Lecture 3
Quantitative Investment Framework: Part 2

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Lecture Outline:

1. Return Factors (cont'd)
2. Factor Diagnostics
3. Multi-Factor return models
4. The curse of T-Cost (turnover, capacity)

VALUE & QUALITY: SUMMARY OF RECENT PERFORMANCE

Quality: R. Novy Marx, 2014, *http://rnm.simon.rochester.edu/research/QDoVI.pdf*
Value: A. Damoradan, 2012, *http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2042657*

	2010	2011	2012	2013	2014	2015	Average
Historical Book/Market Ratio	-0.2	-1.2	0.6	-1.4	-1	-1	-0.70
Historical P/Cash Earnings Ratio	0.3	0.3	0.5	0.4	0.1	-1	0.10
Historical Earnings Yield	1.2	1.1	1	0.2	0.7	0.5	0.78
1 year forward PE	1.4	0.3	0.8	-0.3	0.4	-0.4	0.37
1 year forward PE rel history	0.9	1.5	1.1	0	1.4	0.4	0.88
1 year forward PE rel sector	2	0.8	0.7	0.1	0.4	-0.2	0.63
1 year Historical Dividend Yield	0.5	2.5	0.7	-0.4	0.4	0	0.62

	2010	2011	2012	2013	2014	2015	Average
Earnings Risk (Short high spread)	0.6	1.5	1.3	1.2	1.1	1.8	1.25
Historical Return On Equity	0.7	1.9	0.4	1	0.7	1	0.95
1 year ROE Growth	0.5	-0.3	1.2	1.4	1.3	0.9	0.83
Return On Assets	0.1	0.5	0.4	1	0.2	0.8	0.50

VALUATION

'Value Anomaly' is widely recognized that low PE stocks outperform high PE stocks over the long term. Similar analysis has shown consistent results using P/Sales, P/Dividend and P/Book ratios. Earnings Growth can complement straight Value factors in many markets.

QUALITY

Tilt towards highly profitable and good quality businesses. Similarly over the long term the market also rewards 'earnings certainty' and penalize those stocks that carry a large degree of earnings risk

MOMENTUM & SENTIMENT: SUMMARY OF RECENT PERFORMANCE

Earnings Momentum: R. Novy Marx, 2015, *http://rnm.simon.rochester.edu/research/FMFM.pdf*
Price Momentum: R. Novy Marx, 2012, *http://rnm.simon.rochester.edu/research/MOM.pdf*
Sentiment: P. Santusuosso, 2015, *http://www.ccsenet.org/journal/index.php/ijef/article/view/50440*

	2010	2011	2012	2013	2014	2015	Average
Earnings Momentum (1Mth Change)	1.7	1.5	1.3	1.8	1.6	1.1	1.50
Earnings Momentum (3Mth Change)	1.3	1.3	0.8	1.5	1.8	0.9	1.27
Earnings Momentum Composite	1.2	1.2	1.2	1.7	1.9	1	1.37
5 yrs Historical Earnings Growth	0.4	1	-0.1	0.2	0.7	0.9	0.52
Last Mth Net Revisions to FY1	1.4	0.7	0.8	1.6	1.5	0.5	1.08
Last Mth Net Revisions to FY2	1.8	0.5	1.1	1.5	0.8	1.4	1.18

	2010	2011	2012	2013	2014	2015	Average
3 Mth Price Momentum	0.4	0.5	-1.8	0.6	1.5	0.3	0.25
6 Mth Price Momentum	0.3	0.4	-0.2	1.5	1.6	0.6	0.70
12 Mth Price Momentum	1	1	2.7	2.5	1.7	1.9	1.80
Volatility Adjusted 12 Mth Price Mom	1.2	1	2.2	2.4	1.5	2.1	1.73
Percent Off 52 Week High	0.4	1.3	1.3	1.7	2.1	1.9	1.45
RSI 30 day	0.5	-0.5	0	1.3	1.5	0.5	0.55

	2010	2011	2012	2013	2014	2015	Average
Consensus Recommendation	0.1	0.8	1.2	1.3	0.7	0.3	0.73
1 Mth Change in Recom	1.4	0.9	0.5	0.7	1.3	0.6	0.90
3 Mth Change in Recom	0.8	0.5	0.7	1	1.2	1.3	0.92

MOMENTUM

Momentum theory for stock prices suggests that companies that do well in one (long term) investment period will continue to do well in the subsequent investment horizon. Over short time frames (<1month) studies have also highlighted the tendency of stocks to overreact leading to short term reversion.

EARNINGS & SENTIMENT

Market is not efficient at incorporating new information and a window of opportunity exists to exploit recent analyst revisions in

Return Factors: Value (Cont'd)

MSCI, "FINDING VALUE", 2015: *https://www.msci.com/documents/10199/67b801e5-43ef-4200-8531-540851378835*

A. Damoradan, "Survey of Valuation Approaches", 2006
http://people.stern.nyu.edu/adamodar/pdfiles/papers/valuesurvey.pdf

http://people.stern.nyu.edu/adamodar/pdfiles/invphiloh/valinv.pdf

1. **Common measures**
   A. Price-to-Book (Liquidation Value) – pioneered by B. Graham & D. Dodd – bet on ROE
   B. Earning-to-Price (Current Value) – Basu (1977)
   C. Cash Flow-to-Price
   D. Enterprise multiple = [Common + Pref. Eq. + Debt – Cash] / Operating Income
2. **Explanations**
   A. Most studies conclude that abnormal value returns are not a compensation for additional risk
   B. Behavioral
      a) investors put too much weight on past performance to project future)
      b) Analysts more extensively cover "hot" trending stocks
      c) Value tends to be concentrated in harder-to-trade, low institutional ownership stocks
3. gency

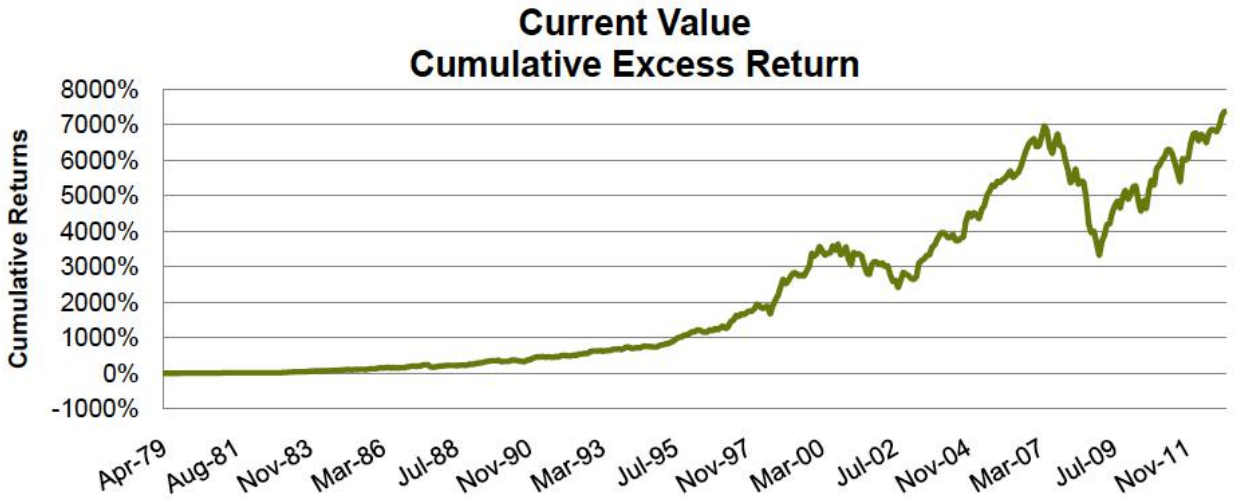
Business Regimes	Excess Return	Tracking Error	Information Ratio
Expansion, Intensifying	7%	6%	1.2
Expansion, Moderating	**6%**	**4%**	**1.5**
Contraction, Intensifying	2%	7%	0.2
Contraction, Moderating	4%	5%	0.8

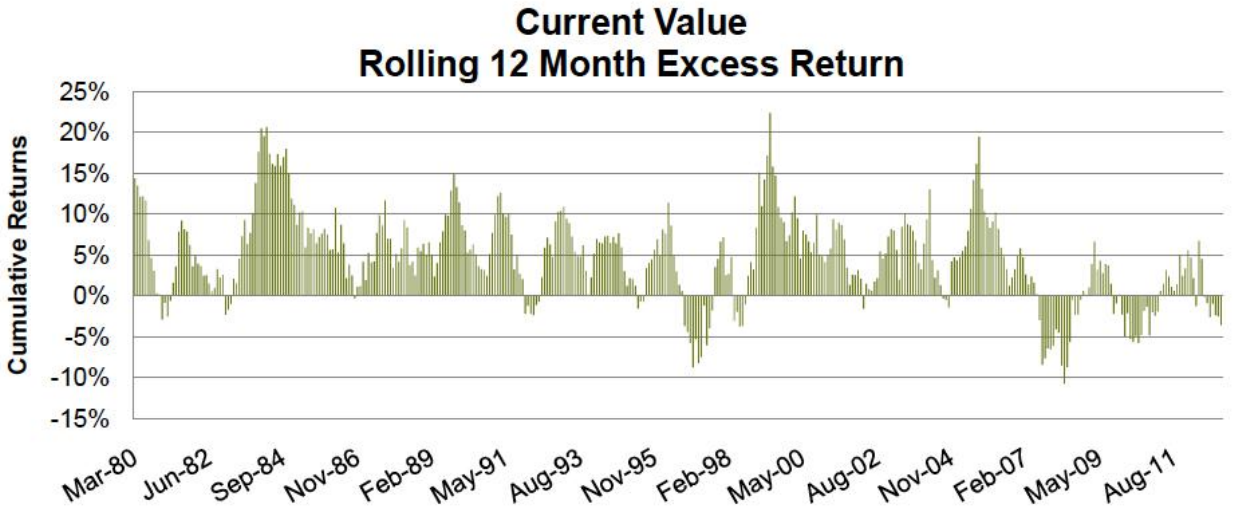
Other Factors: Current Value

- 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

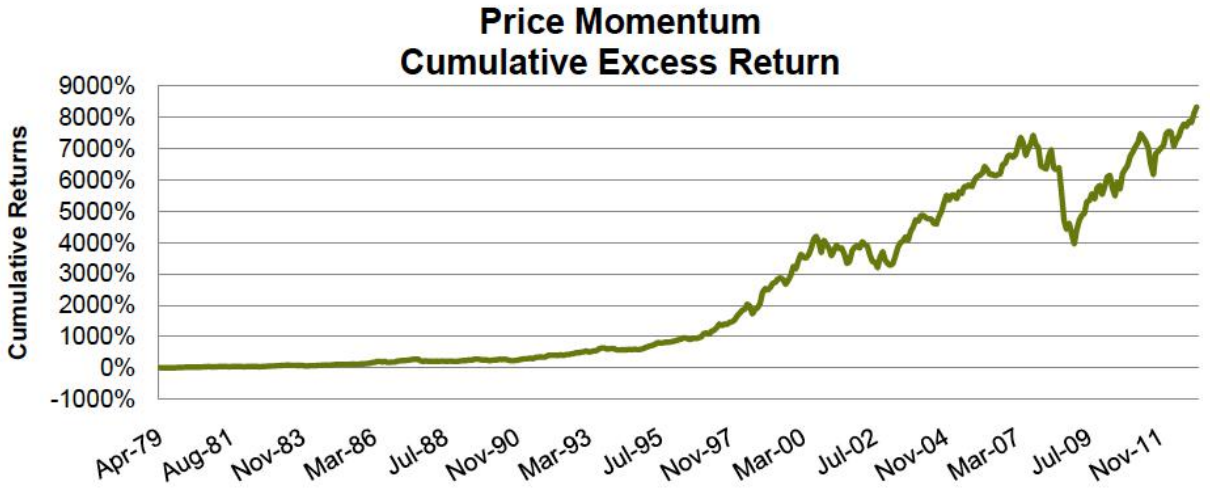
1. **Empirically, stocks exhibit short-to-medium term (2-12mos) momentum followed by long-term reversals (3-5years)**
   A. DeBondt, Thaler (1987) – 3y/3y, 5y/5y returns are negatively autocorrelated
   B. Jegadeesh, Titman (1993) – any combination of J/K, J,K=[2,12]mos is positively autocorrelated
   C. Jegadeesh, Lehmann (1990) – weekly and monthly returns are negatively correlated.
   D. Fama, French (1996) – momentum is profitable on risk-adjusted basis.
2. **Economically significant price momentum (~1%/mos) is concentrated in top & bottom deciles. The middle is relatively flat, outperformance mostly comes from longs side.**
3. **Explanations, Improvements**
   A. Arena, Haggard, Yan (2008) – double sort by momentum & idiosyncratic volatility) = higher returns
   B. Vassalou, Apeddjinou (2004) - explains momentum by corporate innovation (change in gross margin, that is not explained by change in labor and capital it utilizes)
   C. Park (2010) – uses of 50/200 days moving averages ratio to improve Jegadeesh, Titman
   D. Moskowitz, Grinblatt (1999) – cross-industry momentum subsumes stock momentum.
   E. Number of authors conclude that a typical momentum strategy has very low capacity
   F. Disposition effect (sell winners, hold on losers) = under-reaction to new information
   G. Confirmation bias – in a medium-term ignore new information if it contradicts prior

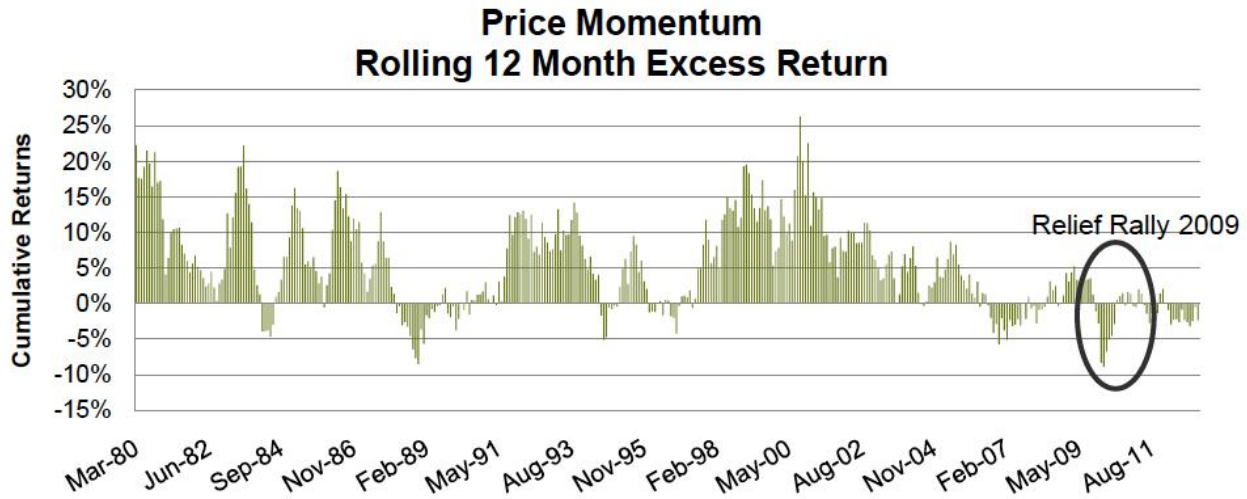
Other Factors: Momentum

- Price Momentum, Analysts Sentiments
  - Price Momentum: long relative winners, short relative losers;
  - Earnings Surprise 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

- **“The Other Side of the Value” by R. Novy-Marx, 2012**
  - A. Profitability, measured by gross profits-to-assets, has roughly the same power as book-to-market predicting the cross-section of average returns.
  - B. Controlling for profitability also dramatically increases the performance of value strategies, especially among the largest, most liquid stocks.
  - C. Controlling for gross profitability explains most earnings related anomalies, and a wide range of seemingly unrelated profitable trading strategies

Explanations:

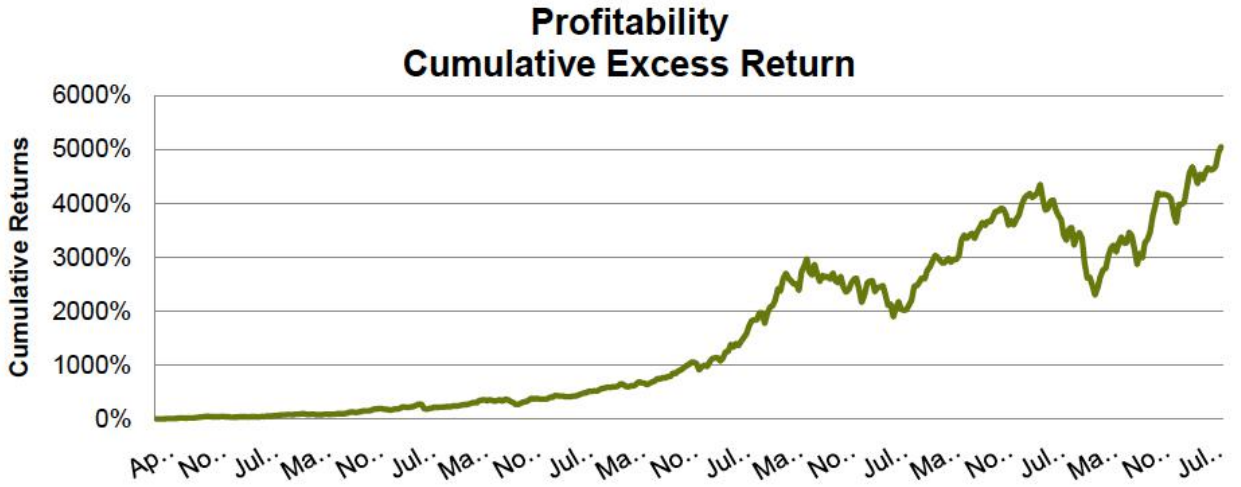
1. **Profitable firms are less prone to distress, have longer cash flow durations, and lower levels of operating leverage.**
2. **Investors underreact to current profitability news. Under-reaction is stronger among firms with greater information uncertainty or more severe limits to arbitrage.**

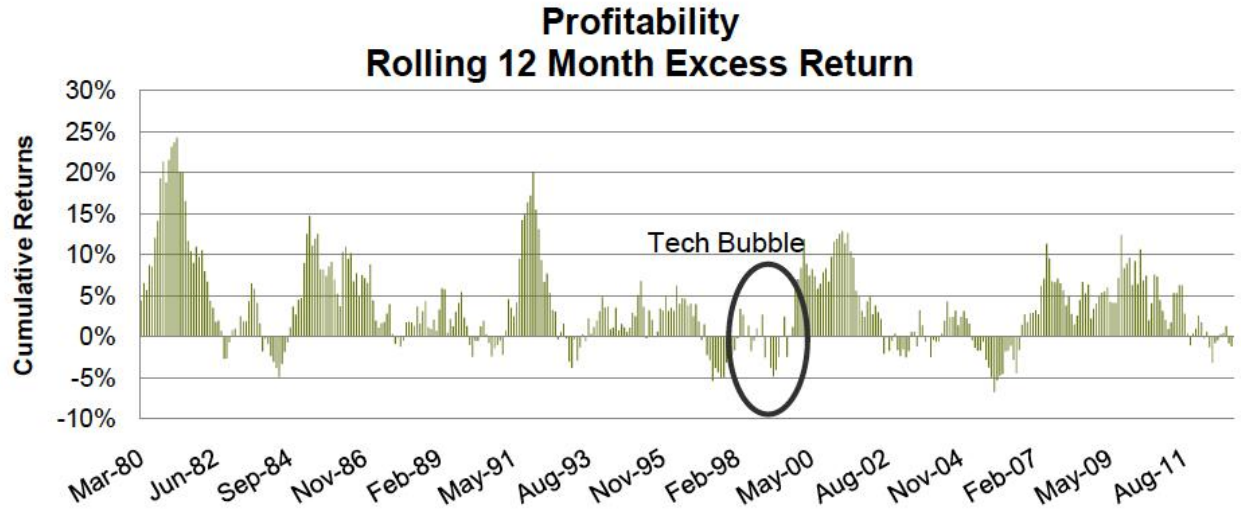
Other Factors: Profitability

- 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

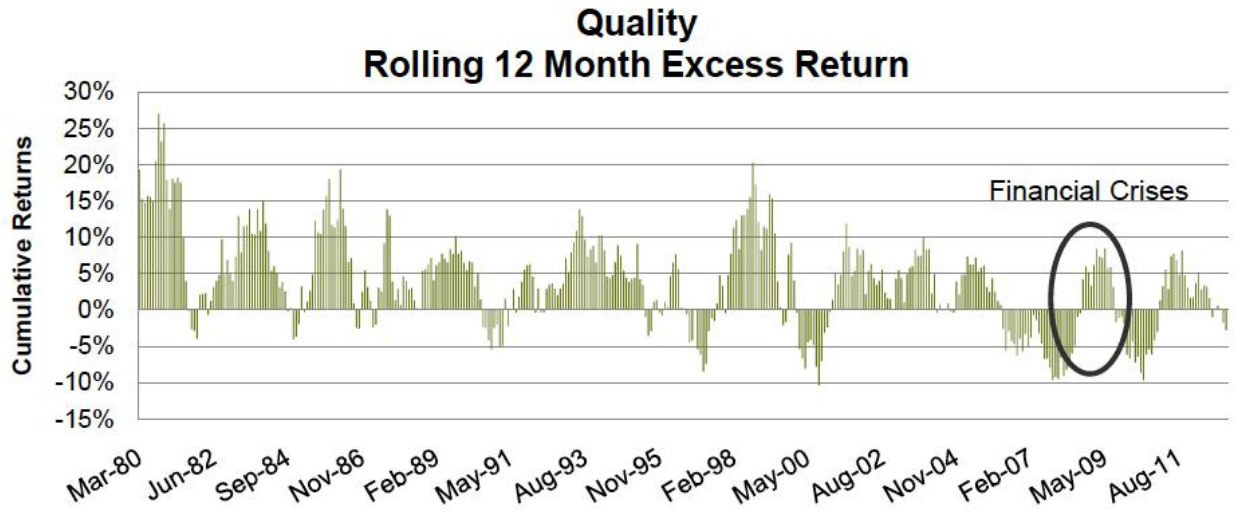
- Accruals, Change in Working Capital, Tax Paid
- “Quality” typically mean “quality of earning”. It is straightforward to price earnings in cash. Projected future earnings in the form of unsold inventory, receivables (e.g. bad balance sheets) may need to be discounted
- Sloan (1996) showed that analysts are fixated on total earnings, e.g. they do not discount low-quality earnings, and these companies underperform their peers over 2-3 years horizon.
- Case in point: prior to mid-2007 banking industry reporting strong profits based on the projection of bad loans being repaid. High earnings encouraged to issue more and more loans … until this bubble burst. Yet missing the run-up in financials during 2003-07 could have been catastrophic for money managers.
- Explanations:
  - Growth-related: high accruals identify “glamour” stocks with the high management projection for future growth. Extreme projections tend to be overly optimistic (see also Economist “Drop the Pops”, "Dimensions of Popularity", by Ibbotson, Idzorek)
  -

Other Factors: Quality

- Types:
  - Change in Working Capital: increasing working capital needs suggest increasing
    1. Chance of receivable/inventory write-downs;
    2. Financing cost associated
  - Tax Paid vs. Tax Reported
    1. Difference in tax item on income statements vs. cash flow statements
    2. 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%
  - Inforr
  - Cyclic

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

Other Factors: Quality



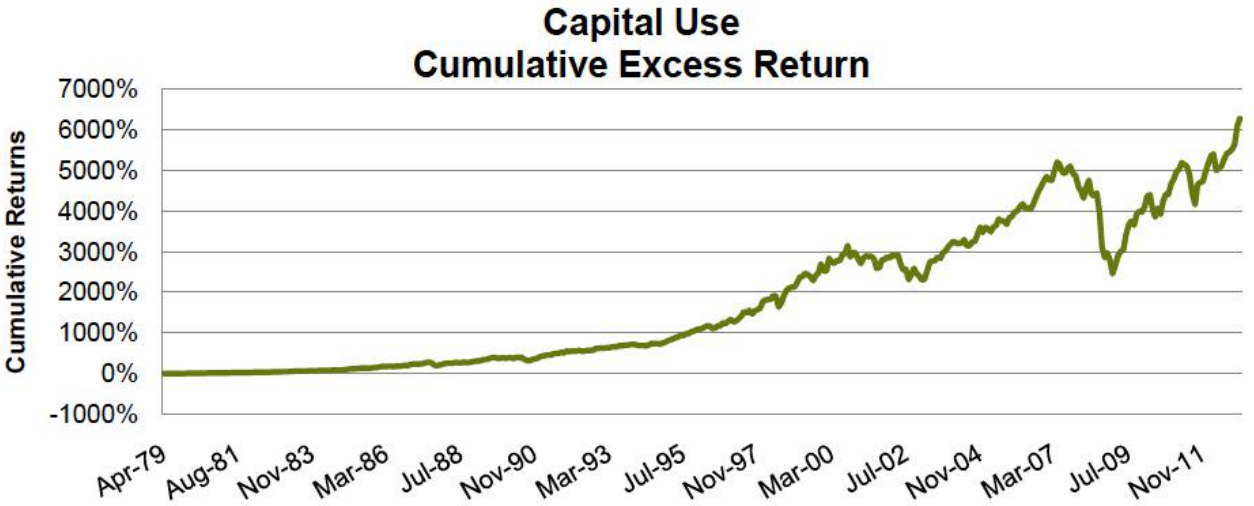
Other Factors: Capital Use

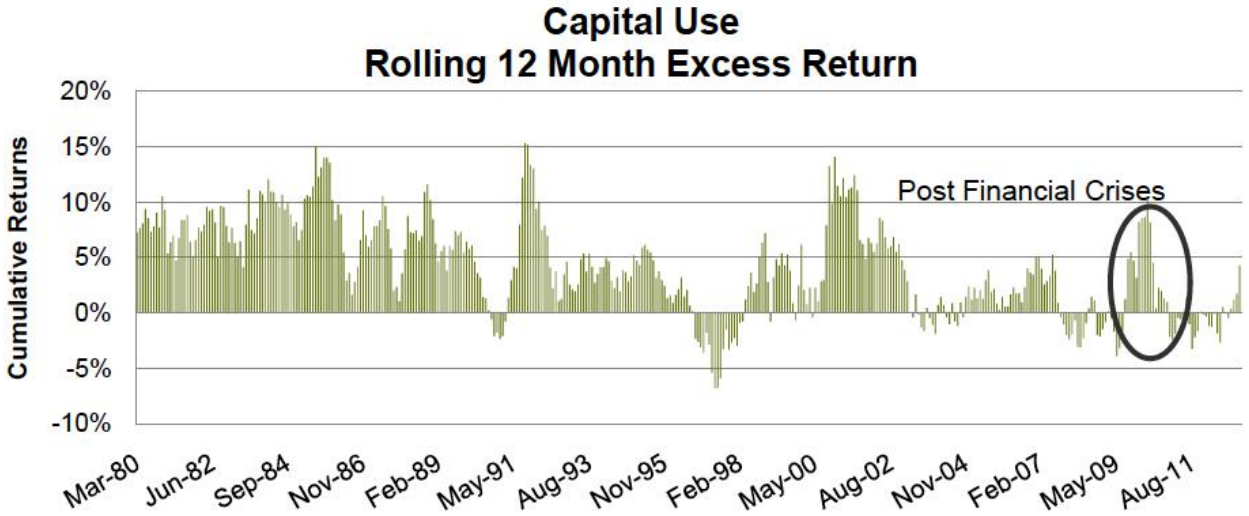
- Ø Dividends Paid, Share Buyback – defensive strategy.
  - = A measure of shareholder friendliness or lack of growth prospect?
- Ø Net External Financing (Bradshaw, Richardson, Sloan: 2006) =

  Sale or purchase of common & pref. stocks - cash dividends + net cash from issuance/retirement of debt
  - = Sell top decile of cash inflows (issuers), buy top decile of cash outflows (repurchasers)
- Ø Explanations
  - = Operating cash flows = net income – accruals. High accruals firms more frequently have higher amount of external financing (IPOs & secondary offerings, M&A, restructurings, etc.)
  - = Firms time their activities to exploit temporary misvaluations of firm's securities
- Ø Effectiveness
  - = Annual Excess Return: 5%
  - = Tracking Error: 5%
  - = Inform[illegible]
  - = Cyclica[illegible]

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





BUILDING AN ALPHA MODEL

FACTOR CONSTUCTION

1. **Compute raw factor (price to book)**
2. **Normalize factor exposure (winsorize, demean within county/sector/industry and then normalize)**
3. **Compute factor returns (mean(F) = Factor Premia, cov(F) = Factor Risk)**
4. **Typically (BARRA): GARCH(1,1) to estimate factor variances and EWMA to estimates factor correlations**
   A. https://www.msci.com/documents/10199/67b801e5-43ef-4200-8531-540851378835
   B. https://www.msci.com/resources/research/barra_risk_model_handbook.pdf
   C. http://www.northinfo.com/documents/8.pdf
5. **Compute residual (specific) risk**
6. **Compute view portfolios**
7. **Combine factor view portfolios into portfolio of factors**
8. **Compute implied alpha**
9. **Mean-variance optimization using alpha, risk and cost models**

http://faculty.washington.edu/ezivot/research/factormodellecture_handout.pdf

BARRA-type Single Factor Model

Consider a single factor model in the form of a cross-sectional regression at time t

$$\underset{(N\times 1)}{\mathbf{R}_t} = \underset{(N\times 1)}{\boldsymbol{\beta}}\ \underset{(1\times 1)}{f_t} + \underset{(N\times 1)}{\boldsymbol{\varepsilon}_t}, t = 1, \ldots, T$$

- $\boldsymbol{\beta}$ is an $N \times 1$ vector of observed values of an asset specific attribute (e.g., market capitalization, industry classification, style classification)
- f_t is an unobserved factor realization.
- $var(f_t) = \sigma_f^2$; $cov(f_t, \varepsilon_{it}) = 0$, for all i, t; $var(\varepsilon_{it}) = \sigma_i^2, i = 1, \ldots, N$.

Estimation

For each time period $t = 1, \ldots T$, the vector of factor betas, $\boldsymbol{\beta}$, is treated as data and the factor realization f_t, is the parameter to be estimated. Since the error term $\boldsymbol{\varepsilon}_t$ is heteroskedastic, efficient estimation of f_t is done by weighted least squares (WLS) (assuming the asset specific variances σ_i^2 are known)

$$\begin{aligned} \hat{f}_{t,wls} &= (\boldsymbol{\beta}'\mathbf{D}^{-1}\boldsymbol{\beta})^{-1}\boldsymbol{\beta}'\mathbf{D}^{-1}\mathbf{R}_t, \; t = 1, \ldots, T \\ \mathbf{D} &= diag(\sigma_1^2, \ldots, \sigma_N^2) \end{aligned} \tag{8}$$

Note 1: σ_i^2 can be consistently estimated and a feasible WLS estimate can be computed *Use Gauss Jordan elimination instead of matrix inversion*

$$\begin{aligned} \hat{f}_{t,fwls} &= (\boldsymbol{\beta}'\hat{\mathbf{D}}^{-1}\boldsymbol{\beta})^{-1}\boldsymbol{\beta}'\hat{\mathbf{D}}^{-1}\mathbf{R}_t, \; t = 1, \ldots, T \\ \hat{\mathbf{D}} &= diag(\hat{\sigma}_1^2, \ldots, \hat{\sigma}_N^2) \end{aligned}$$

Note 2: Other weights besides $\hat{\sigma}_i^2$ could be used

Factor Mimicking Portfolio

The WLS estimate of f_t in (8) has an interesting interpretation as the return on a portfolio $\mathbf{h} = (h_1, \ldots, h_N)'$ that solves

$$\min_{\mathbf{h}} \frac{1}{2}\mathbf{h}'\mathbf{D}\mathbf{h} \text{ subject to } \mathbf{h}'\boldsymbol{\beta} = 1$$

The portfolio $\mathbf{h}$ minimizes asset return residual variance subject to having unit exposure to the attribute β and is given by

$$\mathbf{h}' = (\boldsymbol{\beta}'\mathbf{D}^{-1}\boldsymbol{\beta})^{-1}\boldsymbol{\beta}'\mathbf{D}^{-1}$$

The estimated factor realization is then the portfolio return

$$\hat{f}_{t,wls} = \mathbf{h}'\mathbf{R}_t$$

When the portfolio $\mathbf{h}$ is normalized such that $\sum_i^N h_i = 1$, it is referred to as a *factor mimicking portfolio*.

Combining with Risk Model

A. Using daily estimates for factor returns compute GARCH(1,1) factor volatilities

$$\sigma_t^2 = (1-\alpha-\beta)\sigma_0^2 + \alpha f_{t-1}^2 + \beta\sigma_{t-1}^2$$

A. Compute EWMA for factor correlations (typically 6-12mos half-life)

B. Consider shrinking off-diagonal elements

C. Calculate residual stock returns and fit GARCH(1,1) to these processes. $diag(\quad)$

D. Full risk model is , where covariance matrix is estimated in steps A-C

E. Construct factor mimicking portfolios as h_{GLS} (' 1) 1 ' 1

F. Using Woodbury matrix identity to avoid inversing ; inverse instead.

$h' \quad h \qquad h' diag(\quad) h$

G. Covariance matrix of factor mimicking portfolios is naturally

Combining Factors

A. Optimal factor weights: $w = (h'h)^{-1} F$

B. Combining into portfolio of factors: $P = w'h' = ((h'h)^{-1} F)'h'$

C. Implied stock-level alphas: $= w'h' = ((h'h)^{-1} F)'h'$

D. Sometime alphas are rescaled such that portfolio of factors had certain level of IR consistent with historical observation

$$scale = hist\_IR / [P' / sqrt(P'P)]$$

How To Assess Factors

Quantitative Equity Portfolio Management, by E. Qian, R. Hua, E. Sorensen

- Rank Correlations
- Sharpe Ratio and Information Ratio

$$Sharpe\ Ratio = \frac{R_{strategy} - R_{free}}{Volatiltiy_{strategy}}$$

$$Information\ Ratio = \frac{R_{strategy} - R_{benchmark}}{Tracking\ Error_{strategy}}$$

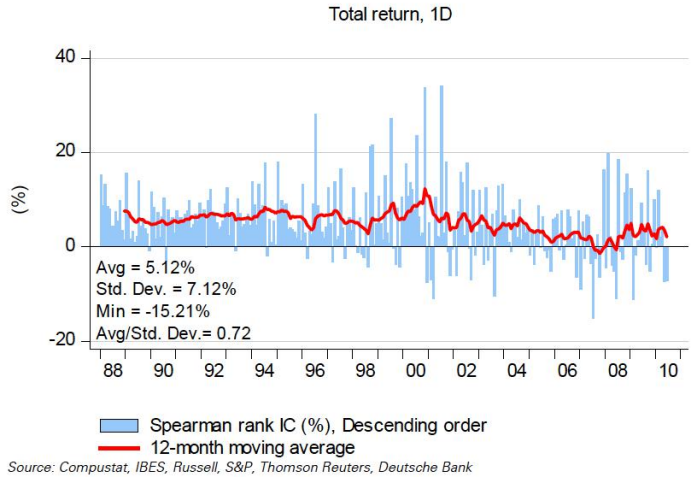
- Turnover (short-horizon strategies have higher turnover)

$$\text{Turnover} = \frac{\sum |\Delta W|}{\sum |W|}$$

- Maximum Drawdowns
- Skewness / Kurtosis: 3rd and 4th moments of return distribution
- Correlations with the market, other factors, co-linearity

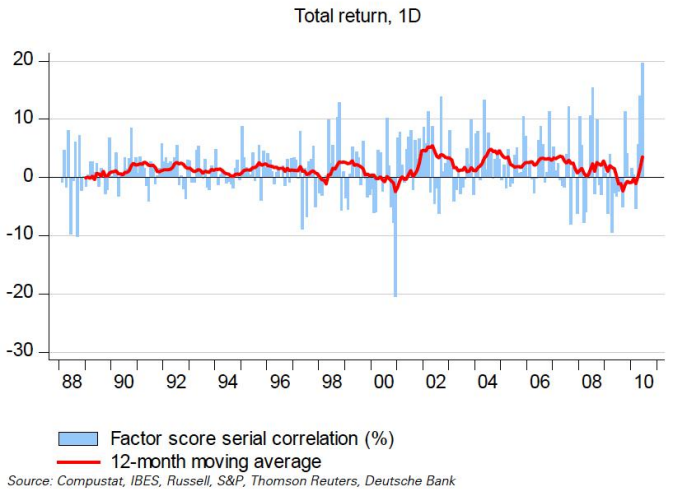
How To Assess Factors

Figure 16: Short-term price reversal



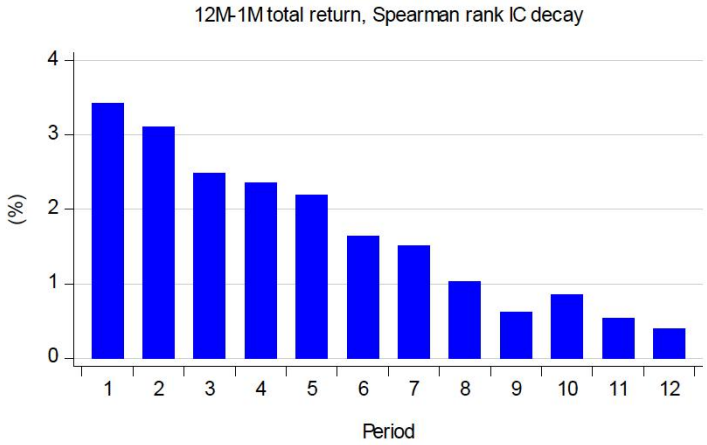
Source: Compustat, IBES, Russell, S&P, Thomson Reuters, Deutsche Bank

Figure 18: Signal serial correlation – reversal



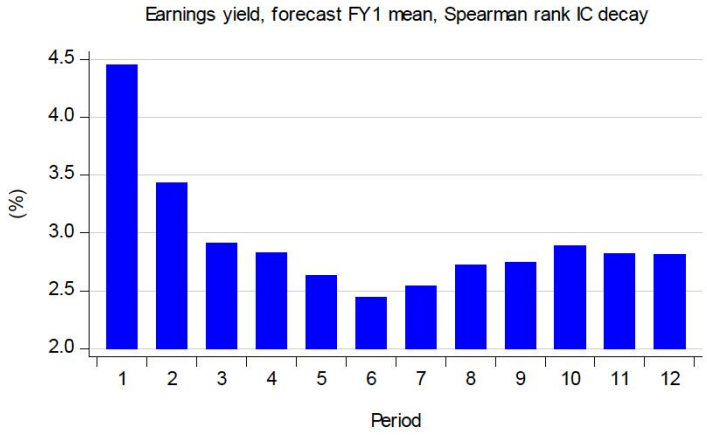
Source: Compustat, IBES, Russell, S&P, Thomson Reuters, Deutsche Bank

Figure 34: IC decay, price momentum



Source: Compustat, IBES, Russell, S&P, Thomson Reuters, Deutsche Bank

Figure 35: IC decay, value



Source: Compustat, IBES, Russell, S&P, Thomson Reuters, Deutsche Bank

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%

Combining Strategies

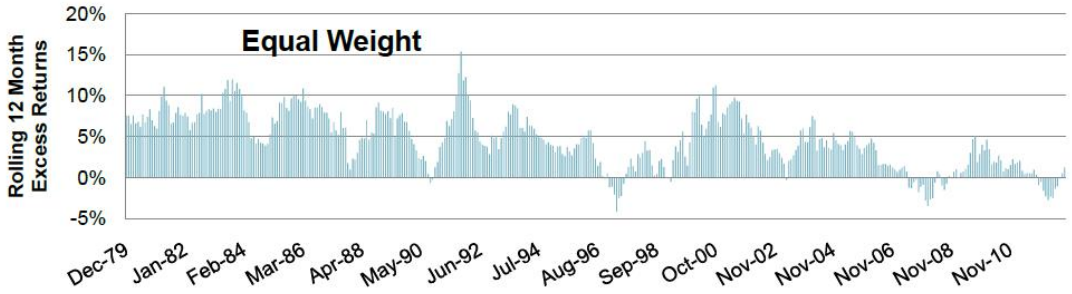
Global Portfolio Optimization
Black, Fischer; Litterman, Robert
Financial Analysts Journal; Sep/Oct 1992; 48, 5; ABI/INFORM Global
pg. 28

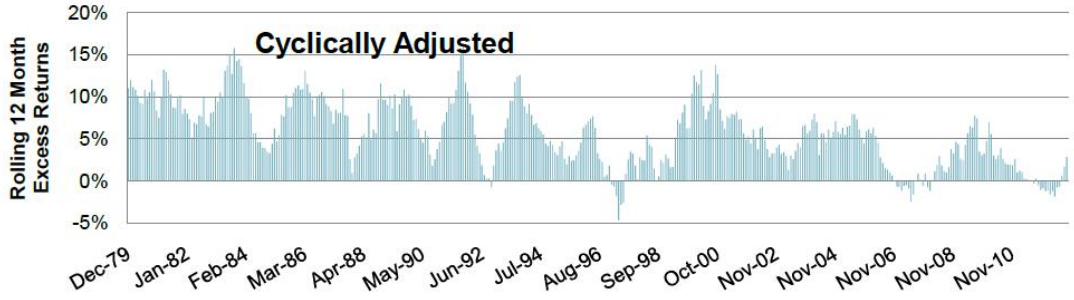
- How to maximize a bag full of tricks?
  - Equal weight: no opinion on individual strategy efficacy
  - No opinion is actually an opinion on the risk/reward trade-offs
  - Results aren't so bad!
  - A standard to beat
- Cyclically adjusted:
  - Strategies have varying degrees of risk/reward profile 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, performs better in some rare cases
- Black-Litterman Framework (http://papers.ssrn.com/sol3/papers.cfm?abstract_id=334304)
  - 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

Combining Strategies

- Centrality of risk allocation across strategies, not the expected returns
- Expected returns, or alphas, can be derived as $\alpha = \lambda \times Inv(COV) \times W$, where λ is the risk aversion parameter, *COV* is the covariance matrix of the strategies, W is allocation across strategies
- Expected returns being a single number disguise the underlying economics behind the investment decision

	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%





Portfolio Construction

- Accounting for the ingredients for constructing a portfolio
  - Client objective: tracking error, geographical preferences etc.
  - Benchmark selection: cap-weighted indices or custom benchmark or short-term instruments?
  - Rebalance frequencies / Turnover
  - T-Cost estimation (commissions, clearing charges, impact, cost of borrow)
- Optimizer to glue them together

$$\max(W'\alpha - \lambda W'\Omega W - Impact - Short\ Cost \cdots)$$

  - Objective
  - Generic optimizers like Matlab, financial apps from Barra, Axioma, Northfield
- Where does “alpha modeling” stop and “portfolio construction” begin?
  - The more flexible the mandate, the more blurred the line between alpha model and portfolio construction
  - Flexibility means significant room to time strategies

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

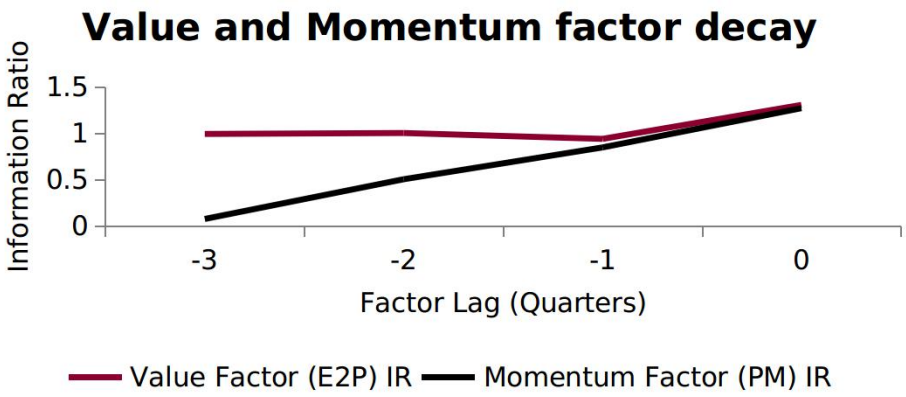
	Long		Short		Total	
Group	Avg. Weight	Return	Avg. Weight	Return	Avg. Weight	Return
Telecommunicatic	3.6%	0.6%	0.6%	0.2%	3.0%	0.4%
Utilities	0.0%	0.0%	0.4%	0.0%	-0.4%	0.0%
Information Techn	8.2%	0.8%	2.2%	0.2%	6.0%	0.6%
Financials	9.1%	0.9%	10.9%	1.1%	-1.8%	-0.2%
Health Care	3.8%	0.5%	0.7%	0.1%	3.1%	0.4%
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

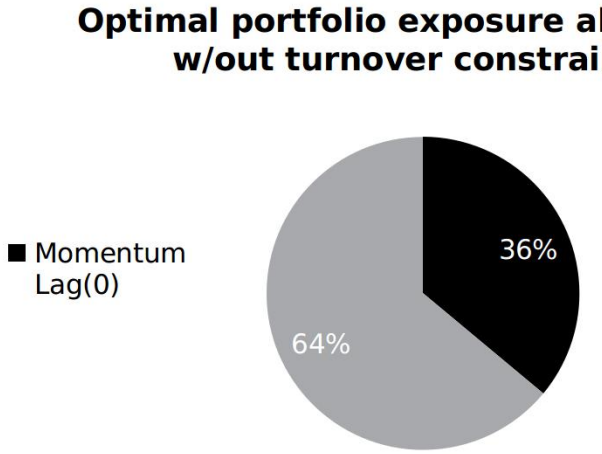
	Long		Short		Total	
Theme > Factor	Avg. Exp.	Return	Avg. Exp.	Return	Avg. Exp.	Return
CAPITAL USE	0.4	-0.7%	0.2	-0.3%	0.2	-0.3%
CURRENT VALUE	0.3	-0.7%	0.0	-0.1%	0.3	-0.7%
DEEP VALUE	-0.4	-0.7%	-0.5	-0.5%	0.1	-0.2%
MOMENTUM	0.5	1.5%	-0.3	-1.3%	0.8	2.8%
PROFITABILITY	1.3	0.0%	0.2	0.2%	1.1	-0.3%
QUALITY	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%

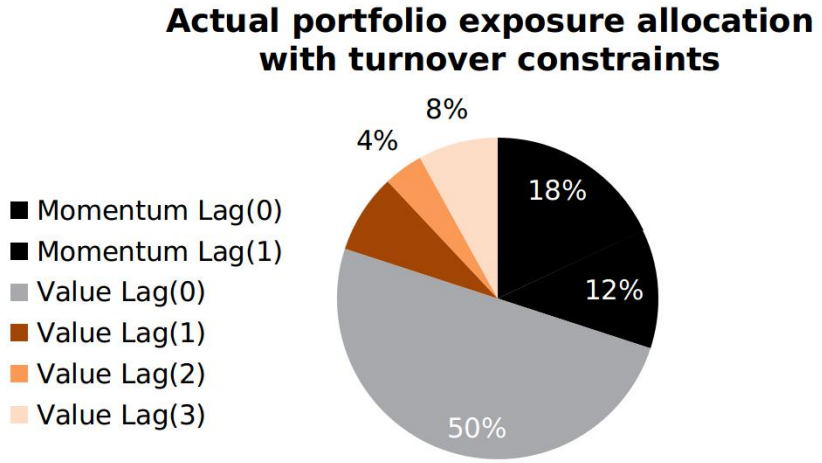
Fast Factors & the Curse of Portfolio Turnover

Equating T-Cost and Turnover leads to underutilization of faster factors and loss of alpha



- Ø "Slow" & "Fast" factors – similar IR if we use most recent values (no lag)
- Ø Factors have negative correlation
- Ø T-cost assumptions impose an artificial limit on exposure to the momentum factor and force the use of lagged factors
- Ø In the end, despite equally compelling levels given current information...we are forced to allocate more to Value because of execution inefficiency





"Information Horizon, Turnover & Optimal Alpha Models" by E. Qian, E. Sorensen, R. Hua, Jour. Portfolio Management, Fall 2007, pp.27-40

Trading Large Caps vs. Small Caps

Market makers supply average liquidity in LC names, but nearly non-exists in SC

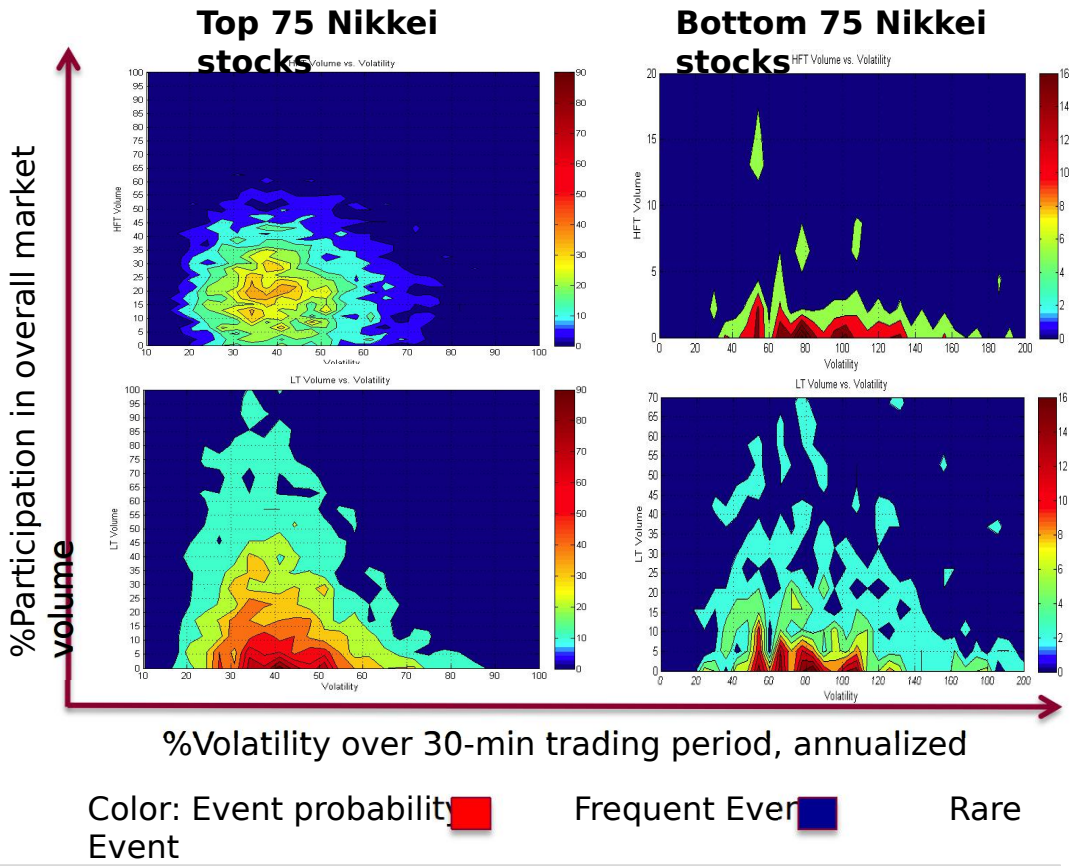
Supply

Market Makers:
In top 75 names provide liquidity within "normal" volatility regime and non beyond that mark

Demand

Institutional Investors:
Trade top and bottom names identically without realizing that liquidity supply is much different.

Frequently originate small trades across wide range of stocks: cash flows, rebalances



Outside of the most liquid names and "normal" volatility, investors need to (a) monitor fragmented market & patiently wait for rare natural liquidity or (b) dislocate the stock price to attract liquidity

N. Bershova, D. Rakhlin "The Non-Linear Market Impact of Large Trades: Evidence from Buy-Side Order Flow" J. of Investment Strategies, v2, n.2, pp 3-47, 2013

Course Projects: Literature

Course Projects: Study one of these. Implement. Suggest Improvements

- The Little Book That Still Beats the Market by Joel Greenblatt
- The Handbook of Equity Market Anomalies, by Leonard Zacks (editor)
- Quantitative Equity Portfolio Management, by E. Qian, R. Hua, E. Sorensen

- Momentum: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=299107
  By Narasimhan Jegadeesh, Sheridan Titman
- Value and momentum everywhere by AQR (Asness, Moskowitz, and Pedersen) (posted on Forum)
- What is Dividend Premium: Laura Liu (posted on Forum)
- Generating Excess Returns through Global Industry Rotation: John Okunev http://papers.ssrn.com/sol3/papers.cfm?abstract_id=904106

Course Projects: Suggestions

1. **Improve StatArb model … Just a suggestion: calculate implied correlation:**
   A. For each stock in the universe for each day (or week) compute matrix *A(t)* of sign correlations of residual returns (e.g. after removing industry or sector returns) with residual returns of all other stocks over some trailing period (6-12 months). Retain top & bottom10% of highly correlated names (or set some minimum threshold). For a few stocks check most correlated names. Do they make sense?
   B. Optional: replace *A(t)* with PCA(*A(t)*) only keeping top few eigenvectors (check spectrum & apply random matrix theory). You can also try A(t) squared instead to overweight highly-correlated names.
   C. Your raw score for stock *I* (raw forward return) will be *A(t)* times stock returns over previous day minus the return of *I* (equivalent of replacing *A(t)* diagonal with -1). Smooth raw score by computing exponential moving average of this signal with 5-10 day half-life. Industry-neutralize and normalize raw score.
   D. Form portfolio (top/bottom deciles or just a factor-mimicking portfolio). Compute all stats (see next page)
2. **Fully replicate a momentum strategy (refer to chapter 8 or Zack's book)**
3. **Fully replicate "Dimensions of Popularity", by Ibbotson, Idzorek. Think what else you can use besides turnover to quantify stock's popularity.**

Course Projects: Requirements

Factor Diagnostics

1. **Define a signal (for example 6 month return from 7 to 2 months ago)**
2. **Define a universe (for example S&P500, Russell 1000, Nikkei 225 etc.)**
   A. If you measure index return from T_1 to T_2 (typically you will work with closing prices), take index weights as of one day before T_1
   B. To evaluate forward performance of a signal from T_1 to T_2,include all stocks in your universe as of one day before T_1
3. **Calculate raw signal exposures for your universe. Neutralize signal within industries (U.S.) or sectors (all other counties) by grouping exposures, subtracting group means, and dividing by stdev (typically of the whole universe, sometime by stdev of a group, if they are drastically different from each other). Winsorize exposures from -3 to 3.**
4. **Define your rebalance strategy (daily/weekly/monthly). Backtest should be at least 5 years, 10 or more is better.**
5. **Calculate IC: rank correlation of your exposures to forward total industry-adjusted returns ("total" means adjusted for corporate actions: dividends, splits, etc. "Industry-adjusted" means your subtract equal weighed industry return)**
6. **Report average IC, moving-average IC, variance(IC), IC/stdev(IC), IC decay (e.g.) rank correlations of the exposures to the returns and to forward exposures over multiple forward periods. If satisfied with the result, move forward.**
7. **Further factor diagnostics: decile (A-C) and factor-mimicking portfolios (D-F)**
   A. For each period form 10 decile sub-portfolios. For each decile calculate total industry-adjusted forward equal weighted returns for multiple periods – days/weeks/months – a.k.a. excess return (ER). Compute hit ratio (HR) – % of stocks outperforming industry.
   B. Average across time for each forward period (e.g. 1,2,3,…N months). Report average ER, HR and t-stat: ER/stdev(ER).
   C. Split your entire testing period into 2 or more sub-periods and report ER/HR/t-stats for each. Are they different?

Factor mimicking portfolios are most useful for multivariate case to evaluate the contribution of a new factor & also remove risk factors

D.

Course Projects: Requirements

Portfolio Construction & Trading

1. **Based on 1-7 decide on portfolio construction rules**
   - A. Simple: invest 1/n of AUM in buying top & selling bottom decile. Continue buying/selling for n periods (n can be 1, it regulates turnover)
   - B. At n+1 period sell/buy the portfolio you bought in the 1st period and buy/sell current top/bottom decides. Continue doing this
   - C. Keep track of all trades. Fill your paper trades at close prices less some T-cost penalty. Try varying costs: 5bps, 10bps, etc.
2. **Do linear optimization. Maximize alpha while keeping maximum industry or sector exposures constrained. As a bonus, add T-Cost (as a linear function of size. Coefficient can be higher as stock capitalization goes down and/or stock volatility goes up). Will be happy to assist with providing more details on the T-Cost. For each optimization allocate some turnover (cumulative difference between current and optimized weights)**
3. **Actually do quadratic mean-variance optimization. Let me know if you have access to any Barra or Axioma models. I'll be happy to assist you and you get extra points for doing it.**
4. **If you did simple portfolio construction (as in item 1), report cumulative portfolio performance (ER/IR/hit ratios, max drawdown, skewness, kurtosis of returns as a function of n and T-costs. If you did steps 2 or3, report the same stats as a function of turnover, level of T-Cost and sector constraints. Try to evaluate portfolio capacity.**
5. **Calculate correlation of portfolio returns to market. It shouldn't be high… Does outperformance come from the long or short side of portfolio? If short side, you may need to add borrow costs (2-25 bps range per month of holding the position, make it higher as stock capitalization goes lower)**
6. **Bonus: you can regress portfolio returns on industry (sector) returns and check how much of the performance can be attributed to industry (sector) returns and how much to stock selection.**