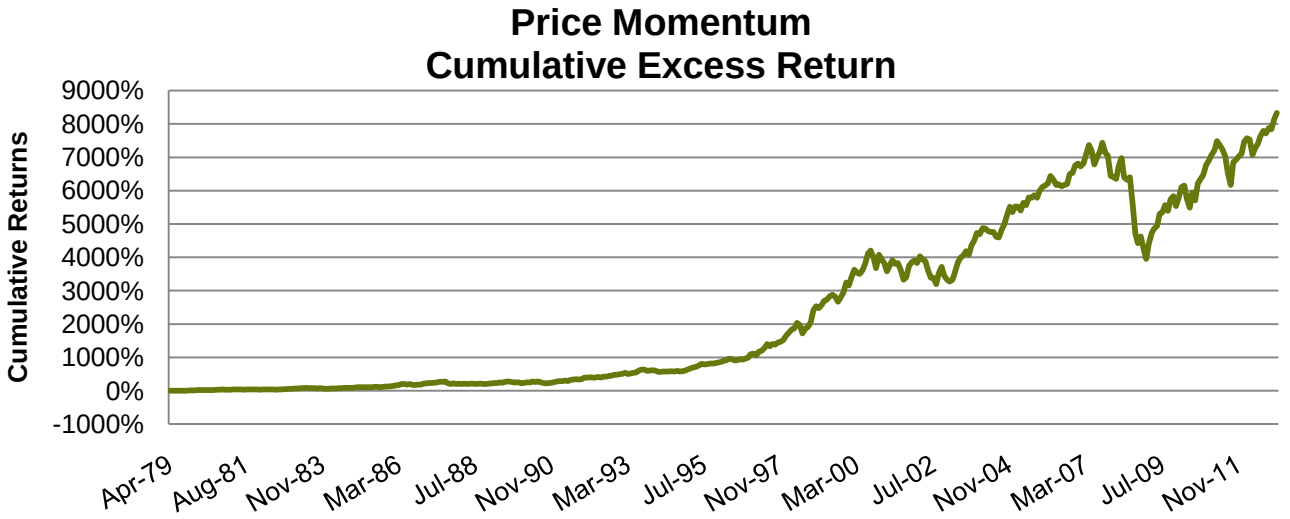


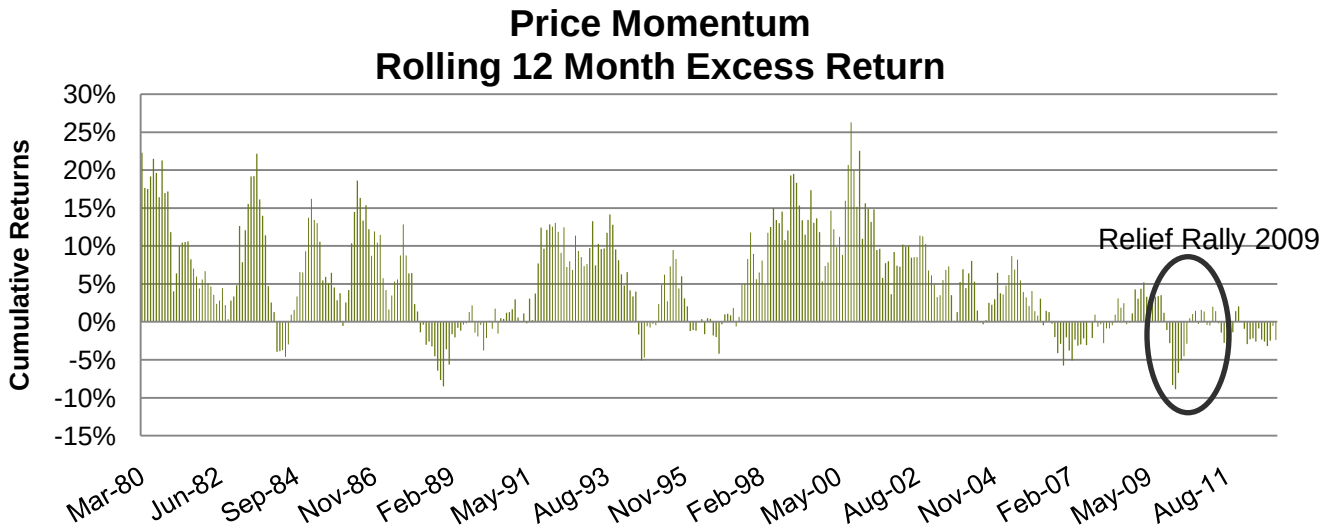
Other Factors – Momentum

- Price Momentum, Analysts Sentiments
  - Price Momentum: long relative winners, short relative losers;
  - Sentiments: long analyst upgrades, short analyst downgrades;
  - Significant drawdown risk around turning point;
  - Not applicable to all sectors: mature industries such as food products are inherently valuation driven;
- Effectiveness
  - Annual Excess Return: 5.3%
  - Tracking Error: 5.8%
  - Information Ratio: 0.9
- Cyclicality: works well during recession

Business Regimes	Excess Return	Tracking Error	Information Ratio
Expansion, Intensifying	5%	5%	1.0
Expansion, Moderating	**6%**	**4%**	**1.3**
Contraction, Intensifying	5%	6%	0.9
Contraction, Moderating	5%	4%	1.2

Other Factors – Momentum



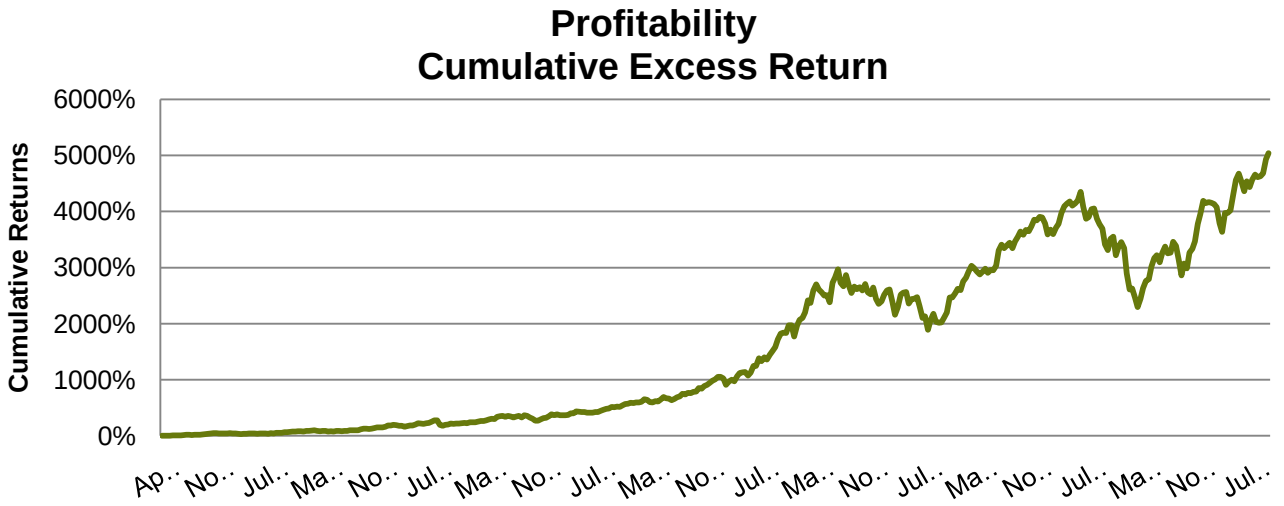


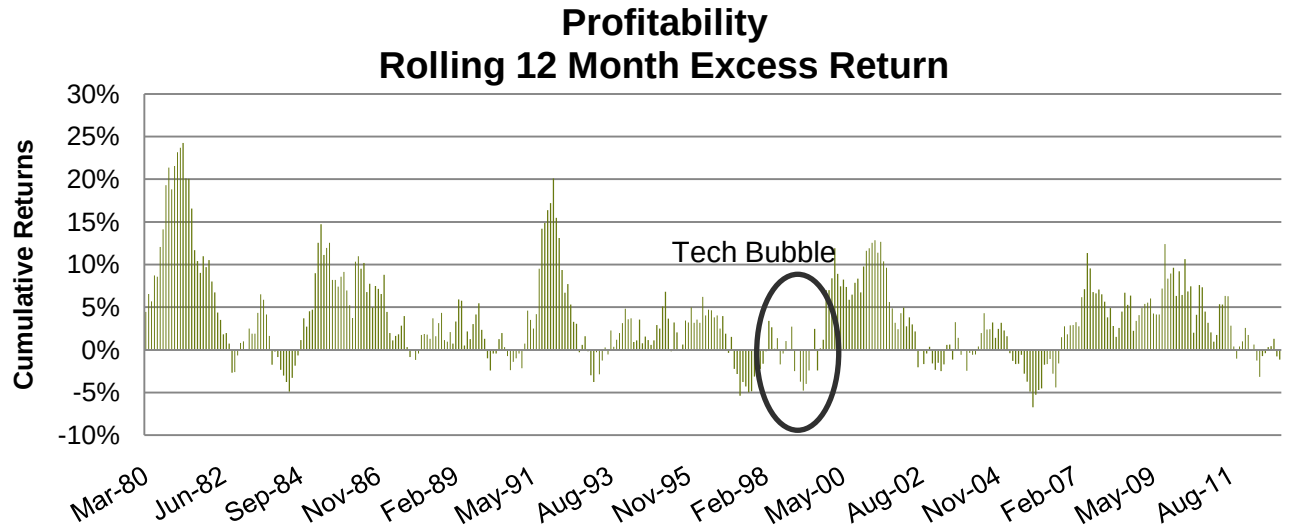
Other Factors – Profitability

- Asset Turnover, ROE, Gross Margin
  - Asset Turnover: measures how quickly companies turn over their inventory, most effective for retails;
  - ROE: the profitability that ultimately matters to equity investors and the link between P/B to Earnings;
  - Gross Margin: pricing power measure; Apple vs. Nokia;
  - Not applicable to all sectors: gross margin ill-defined for financial firms;
- Effectiveness
  - Annual Excess Return: 3.9%
  - Tracking Error: 4.6%
  - Information Ratio: 0.8
- Cyclicality: best strategy during early phase of recession

Business Regimes	Excess Return	Tracking Error	Information Ratio
Expansion, Intensifying	3%	4%	0.7
Expansion, Moderating	2%	3%	0.7
Contraction, Intensifying	**7%**	**4%**	**1.6**
Contraction, Moderating	1%	3%	0.3

Other Factors – Profitability





Other Factors – Quality

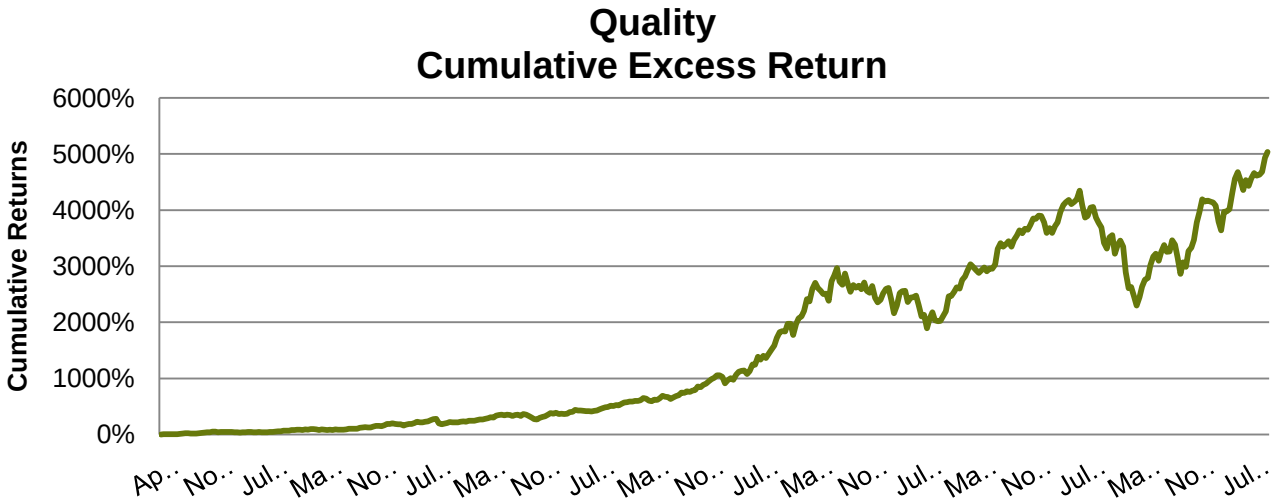
- Change in Working Capital, Tax Paid
  - Change in Working Capital: increasing working capital needs suggest increasing
    - Chance of receivable/inventory write-downs;
    - Financing cost associated
  - Tax Paid vs. Tax Reported
    - Difference in tax item on income statements vs. cash flow statements
    - Under-payment of taxes, even if legitimate, suggest future reversal → low quality earnings
  - Not applicable to all sectors: working capital ill-defined for financial firms;

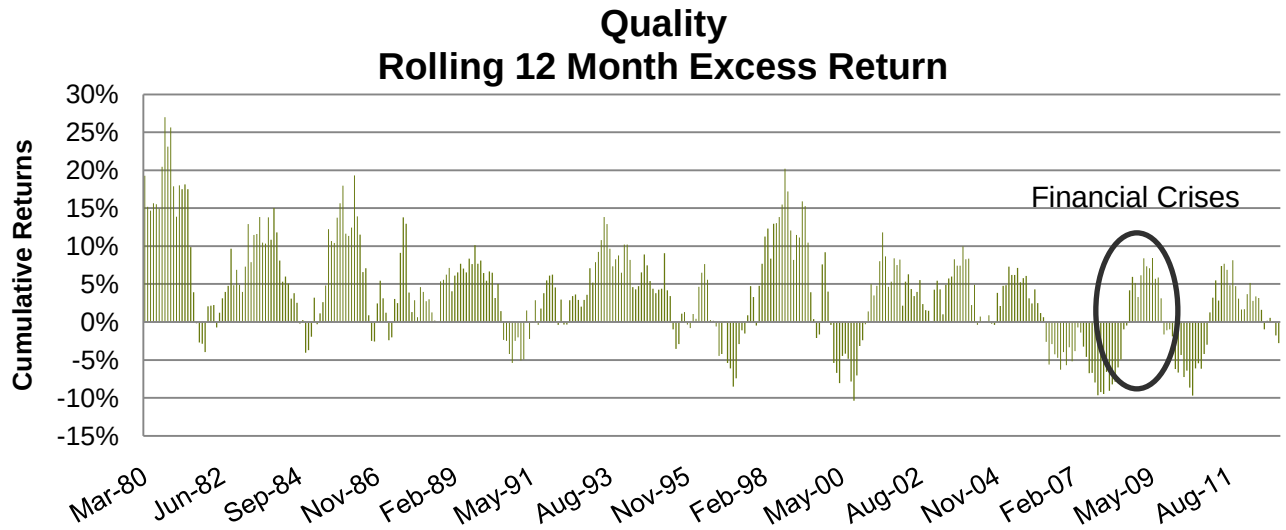
- Effectiveness
  - Annual Excess Return: 4%
  - Tracking Error: 6%
  - Information Ratio: 0.7

Business Regimes	Excess Return	Tracking Error	Information Ratio
Expansion, Intensifying	4%	4%	1.0
Expansion, Moderating	**6%**	**3%**	**1.7**
Contraction, Intensifying	3%	4%	0.6
Contraction, Moderating	6%	4%	1.5

- Cyclicality: best strategy during early phase of recession

Other Factors – Quality



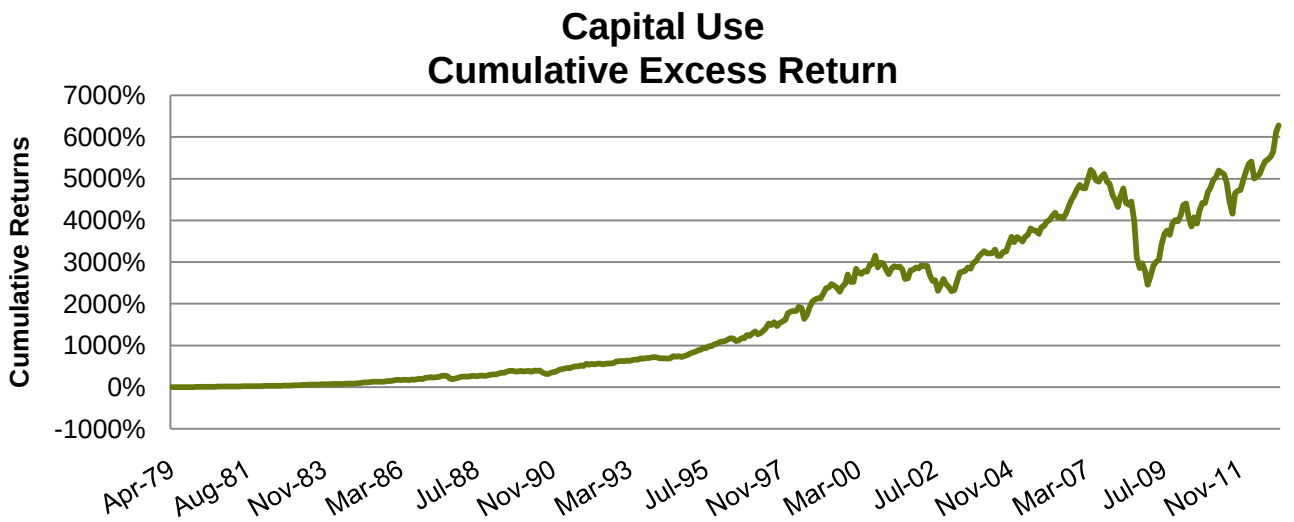


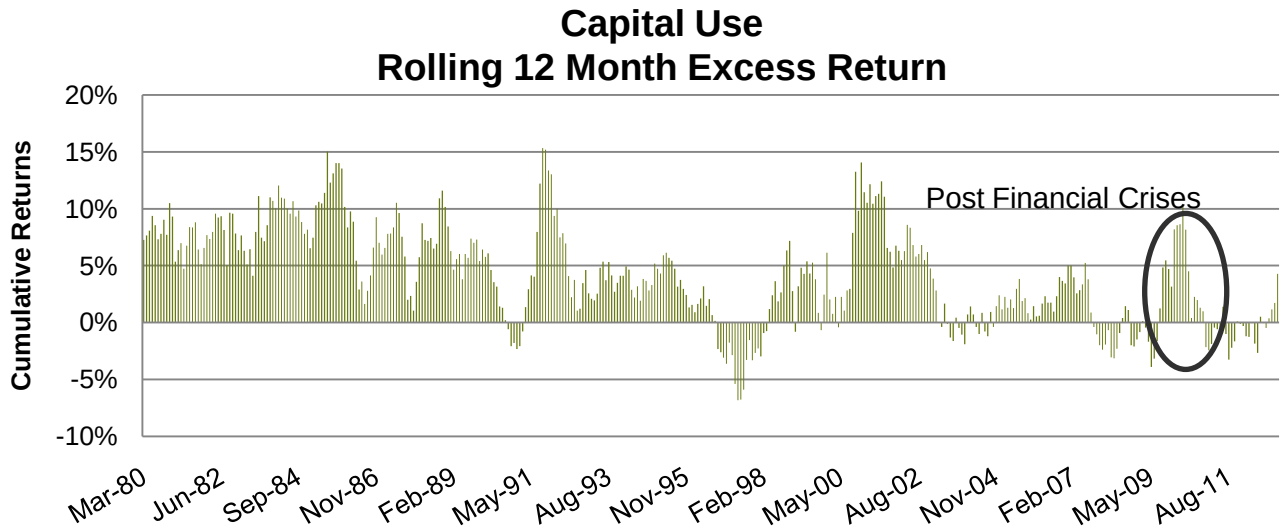
Other Factors – Capital Use

- Dividends Paid, Share Buyback
  - A measure of shareholder friendliness;
  - Could also suggest lack of growth prospect for a firm;
  - Defensive strategy: this seems to be all investors do today;
- Effectiveness
  - Annual Excess Return: 5%
  - Tracking Error: 5%
  - Information Ratio: 1.0
- Cyclicality: skewed by recent experience

Business Regimes	Excess Return	Tracking Error	Information Ratio
Expansion, Intensifying	5%	4%	1.4
Expansion, Moderating	4%	3%	1.0
Contraction, Intensifying	3%	5%	0.5
Contraction, Moderating	5%	4%	1.2

Other Factors – Capital Use

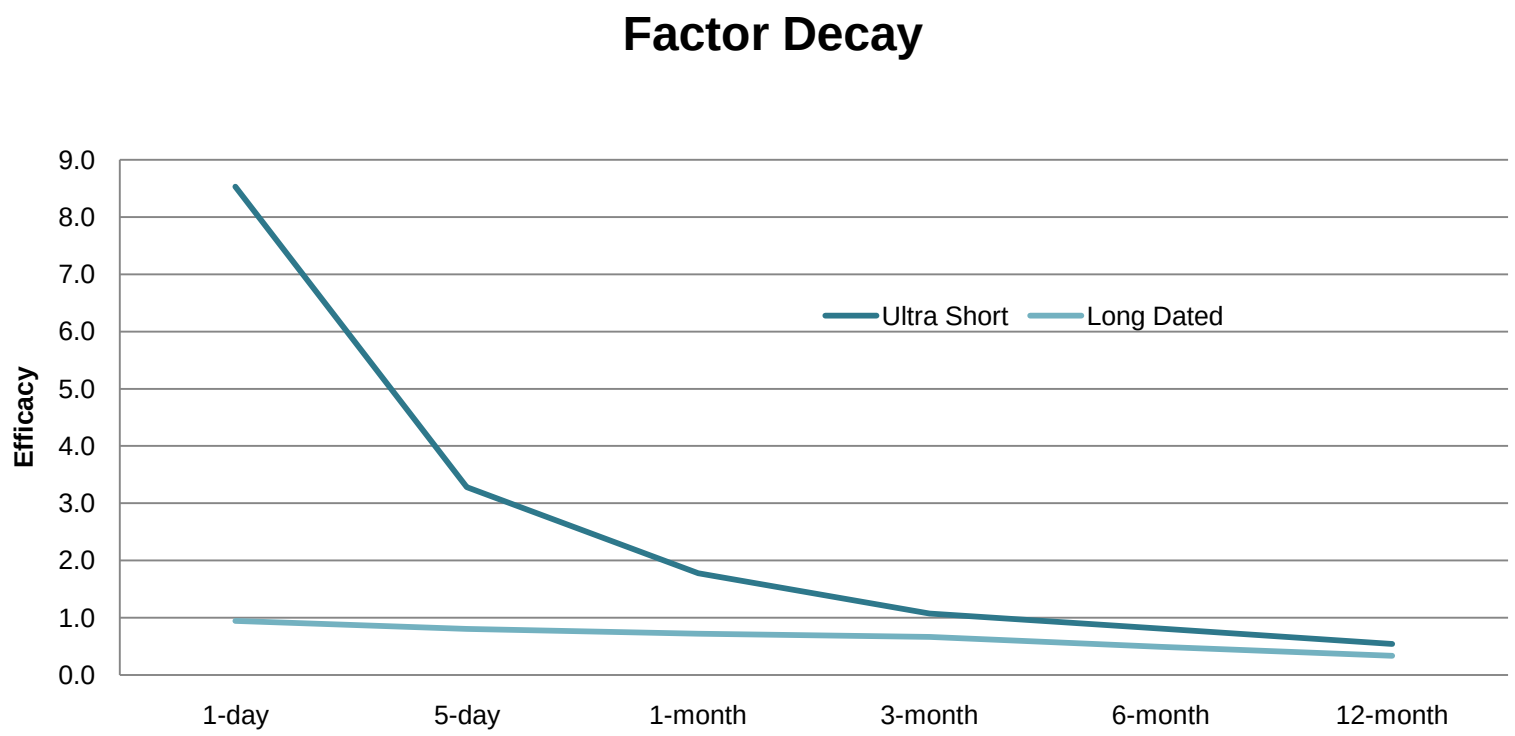




How to assess strategies

- Rank Correlations
- Sharpe Ratio and Information Ratio
  - $Sharpe\ Ratio = \frac{R_{strategy} - R_{free}}{Volatiltiy_{strategy}}$
  - $Information\ Ratio = \frac{R_{strategy} - R_{benchmark}}{Tracking\ Error_{strategy}}$
- Turnover:
  - $\text{Turnover} = \frac{\sum |\Delta W|}{\sum |W|}$
  - Short Horizon Strategy has high turnover; Long-dated strategy has low turnover
- Maximum Drawdowns
- Skewness / Kurtosis: 3rd and 4th moments of return distribution
- Correlation with the market, other factors, co-linearity

Time Horizon – Factor Decay



Time Horizon – Another Form of Diversification

- Investment style is mostly defined by time horizon
  - Toolsets and performance systems
  - Analysts “style” and focus
  - Turnover – good proxy for horizon
- Blending and varying different time horizons can improve performance
  - Works when traditional approaches fail
- Time horizon diversification has worked well in every crisis
  - Lengthen Time Horizon in your strategies when risk subsides
  - Shorten your time horizon when risk aversion rises and investors aren’t concerned with fundamentals

Correlation of Strategies Based on Time Horizon[1]
1977-2010

	Time Horizon			
	Long	**Medium**	**Short**	**Ultrashort**
Long	100%	(58%)	(36%)	7%
Medium		100%	42%	(4%)
Short			100%	0%
Ultrashort				100%

Putting them together

- How to maximize a bag full of tricks?
  - Equal weight: no opinion on individual strategy efficacy
    - No opinion is actually an opinion on the risk/reward trade-offs
    - Results aren't so bad!
    - A standard to beat
  - Cyclically adjusted:
    - Strategies have varying degrees of risk/reward profile depending on their relationships with risk
    - For example, in recession, we favor profitability and momentum, but caution is to the upside risk
  - Opinion Pooling:
    - Black-Litterman Framework: fundamentally mean-variance trade-off between factors;
    - Copula-based: similar to BL framework with more esoteric statistics, can perform better in some rare circumstances;
- Black-Litterman Framework
  - Fundamentally no different from a fundamental manager hedging his/her bet between growth and value;
  - Risk, Reward, as well as Correlation among strategies are considered simultaneously

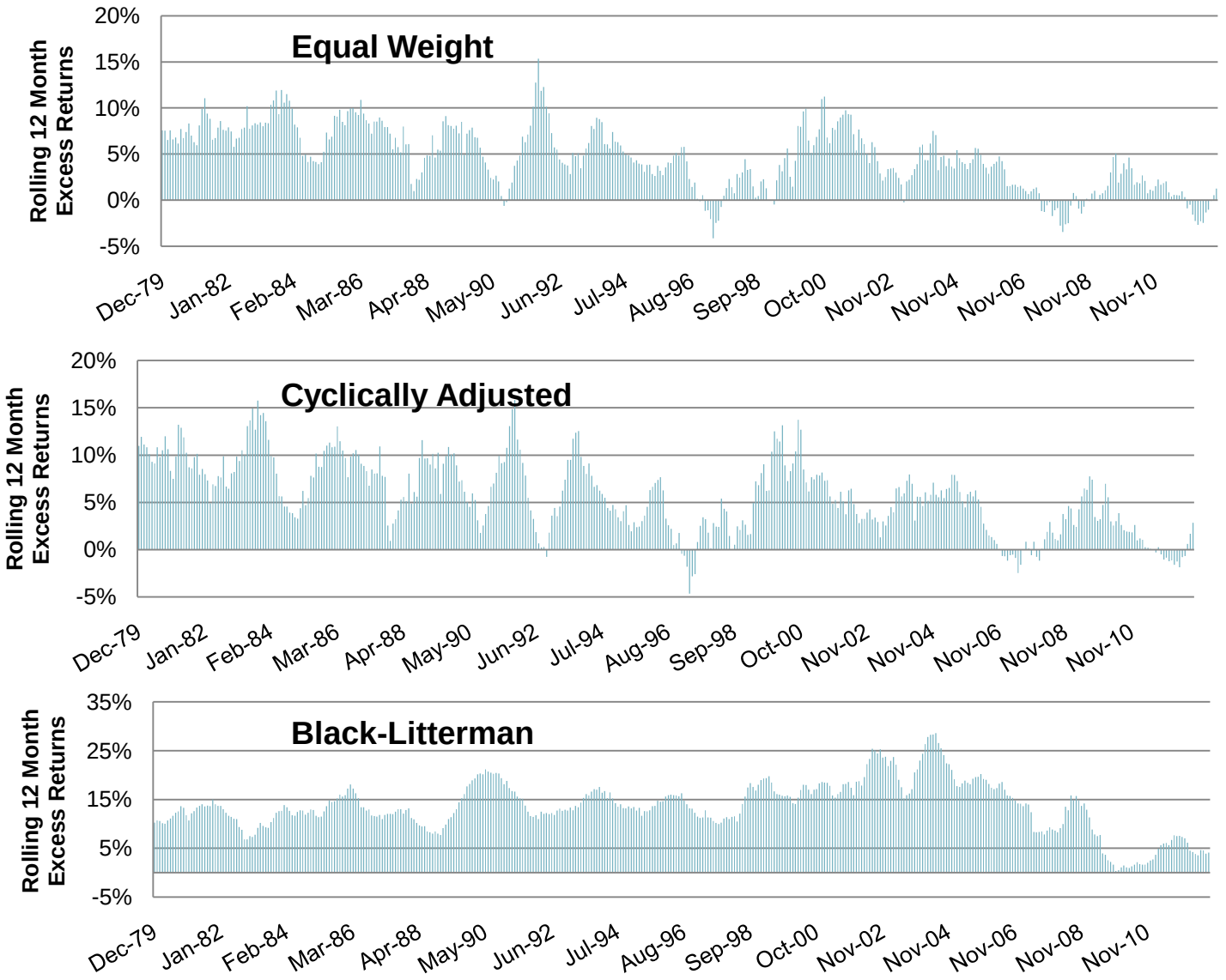
Putting them together

- Centrality of risk allocation across strategies, not the expected returns
  - Expected Returns, or Alphas, can be derived as $\alpha = \lambda \times COVARIANCE^{-1} \times W$ where λ is the risk aversion parameter, covariance is the covariance matrix of the strategies, W is the allocation across strategies;
  - Expected Returns being a single number disguise the underlying economics behind the investment decision

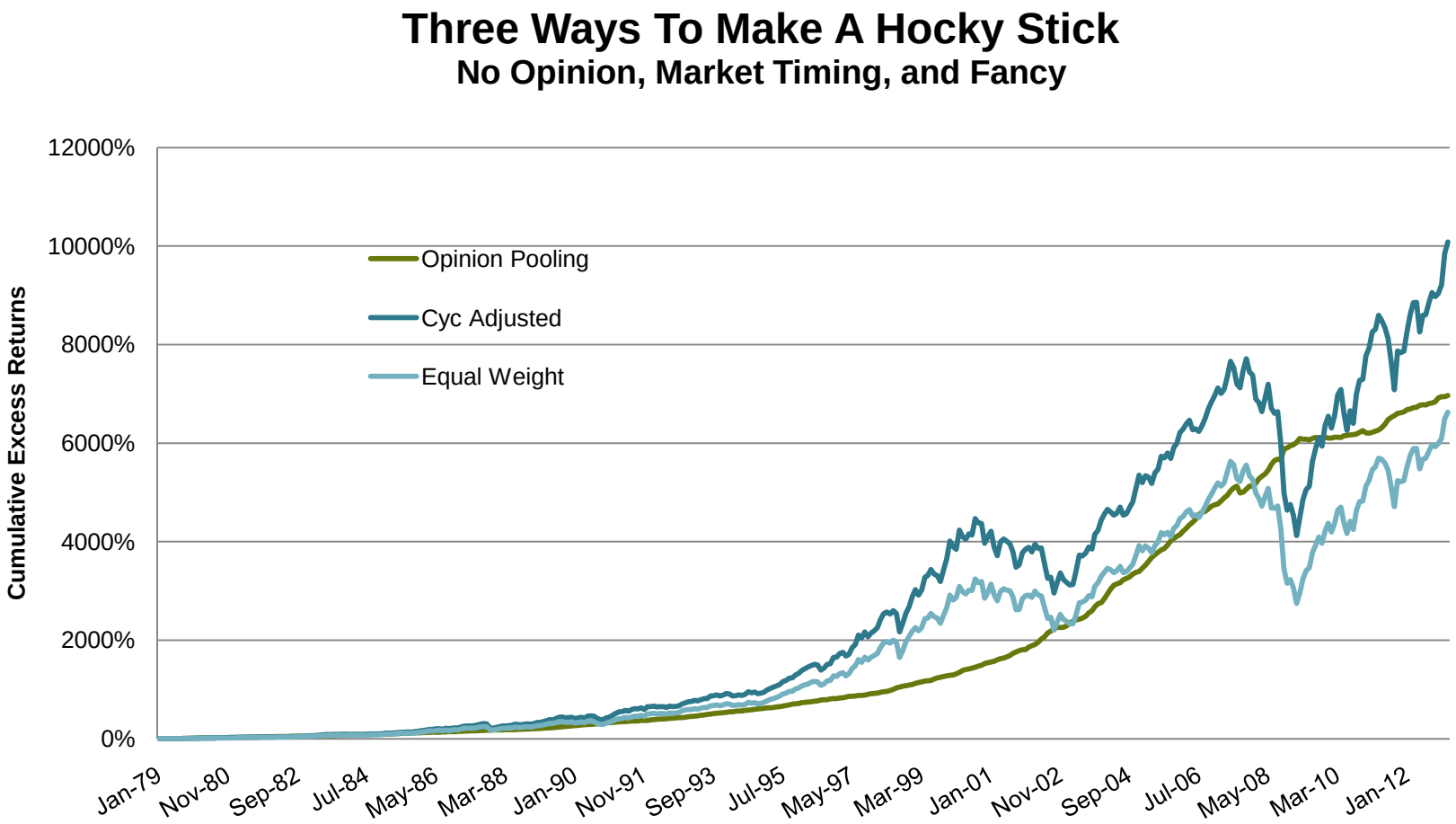
- Efficacies

	Equal Weight	CyclicallyAdjusted	Black-Litterman
Excess Return	4.5%	5.6%	13.3%
Tracking Error	2.5%	2.8%	2.5%
Information Ratio	1.8	2.0	5.3
Max (excess)	2.8%	2.8%	3.8%
Min (excess)	-1.9%	-2.1%	-2.7%
Hit Rate (excess)	69%	69%	96%

Putting them together



Putting them together



Portfolio Construction

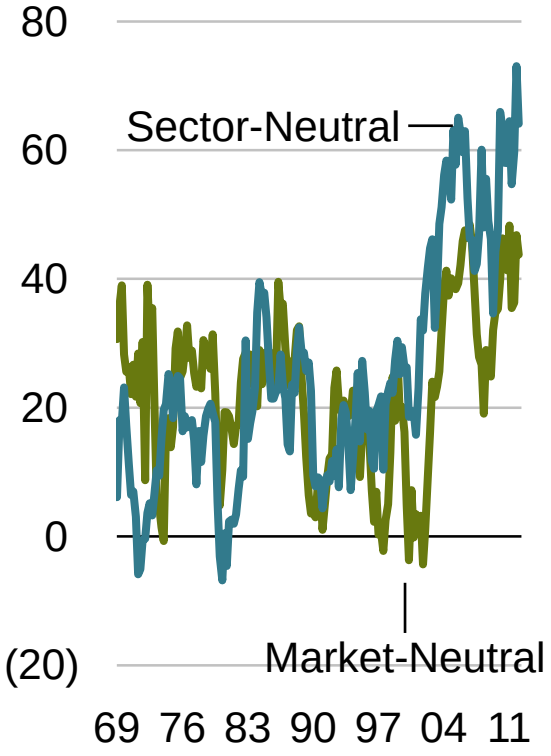
- Accounting for the ingredients for constructing a portfolio
  - Client objective: tracking error, geographical preferences etc.;
  - Benchmark selection: cap-weighted indices or custom benchmarks, or short-term instruments?
  - Rebalance Frequencies / Turnover
  - Transaction Cost Estimation
    - Fixed Transaction Cost: broker commissions;
    - Market Impact: supply/demand of liquidity;
    - Short Locate and Short Cost;
  - Optimizer to glue them together
    - Objective Function: $\max(W'\alpha - \lambda W'\Omega W - Impact - Short\ Cost \cdots)$
    - Typical optimizers: generic ones like MatLab, or for financial appliations such as Barra Optimizer, Axioma Optimizer, Northfield Optimizer

- Where does “alpha model” stop and “portfolio construction” begin?
  - The more flexible the mandate, the more blurred between alpha model and portfolio construction;
  - Flexibility means significant room to time strategies

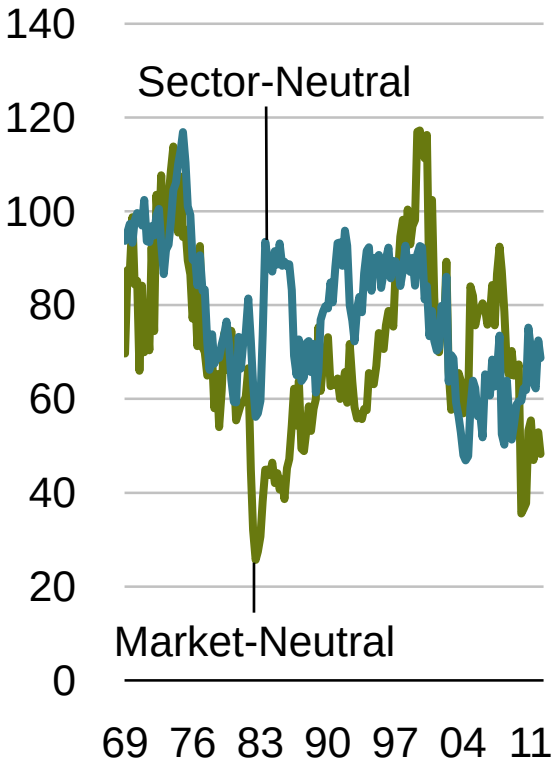
Blending Portfolios Can Drive Volatile Style Exposure: For Example, Low P/Book + High ROE Portfolio…

"Core" portfolio (percent)

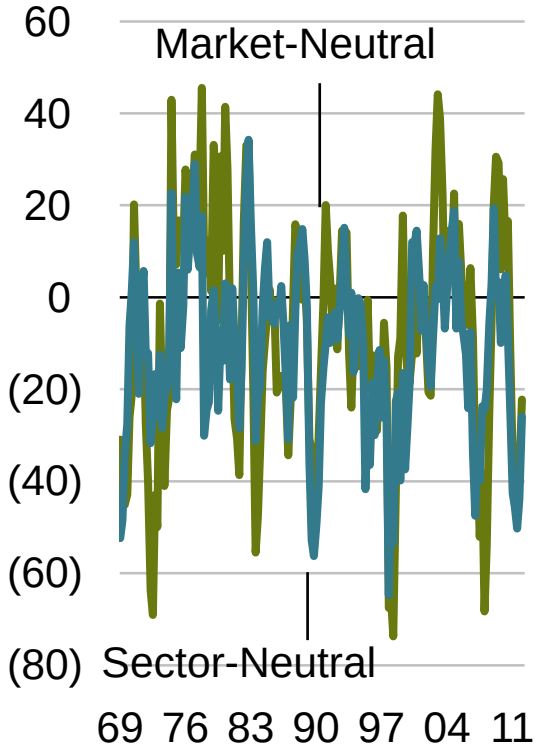
Active Exposure to ROE Market- vs. Sector-Neutral Construction



Active Exposure to Value Market- vs. Sector-Neutral Construction



Active Exposure to Momentum Market- vs. Sector-Neutral Construction

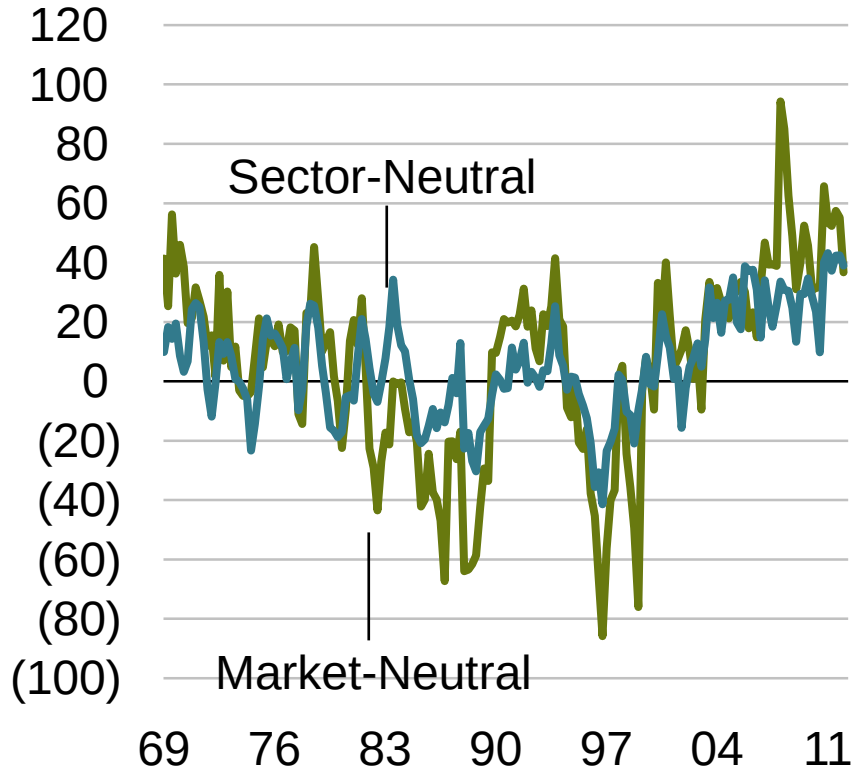


Source: Center for Research in Security Prices (CRSP), FactSet and AllianceBernstein

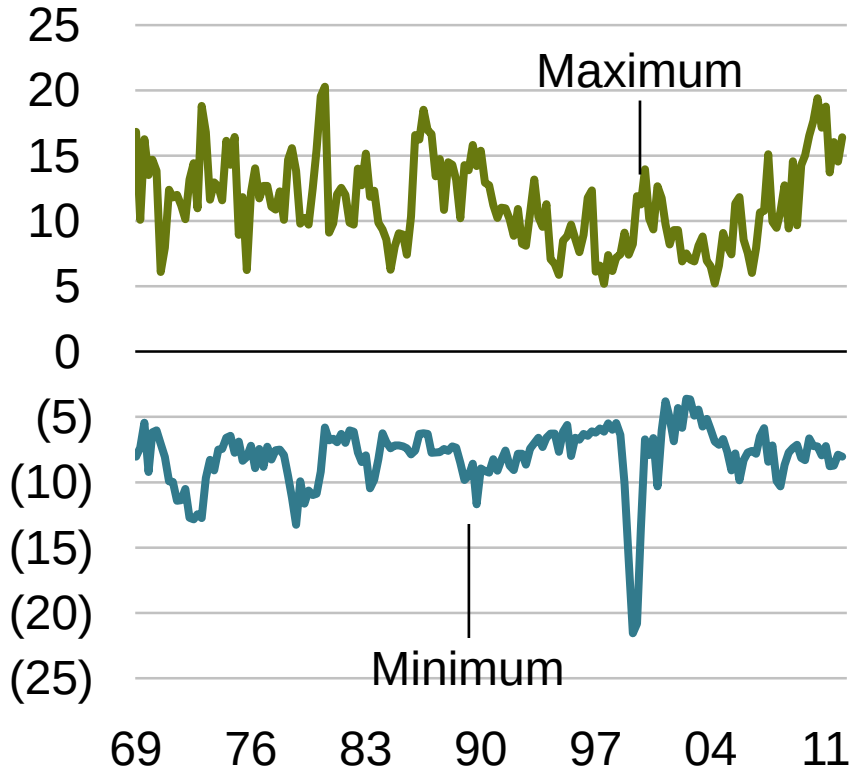
…And Unintended Exposures to Other Risk Factors

"Core" portfolio (percent)

Active Exposure to Beta: Market- vs. Sector-Neutral Construction



Active Exposure to Sectors: Size of Largest Under- and Overweight



Source: CRSP, FactSet and AllianceBernstein

Portfolio Consisting of "Style Intense" Managers Can Result in Unintuitive Risk Profile

Tracking Error Decomposition over Time—S&P 500 Universe

Portfolio of Lowest 10% on Price/Book and Highest 10% ROE

	Market Neutral			Sector-Neutral
	April 10, 2013	**March 30, 2009**	**March 30, 2001**	**April 10, 2013**
Styles	4%	15%	8%	1%
Beta/Vol.	30%	53%	42%	19%
Size	26%	6%	5%	11%
Sectors	16%	20%	16%	(1)%
Idiosyncratic	20%	6%	15%	59%

Source: CRSP, FactSet and AllianceBernstein

Performance Attributions – Risk Analysis

Date	19-Apr-2013
Managed	Global Long/Short
Benchmark	USD Cash
Market	MSCI World
Base Currency	USD
Long Volatility	31.2%
Short Volatility	31.7%
Tracking Error	**5.6%**

Portfolio Relative Contribution to Tracking Error (RCTE)

	Long	Short	Total
Factor	99%	99%	34%
THEMES	1%	2%	24%
CONTROL	-3%	1%	9%
INDUSTRY	90%	86%	-1%
COUNTRY	1%	1%	2%
CURRENCY	10%	10%	0%
Residual	1%	1%	66%
Total	100%	100%	100%
Beta	2.55	2.60	-0.04
Dispersion Measure	81%	80%	

Factor Relative Contribution to Tracking Error (RCTE)

	Long		Short		Total	
Theme > Factor	**Exposure**	**RCTE**	**Exposure**	**RCTE**	**Exposure**	**RCTE**
CAPITAL USE	1.7	-0.3%	0.8	-0.3%	0.8	-0.3%
CURRENT VALUE	1.7	0.7%	0.3	0.4%	1.5	0.4%
DEEP VALUE	-1.3	-0.4%	-2.7	-0.5%	1.4	0.9%
MOMENTUM	1.2	-2.0%	-0.6	-0.8%	1.8	16.4%
PROFITABILITY	2.5	-0.6%	0.6	-0.1%	1.9	6.7%
QUALITY	0.8	0.1%	0.3	-0.1%	0.5	0.1%
TECHNICAL	1.6	3.2%	1.4	3.0%	0.2	0.1%
CONTROL						
COMMODITY	0.0	0.0%	0.0	0.0%	0.0	0.1%
LEVERAGE	0.6	0.4%	0.6	0.2%	0.0	0.2%
LIQUIDITY	0.7	0.8%	1.1	1.2%	-0.4	0.5%
MARKET	-0.2	-3.5%	0.1	-0.2%	-0.3	4.7%
MOMENTUM	0.2	-0.1%	0.2	-0.1%	0.0	0.2%
RISK	-2.2	-4.6%	-1.8	-4.1%	-0.3	2.2%
SIZE	-4.8	3.7%	-4.7	3.6%	-0.1	0.7%

Performance Attributions – Factor Attributions

Portfolio Return Contribution

	Long	Short	Total
Risk Free	0.13%	0.12%	0.01%
Factor	8.96%	5.95%	3.01%
THEMES	-1.08%	-2.21%	1.13%
CONTROL	1.47%	1.71%	-0.24%
INDUSTRY	8.58%	6.45%	2.12%
Residual	5.55%	1.01%	4.54%
Total	**14.64%**	**7.08%**	**7.56%**

INDUSTRY Return Contribution

	Long		Short		Total	
Group	Avg. Weight	Return	Avg. Weight	Return	Avg. Weight	Return
Telecommunicatio	3.6%	0.6%	0.6%	0.2%	3.0%	0.4%
Utilities	0.0%	0.0%	0.4%	0.0%	-0.4%	0.0%
Information Techn	8.2%	0.8%	2.2%	0.2%	6.0%	0.6%
Financials	9.1%	0.9%	10.9%	1.1%	-1.8%	-0.2%
Health Care	3.8%	0.5%	0.7%	0.1%	3.1%	0.4%
Consumer Staples	12.1%	1.1%	10.4%	1.2%	1.7%	0.0%
Consumer Discret	28.7%	2.5%	23.1%	2.0%	5.6%	0.6%
Industrials	18.6%	2.6%	21.4%	3.1%	-2.9%	-0.5%
Energy	11.9%	0.3%	9.8%	-0.3%	2.1%	0.6%
Materials	3.9%	-0.9%	8.2%	-1.2%	-4.3%	0.2%

Factor Return Contribution

	Long		Short		Total	
Theme > Factor	Avg. Exp.	Return	Avg. Exp.	Return	Avg. Exp.	Return
CAPITAL USE	0.4	-0.7%	0.2	-0.3%	0.2	-0.3%
CURRENT VALUE	0.3	-0.7%	0.0	-0.1%	0.3	-0.7%
DEEP VALUE	-0.4	-0.7%	-0.5	-0.5%	0.1	-0.2%
MOMENTUM	0.5	1.5%	-0.3	-1.3%	0.8	2.8%
PROFITABILITY	1.3	0.0%	0.2	0.2%	1.1	-0.3%
QUALITY	0.1	0.0%	0.0	-0.1%	0.0	0.1%
TECHNICAL	-0.3	-0.5%	-0.4	-0.1%	0.1	-0.4%
CONTROL						
CRUDE	0.2	0.3%	0.5	0.5%	-0.3	-0.2%
MARKET	0.5	-1.9%	0.7	-2.3%	-0.1	0.4%
LEVERAGE	0.3	-0.2%	0.3	0.1%	0.0	-0.2%
LIQUIDITY	0.2	0.4%	0.5	0.7%	-0.2	-0.3%
SIZE	-1.3	-0.4%	-1.4	-0.6%	0.1	0.2%
RISK	-0.7	3.4%	-0.7	3.4%	0.0	-0.1%

Parting Remarks

- Investments
  - Be open minded: all forms of analysis have their use under right circumstances
    - Don’t confuse concurrency with causality
    - Don’t assume completeness of your framework/thinking
  - Be prepared: intuition does matter
  - Be rigorous: accuracy does matter and matter a lot in most situations
  - Specialize: excel at one or a few things
  - Learn Math: statistics and linear algebra
  - Learn Programming: need I say more?
  - Don’t forget: investment is fun!

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- **Leverage Risk:** Trying to enhance investment returns by borrowing money or using other leverage tools—magnify both gains and losses, resulting in greater volatility.
- **Short Sale Risk:** The risk that the Portfolio will incur a loss by subsequently buying a security at a higher price than the price at which it sold the security short. The amount of such loss is theoretically unlimited. Short sale is a form of leverage.
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