Equity in the Cross Section, Part 1

15.433 Financial Markets

September 14 & 19, 2017

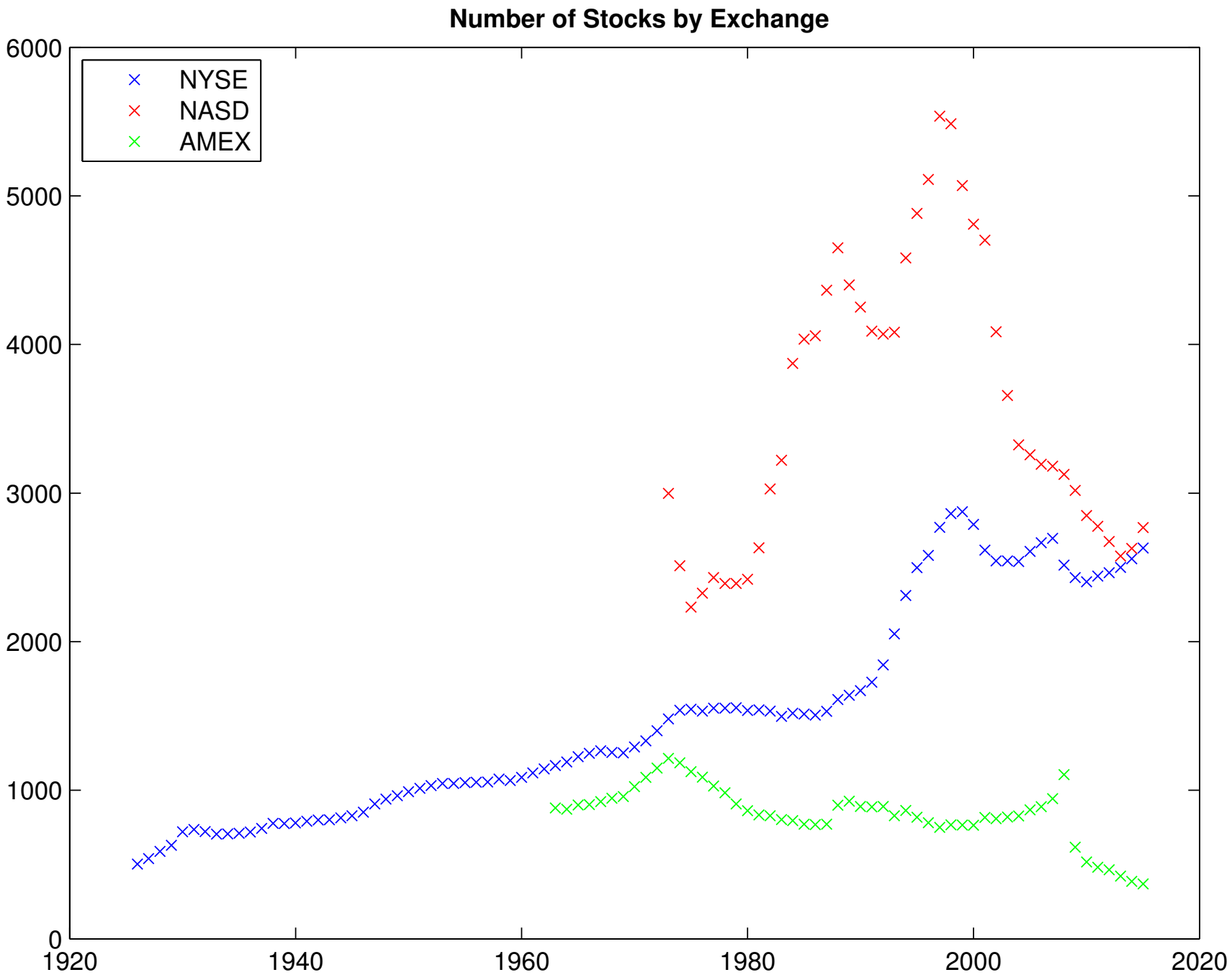
This Version: September 12, 2017

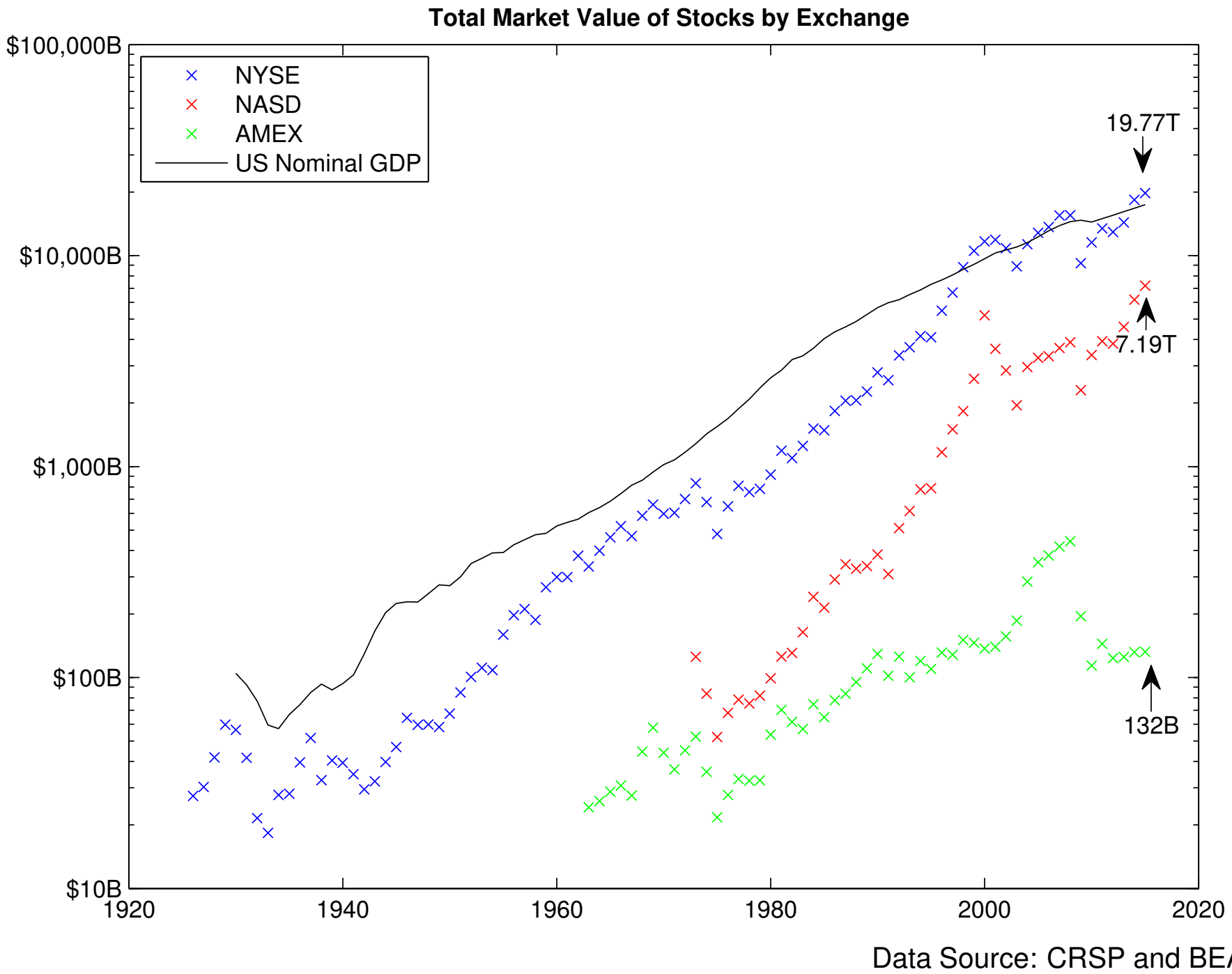
Outline

- Quant investing.
- Forming portfolios using quantitative signals.
- Testing the CAPM using size- and value-sorted portfolios.
- The Fama-French three factor model.

In Search for Alpha

- According to Theory
  - The CAPM: No way.
  - Believers of market efficiency: no true alpha, only beta in disguise.
  - Behavioral finance: true alpha caused by behavioral biases.
- In Practice
  - Stock picking: understand your stock, focus on the stories.
    (Examples: Warren Buffett, Peter Lynch)
  - Quant investing: understand your risk, focus on the numbers.
    (Examples: DFA, GSAM's Global Alpha, D.E. Shaw, BGI, LSV, AQR)


Number of Stocks by Exchange
NYSE
NASD
AMEX
6000
5000
4000
3000
2000
1000
0
1920
1940
1960
1980
2000
2020

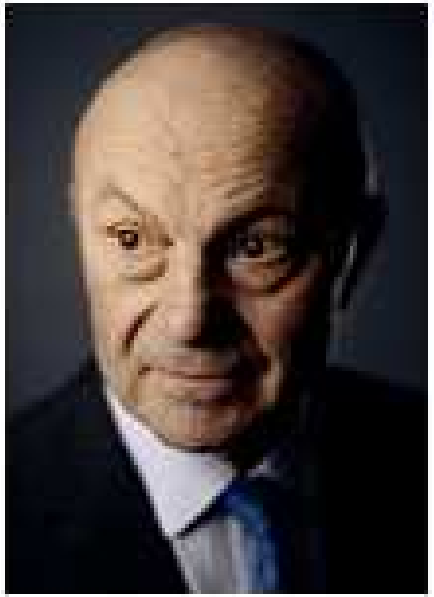

Total Market Value of Stocks by Exchange
NYSE
NASD
AMEX
US Nominal GDP
19.77T
7.19T
132B
$100,000B
$10,000B
$1,000B
$100B
$10B
1920
1940
1960
1980
2000
2020
Data Source: CRSP and BEA

Quant Investing

- Quant investing approaches the markets with an investment philosophy that is very different from stock picking.
- Instead of spending time to study each individual stock, it uses quantitative signals (e.g., market cap, profitability, book-to-market, and past returns) to form portfolios.
- The key insight is that such quantitative signals are useful in separating one group of stocks from another, exploiting the potential mis-pricing or differences in risk exposure.
- Quant investing has a razor sharp focus. For a given signal, the only risk it's interested in taking is the target risk factor. The portfolio approach helps diversify away unwanted idiosyncratic risk, and the long/short factor approach helps take out the unwanted systematic risk.

The Academic Influence

- Quant investing puts into practice ideas that have been created and tested in academic research papers.
- The intellectual foundation and the framework of portfolio construction and factor building were provided mostly by papers written by Prof. Eugene Fama and his co-authors.
- In fact, many of the early quant investors were Prof. Fama's students at Chicago in the 1970s.
- The most creative part of quant investing is to come up with signals that could generate alpha. Most of the signals used today have their origin in academic papers.



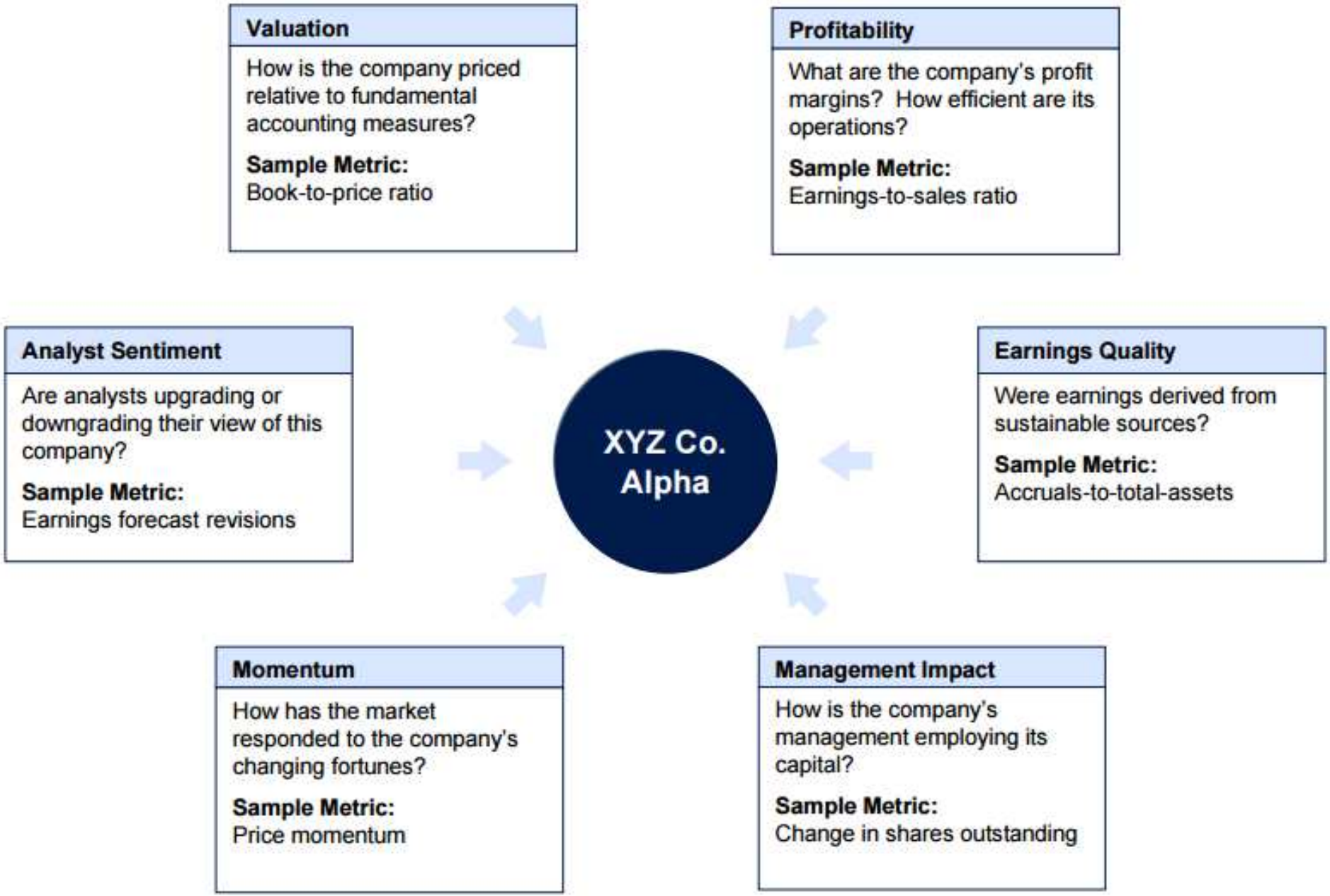
Eugene F. Fama
Prize share: 1/3

From Alpha to Beta

- Quant investing in the hedge fund space (long/short equity) started out in the 1990s, and grew quite rapidly in 2000s.
- As usual, success leads to imitation. The "2007 quant meltdown" was a result of over-crowding in this space: too many quant funds trading on too many similar signals.
- The unwinding of the "crowded trades" created large losses for many quant funds. Previously unrelated stocks suddenly started to move together during the unwind.
- In recent years, this idea of quant investing is showing up in the world of mutual funds and ETFs.
- While the sales pitch in the quant hedge fund world is all about Alpha, now the emphasis is on Beta: smart beta and factor investing.

Form Portfolios by Quant Signals

- Quant investing uses stock characteristics as signals. Some widely used stock characteristics are:
  - size: measured by market capitalization.
  - value: measured by the ratio of book equity to market value of equity.
  - momentum: measured by past stock performance.
- Stocks with the same characteristics are considered to be indistinguishable from one another and are sorted into the same portfolio.
- It is typical to sort stocks into terciles, quintiles, and deciles.
- It is also typical to identify two characteristics and do a double sort (e.g., the 5×5 Fama-French portfolios).



Source: Prof. Kent Daniel

Market Capitalization = Stock Price $\times$ Number of Shares Outstanding

	Size Decile	Avg. Size (m$)	Number of Stocks
Small	1	116	1362
	2	472	470
	3	912	378
	4	1,509	304
Med	5	2,308	233
	6	3,378	207
	7	5,212	225
	8	8,890	182
	9	17,244	182
Big	10	83,791	173

As of July 2015. Source: Prof. Ken French's Website.

BtM= book-to-market ratio = book value of equity / market value of equity

	BtM Decile	Avg. BtM	Number of Stocks	Avg. Size (m$)
Growth	1	0.095	432	8,440
	2	0.196	338	9,895
	3	0.269	330	10,430
	4	0.348	276	10,210
Neutral	5	0.431	314	4,726
	6	0.547	319	7,310
	7	0.654	333	2,586
	8	0.817	327	5,728
	9	0.972	378	2,878
Value	10	1.339	371	2,359

As of 2015. Source: Prof. Ken French's Website.

Sorting is Done Dynamically

- Stock characteristics fluctuate over time. Need to periodically update this information and re-sort stocks by their new characteristics. The sorting frequency depends on the variability of the signals.
- For example, Fama and French resort their size-sorted portfolios at the end of each June. A stock that was in the top size decile last year might have shrunk in size and gets re-sorted into a lower decile this year.
- So the stock composition of a characteristics-sorted portfolio changes over time. The turnover rate is higher for characteristics that move more frequently.
- For example, the momentum strategy requires you to re-sort stocks every month using past returns. Compared with the size-sorted portfolio, the momentum sorting is more frequent (once a month vs. one a year) and the sorting signal is also more variable (past returns vs. market cap).

The Fama French 25 Portfolios:

- Size labels: A (small), B, C, D, and E (big).
- BtM labels: 1 (low), 2, 3, 4, and 5 (high).

	1	2	3	4	5
A	A1				A5
B					
C					
D					
E	E1				E5

A1 $\rightarrow$ small growth A5 $\rightarrow$ small value

E1 $\rightarrow$ big growth E5 $\rightarrow$ big value

How many stocks are there in each portfolio?

- Each month, we have a cross section of stocks.
- The size of the cross section varies from month to month.
- So our portfolio size also varies from month to month.

July 2015

	1	2	3	4	5
A	269	208	285	347	542
B	159	115	134	141	82
C	107	89	89	78	55
D	120	103	75	51	35
E	115	91	50	43	35

January 1962

	1	2	3	4	5
A	7	12	32	56	92
B	25	28	46	48	50
C	31	47	43	51	29
D	60	57	47	26	18
E	81	62	35	22	11

Source: Prof. Ken French's Website.

The average market capitalization of each portfolio

Average Size ($M) as of July 2015

	1	2	3	4	5
A	246	235	243	240	149
B	1,220	1,201	1,211	1,135	1,084
C	2,831	2,944	2,720	2,753	2,819
D	6,860	6,863	6,895	6,806	6,737
E	48,736	56,086	56,500	44,859	40,072

The average book-to-market ratio of each portfolio

Book-to-Market as of July 2015

	1	2	3	4	5
A	0.15	0.31	0.49	0.72	1.36
B	0.14	0.32	0.49	0.71	1.18
C	0.13	0.30	0.48	0.73	1.33
D	0.15	0.31	0.49	0.72	1.11
E	0.14	0.30	0.51	0.78	1.10

Testing the CAPM using 25 Fama-French Portfolios

1. For each portfolio i, we perform regression to obtain an estimate for beta:

$$R_t^i - r_f = \alpha_i + \beta_i \left(R_t^M - r_f\right) + \epsilon_t^i$$

2. Estimate the market risk premium:

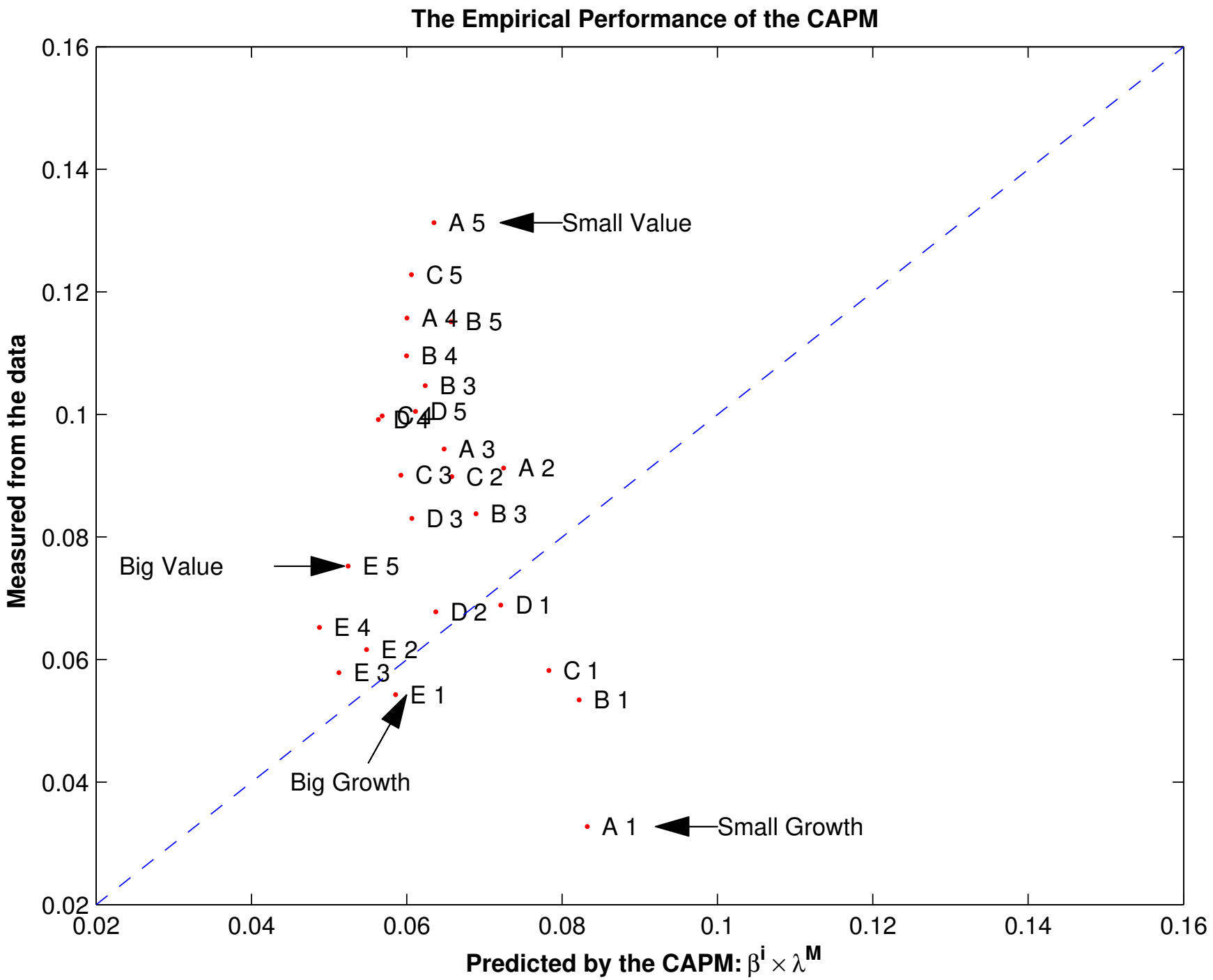
$$\lambda^M = \frac{1}{T} \sum_{t=1}^{T} \left(R_t^M - r_f\right)$$

3. The risk premium of portfolio i predicted by the CAPM:

$$\beta_i \, \lambda^M$$

4. Estimate the risk premium of portfolio i using realized returns:

$$\frac{1}{T} \sum_{t=1}^{T} \left(R_t^i - r_f\right)$$


The Empirical Performance of the CAPM
Measured from the data
Predicted by the CAPM: $\beta^i \times \lambda^M$
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
A 5
Small Value
C 5
A 4
B 5
B 4
B 3
C 4
D 5
D 4
A 3
C 3
C 2
A 2
D 3
B 3
Big Value
E 5
D 2
D 1
E 4
E 2
E 3
C 1
E 1
B 1
Big Growth
A 1
Small Growth

Annualized CAPM Alpha (in %) with t-stat's

	1	2	3	4	5
A	**-5.05** [-2.19]	1.88 [0.95]	2.95 [1.80]	**5.57** [3.46]	**6.78** [3.82]
B	-2.88 [-1.68]	1.49 [1.08]	**4.23** [3.27]	**4.96** [3.78]	**4.94** [3.06]
C	-2.01 [-1.41]	**2.40** [2.23]	**3.08** [2.83]	**4.29** [3.68]	**6.22** [4.31]
D	-0.32 [-0.30]	0.40 [0.45]	**2.24** [2.21]	**4.28** [3.96]	**3.94** [2.81]
E	-0.43 [-0.56]	0.68 [0.91]	0.66 [0.70]	1.65 [1.50]	2.28 [1.57]

Monthly data from January 1962 through July 2015.

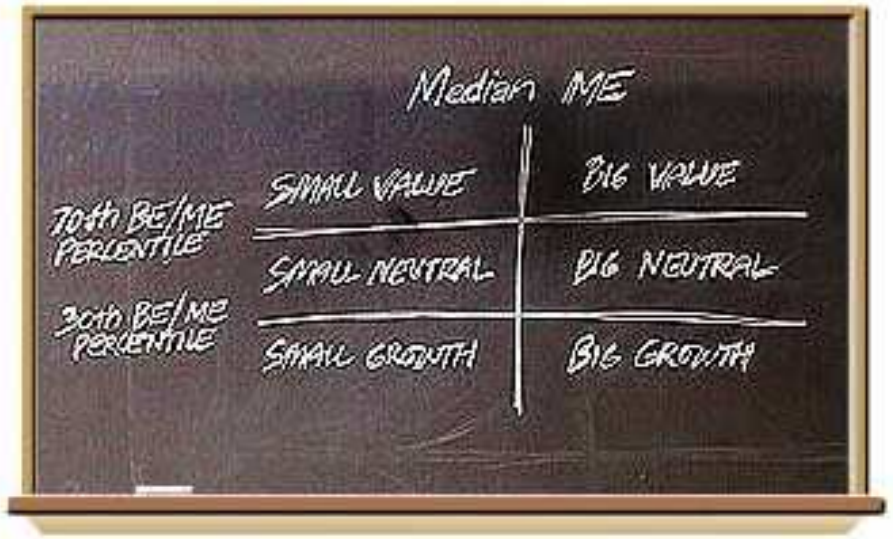
The Fama and French Factors:

- Small Minus Big:

$$R^{\text{SMB}} = R^{\text{small}} - R^{\text{big}}$$

- High Minus Low:

$$R^{\text{HML}} = R^{\text{value}} - R^{\text{growth}}$$



R^{small}=1/3 (Small Value + Small Neutral + Small Growth)
R^{big} = 1/3 (Big Value + Big Neutral + Big Growth)
R^{value}=1/2 (Small Value + Big Value)
R^{growth}=1/2 (Small Growth + Big Growth)

The Fama-French Three-Factor Alpha and Beta's

$$R_t^i - r_f = \alpha_i + \beta_i \left(R_t^M - r_f\right) + s_i \, R_t^{\text{SMB}} + h_i \, R^{\text{HML}} + \epsilon_t^i$$

- β_i: the market beta.
- s_i: the size beta.
- h_i: the value beta.
- α_i: the Fama-French three-factor alpha.

Factor Exposures

$$R_t^i - r_f = \alpha_i + \beta_i \left(R_t^M - r_f\right) + s_i \, R_t^{\text{SMB}} + h_i \, R^{\text{HML}} + \epsilon_t^i$$

SMB beta s

	1	2	3	4	5
A	1.38	1.30	1.10	1.03	1.09
B	0.99	0.87	0.77	0.73	0.87
C	0.73	0.53	0.44	0.40	0.55
D	0.38	0.22	0.18	0.22	0.25
E	-0.24	-0.22	-0.23	-0.20	-0.08

HML beta h

1	2	3	4	5
-0.29	0.04	0.28	0.46	0.70
-0.39	0.13	0.39	0.56	0.81
-0.44	0.18	0.44	0.62	0.77
-0.42	0.21	0.45	0.57	0.81
-0.36	0.09	0.30	0.60	0.76

The Explanatory Power of the Factors

- One Factor:

$$R_t^i - r_f = \alpha_i + \beta_i \left(R_t^M - r_f\right) + \epsilon_t^i$$

- Three Factors:

$$R_t^i - r_f = \alpha_i + \beta_i \left(R_t^M - r_f\right) + s_i\, R_t^{\text{SMB}} + h_i\, R^{\text{HML}} + \epsilon_t^i$$

R2 (%) in one-factor

	1	2	3	4	5
A	63	64	67	64	62
B	75	76	75	73	68
C	80	83	79	75	70
D	85	87	82	78	71
E	89	88	80	72	63

R2 (%) in three-factor

	1	2	3	4	5
A	91	94	95	94	95
B	95	94	94	94	95
C	95	91	90	90	90
D	94	89	88	89	87
E	94	90	86	89	80

The Pricing Relation:

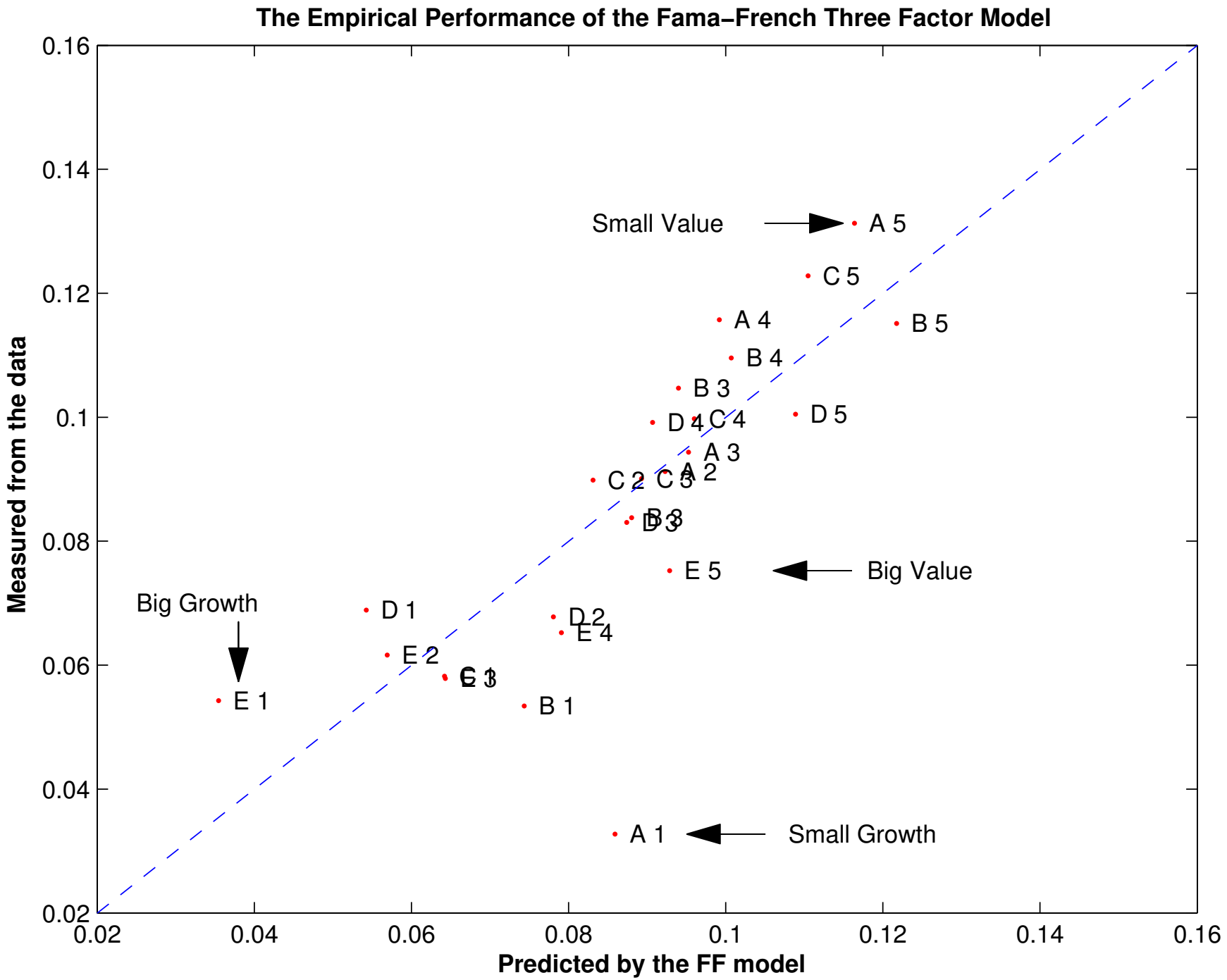
$$E(R_t^i) - r_f = \beta_i \left(E\left(R_t^M\right) - r_f\right) + s_i\, E\left(R_t^{\text{SMB}}\right) + h_i\, E\left(R_t^{\text{HML}}\right)$$

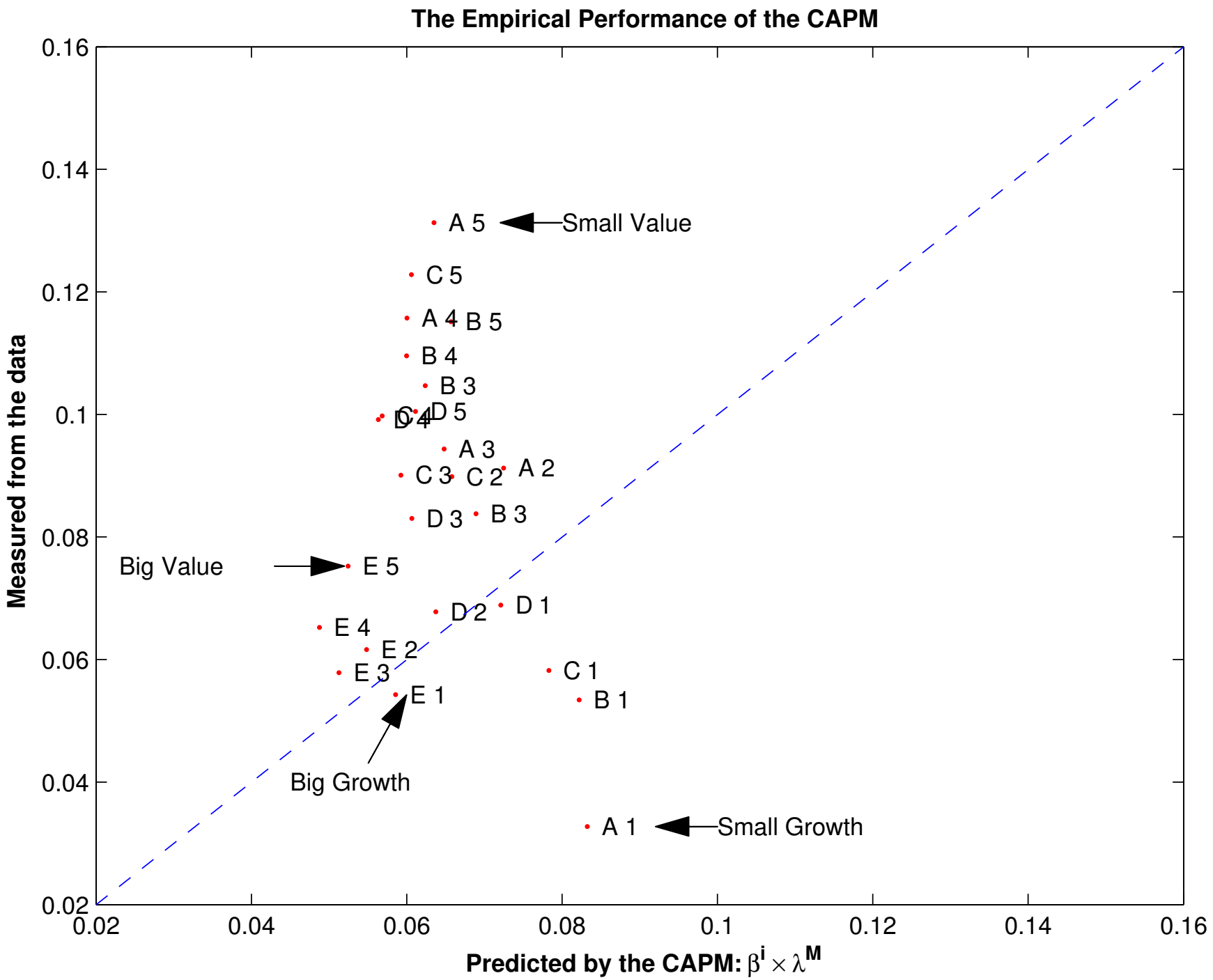
- Using annual returns from 1962 through 2014:

$E(R^M - r_f)$	$E(R^{\text{SMB}})$	$E(R^{\text{HML}})$
6.46%	3.20%	5.15%
[2.64]	[1.68]	[2.78]

- Using annual returns from 1927 through 2014:

$E(R^M - r_f)$	$E(R^{\text{SMB}})$	$E(R^{\text{HML}})$
8.40%	3.40%	5.00%
[3.81]	[2.28]	[3.33]


The Empirical Performance of the Fama–French Three Factor Model
Measured from the data
Predicted by the FF model
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
Small Value
A 5
C 5
A 4
B 5
B 4
B 3
D 5
D 4
C 4
A 3
A 2
C 2
C 3
B 2
D 3
E 5
Big Value
Big Growth
D 1
D 2
E 4
E 2
E 3
C 1
B 1
E 1
A 1
Small Growth


The Empirical Performance of the CAPM
Measured from the data
Predicted by the CAPM: $\beta^i \times \lambda^M$
0.02
0.04
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A 5
Small Value
C 5
A 4
B 5
B 4
B 3
C 4
D 5
D 4
A 3
C 3
C 2
A 2
D 3
B 3
Big Value
E 5
D 2
D 1
E 4
E 2
E 3
C 1
E 1
B 1
Big Growth
A 1
Small Growth

Peter Lynch and the Magellan Fund

$$R_t - R_t^f = \alpha + \beta \left(R_t^M - R_t^f \right) + s\, R_t^{SMB} + h\, R_t^{HML} + \epsilon_t$$

	Overall Period 76/6 – 98/12		Peter Lynch 76/6 – 90/5		Post-Lynch 90/6 – 98/12	
	estimate	s.e.	estimate	s.e.	estimate	s.e.
α	0.51	0.11	0.75	0.13	0.07	0.14
β	1.12	0.03	1.13	0.03	1.04	0.04
s	0.34	0.04	0.55	0.05	0.05	0.05
h	0.02	0.05	-0.01	0.06	0.005	0.06
R^2	0.91		0.94		0.90	

Warren Buffett and Berkshire Hathaway

Monthly returns of BRK.A from November 1976 through December 2008.

The sample mean is 1.69% and the standard deviation is 7.29%.

alpha	1.36% [4.04]	1.11% [3.38]
Market beta	0.71 [9.50]	0.93 [11.60]
SMB beta		-0.26 [-2.42]
HML beta		0.58 [4.67]
R^2	19.10%	26.33%

Subsample Analysis:

	First Half 197611-199212		Second Half 199301-200812	
alpha	1.83%	1.49%	0.84%	0.69%
	[3.69]	[2.99]	[1.91]	[1.74]
Market beta	0.93	1.04	0.46	0.70
	[8.70]	[8.38]	[4.53]	[7.16]
SMB beta		0.31		-0.57
		[1.54]		[-4.83]
HML beta		0.58		0.44
		[2.64]		[3.18]
R^2	28.28%	31.68%	9.72%	29.81%

Where Does Market Risk Premium Come from?

The market risk premium has its foundation in the CAPM:

- Investors are risk averse.
- Investors in aggregate cannot avoid holding the risk of the overall market.
- Negative beta stocks tend to do well when the market does badly.
- By contrast, positive beta stocks tend to do poorly when the market does badly.
- As a result, risk-averse investors are willing to pay a premium for negative beta stocks and demand a premium for positive beta stocks.
- The market risk premium is a reward for holding the market risk.

Where Do Size and Value Premiums Come from?

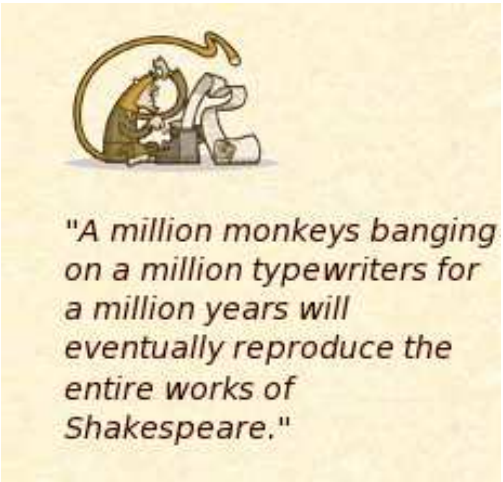
- Unlike the market portfolio, the Size and Value portfolios are empirically motivated.
- If we think of them as risk premiums, then we need to understand the *real, macroeconomic, aggregate, nondiversifiable* risk that is proxied by the SMB and HML portfolios.
- In particular, why are investors so concerned about holding stocks that do badly when the SMB and HML portfolios do badly, even though the market does not fall?
  - We know that small stocks are riskier because they have higher betas. The reward demanded for holding small stocks, however, is larger than what can be justified by the CAPM.
  - Similarly, after controlling for the CAPM, why do investors still consider value stocks risky and demand an additional premium?

Why Do We Care?

- The prevalent usage of size and value as "risk factors."
- Morningstar.com classifies stocks and mutual funds based on these factors.
- Index funds and ETFs are being offered based on the three factor model.
- Nevertheless, we know very little about the nature of these factors:
  - Are they risk factors?
  - If so, what risk?
  - If not, then what are they?
- Stock pickers: know your stock. Quant investors: know your risk.

Explaining the Size and Value "Anomalies"

- The Rational Camp
  - Value: proxies for the "distress risk."
  - Size: proxies for the illiquidity of the stock.
  - HML and SMB contain information above and beyond that in the market return for forecasting GDP growth.
  - Proxies for variables that forecast time-varying investment opportunities or time-varying risk aversion.
- The Behavioral Camp
  - Expectational errors made by investors
- The Critics
  - Survival bias
  - Data snooping



Equity in the Cross Section, Part 2

15.433 Financial Markets

September 21 & 26, 2017

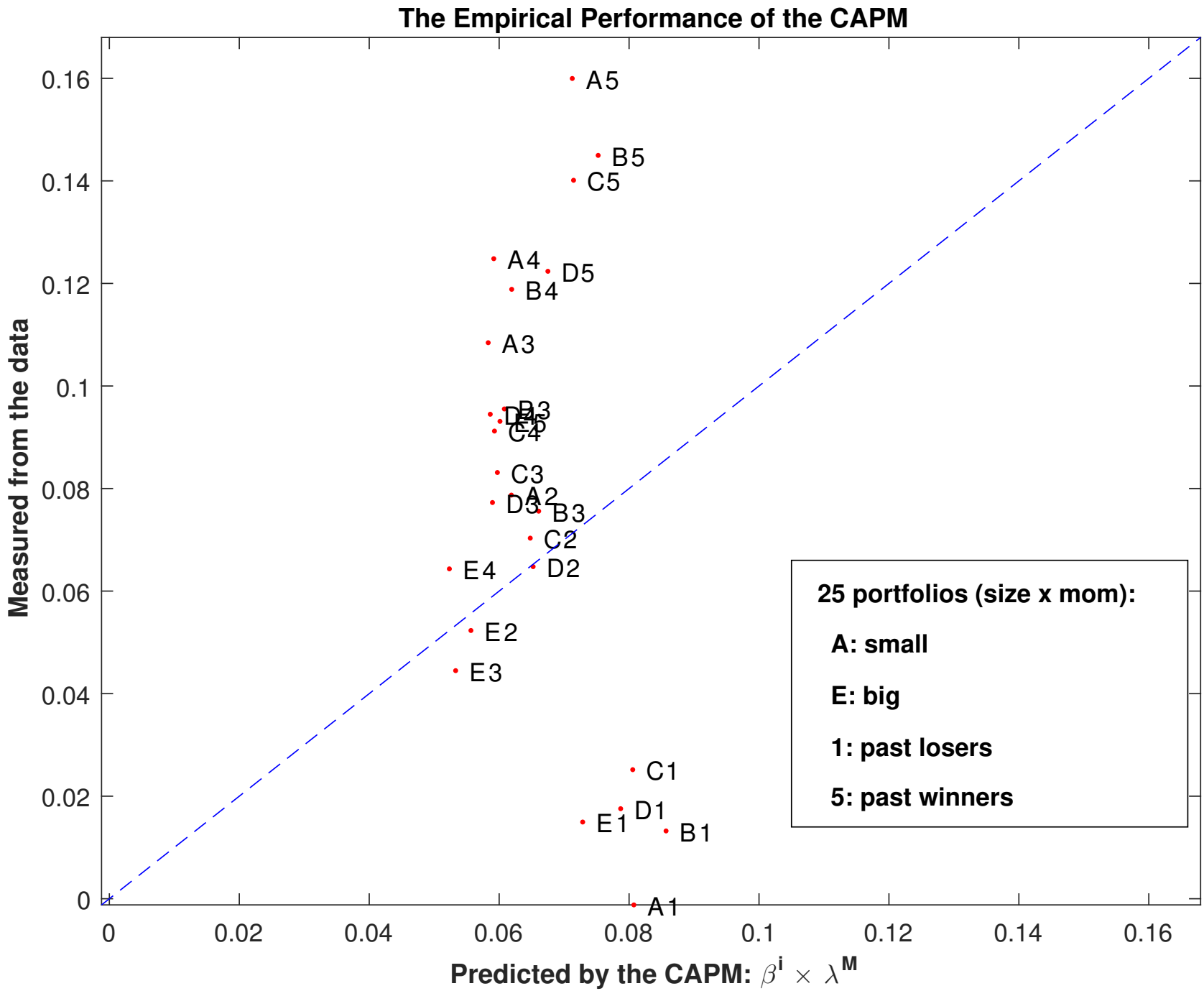
This Version: September 19, 2017

Outline

- The momentum profit and the four factor model.
- Quant investing: crowded trades, over-used signals. What next?
- Currency carry trade.

The Momentum Profit from Buying Winners and Selling Losers

- In a 1993 *Journal of Finance* article, Jegadeesh and Titman show that firms with high (low) returns in the prior year tend to have high (low) returns in the next few months
- In month t, sort stocks by their month t-12 to month t-2 cumulative returns, skipping month t-1 returns because of short-term reversal.
- The momentum profit looks impressive on paper, but the strategy involves high turnovers and transaction costs, and is also more volatile.
- Internationally, the evidence for momentum profit is strong, with the exception of a few countries including Japan.
- The momentum profit cannot be explained by the Fama-French factors: add the momentum factor to form the four-factor model.


The Empirical Performance of the CAPM
Measured from the data
Predicted by the CAPM: $\beta^i \times \lambda^M$
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
A5
B5
C5
A4
D5
B4
A3
B3
C4
C3
A2
D3
B3
C2
E4
D2
E2
E3
C1
D1
E1
B1
A1
25 portfolios (size x mom):
A: small
E: big
1: past losers
5: past winners


The Empirical Performance of the Fama-French Three Factor Model
Measured from the data
Predicted by the FF model
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
A5
B5
C5
D5
A4
B4
A3
E5
D4
B3
C4
C3
A2
D3
B3
C2
E4
D2
E2
E3
C1
D1
E1
B1
A1

The Performance of Momentum Strategy in the CAPM

CAPM Alpha (in %, annualized by x12) with t-stat's

	1	2	3	4	5
A	**-8.19** [-3.31]	1.68 [1.00]	**5.01** [3.33]	**6.57** [4.36]	**8.87** [4.64]
B	**-7.25** [-3.44]	0.95 [0.65]	**3.47** [2.82]	**5.69** [4.54]	**6.97** [4.16]
C	**-5.54** [-2.78]	0.55 [0.46]	**2.34** [2.18]	**3.19** [3.08]	**6.87** [4.58]
D	**-6.11** [-3.08]	-0.05 [-0.04]	1.83 [1.98]	**3.59** [4.26]	**5.49** [4.03]
E	**-5.79** [-3.07]	-0.33 [-0.28]	-0.88 [-1.08]	1.20 [1.46]	**3.30** [2.70]

Monthly data from January 1962 through July 2015.

The Performance of Momentum Strategy in the FF3 Model

FF3 Alpha (in %, annualized by x12) with t-stat's

	1	2	3	4	5
A	**-12.14** [-6.75]	**-2.46** [-2.66]	1.21 [1.56]	**3.39** [4.32]	**6.84** [6.20]
B	**-10.27** [-6.18]	**-2.38** [-2.47]	0.44 [0.60]	**2.92** [4.34]	**5.97** [5.82]
C	**-7.86** [-4.33]	**-2.13** [-2.19]	-0.45 [-0.59]	0.77 [0.97]	**6.51** [5.80]
D	**-8.24** [-4.24]	**-2.25** [-2.06]	-0.29 [-0.36]	**2.10** [2.69]	**5.52** [4.55]
E	**-6.68** [-3.54]	-1.28 [-1.12]	-1.41 [-1.90]	1.19 [1.57]	**4.47** [3.69]

Monthly data from January 1962 through July 2015.

The winner/loser portfolios tend to be more volatile:

The monthly market volatility is 4.46% for the same sample period.

Monthly Standard Deviation (in %)

	1	2	3	4	5
A	8.02	5.87	5.43	5.48	6.73
B	7.85	5.88	5.28	5.38	6.69
C	7.39	5.53	5.05	4.99	6.26
D	7.27	5.53	4.86	4.78	5.86
E	6.79	4.92	4.38	4.32	5.23

Monthly data from January 1962 through July 2015.

Momentum Profits around the World:

Portfolio	Mean	Std. Dev.	t(mean)
Panel A: Country-Neutral Momentum Strategies			
All stocks (country-neutral)	0.0093	0.0239	5.36
By country:			
Austria	0.0080	0.0498	2.23
Belgium	0.0110	0.0444	3.42
Denmark	0.0109	0.0478	3.16
France	0.0097	0.0496	2.72
Germany	0.0072	0.0395	2.52
Italy	0.0093	0.0508	2.53
Netherlands	0.0126	0.0497	3.51
Norway	0.0099	0.0658	2.09
Spain	0.0132	0.0801	2.28
Sweden	0.0016	0.0632	0.36
Switzerland	0.0064	0.0428	2.08
United Kingdom	0.0089	0.0408	3.02

"International Momentum Strategies" by Rouwenhorst, *The Journal of Finance*, 1998.

The Momentum Factor:

- Double sort stocks by size and prior (2-12 months) returns.
- Six value-weighted portfolios are formed monthly. For example, "Small High" contains small stocks with high (the top 30%) past (2-12 months) returns; "Big Low" contains large stocks with low (the bottom 30%) past (2-12 months) returns.
- The moment factor:

$$R^{\text{MOM}} = R^{\text{winner}} - R^{\text{loser}}$$

R^{winner}= 1/2 (Small High + Big High)

R^{loser}= 1/2 (Small Low + Big Low)

The Four-Factor Model:

Add MOM to the Fama-French three-factor model:

$$E(R_t^i) - r_f = \beta_i \left(E(R_t^M) - r_f\right) + s_i \, E\left(R_t^{\text{SMB}}\right) + h_i \, E\left(R_t^{\text{HML}}\right) + w_i \, E\left(R_t^{\text{MOM}}\right)$$

where the market beta, size beta, value beta, and momentum beta can be estimated by the following regression:

$$R_t^i - r_f = \alpha_i + \beta_i \left(R_t^M - r_f\right) + s_i \, R_t^{\text{SMB}} + h_i \, R^{\text{HML}} + w_i \, R^{\text{MOM}} + \epsilon_t^i$$

The Factor Premiums and Volatility from 1962 to 2014:

- Using annual returns:

$E(R^M - r_f)$	$E(R^{\text{SMB}})$	$E(R^{\text{HML}})$	$E(R^{\text{MOM}})$
6.46%	3.20%	5.15%	8.63%
[2.64]	[1.68]	[2.78]	[3.47]

- Using monthly returns:

$E(R^M - r_f)$	$E(R^{\text{SMB}})$	$E(R^{\text{HML}})$	$E(R^{\text{MOM}})$
0.49%	0.22%	0.36%	0.71%
[2.79]	[1.79]	[3.23]	[4.27]

- Factor volatility (monthly):

σ^M	σ^{SMB}	σ^{HML}	σ^{MOM}
4.46%	3.08%	2.84%	4.21%

Fidelity Magellan, monthly returns

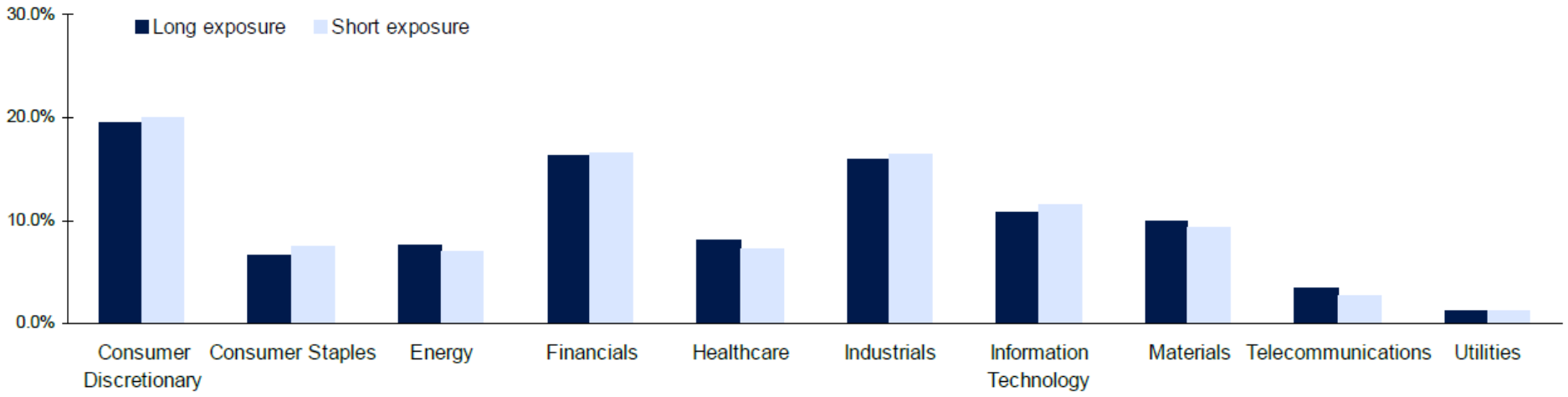
manager	tenure	mean excess	alpha	market beta	SMB beta	HML beta	MOM beta
Stansky	96-05	0.37 [0.74]	0.03 [0.35]	0.99 [50.41]	-0.14 [-7.72]	-0.04 [-1.46]	-0.01 [-0.50]
Vinik	92-96	0.95 [2.26]	-0.31 [-1.19]	1.00 [9.21]	0.12 [0.88]	0.07 [0.55]	0.29 [2.37]
Smith	90-92	0.80 [0.77]	0.26 [2.09]	1.14 [36.69]	0.01 [0.30]	-0.01 [-0.21]	-0.03 [-0.82]
Lynch	76-90	1.59 [3.45]	0.64 [5.01]	1.12 [36.38]	0.49 [9.67]	0.03 [0.59]	0.16 [4.08]
Habermann	72-76	-0.83 [-0.68]	0.42 [0.64]	1.00 [7.85]	0.79 [3.52]	-0.44 [-2.25]	0.07 [0.38]
Johnson	63-72	2.45 [3.32]	0.83 [2.60]	1.10 [11.67]	1.20 [10.07]	0.13 [0.90]	0.75 [7.36]

Popular Quant Signals

- **Valuation:** book-to-market, Fama and French 1992.
- **Momentum:** price momentum, Jegadeesh and Titman 1993.
- **Profitability:** earnings-to-sales ratio; profit/book-equity, Fama and French 2014.
- **Earnings Quality:** accruals to total assets, Sloan, 1996.
- **Analysts Sentiment:** earnings forecast revisions, Stickel, 1991.
- **Management Impact:** change in shares outstanding: seasoned equity offering, Loughran and Ritter 1994; share repurchases, Ikenberry, Lakonishok, and Vermaelan 1995. Investment (asset growth), Fama and French 2014.

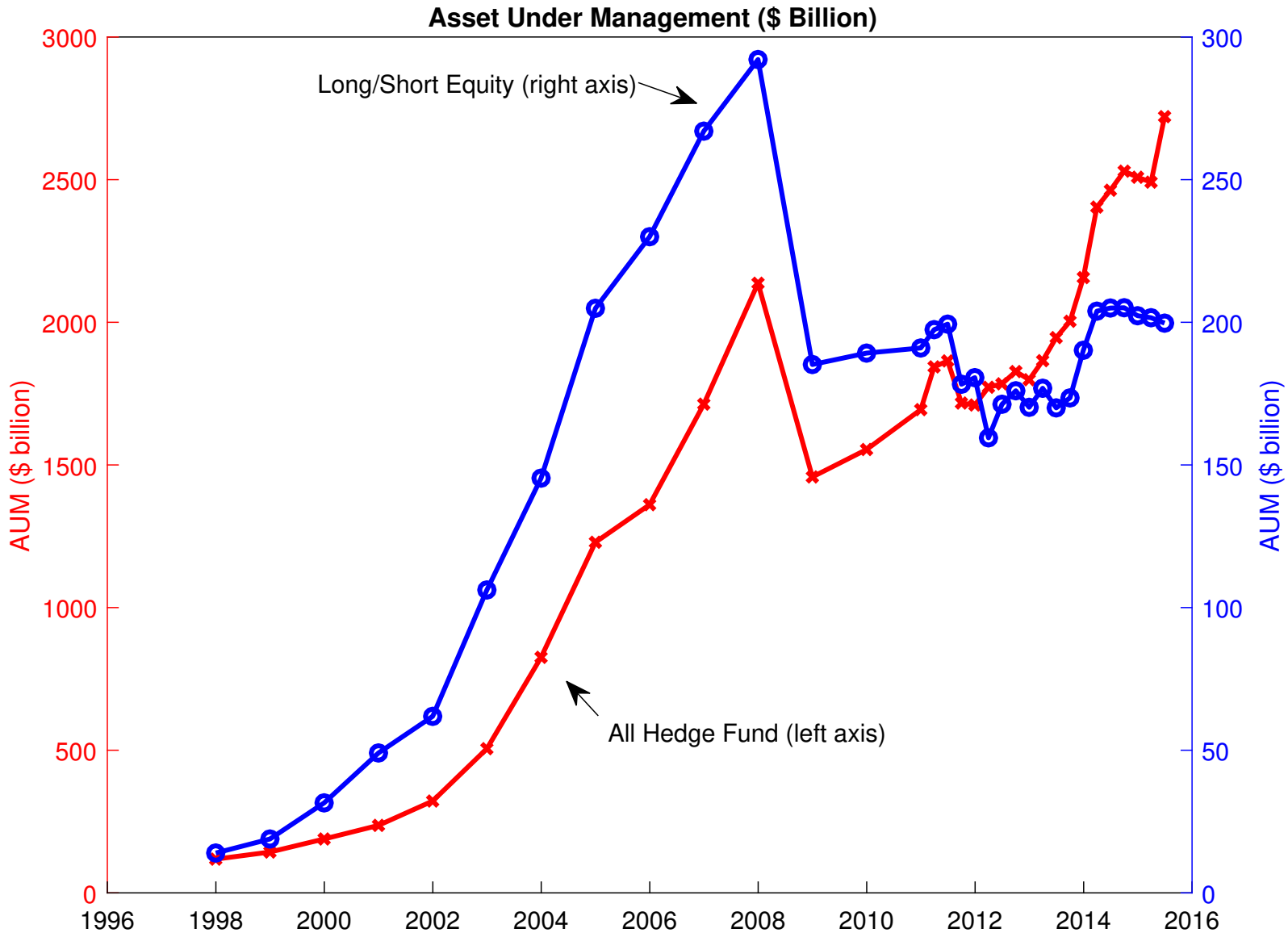
GSAM's Global Equity Opportunities

- +1000 positions on individual stocks.
- Market neutral and industry neutral.
- +$24 billion and -$24 billion with 6$ billion AUM.
- The average holding period: in months.
- Correlation with different quant shops: very low.



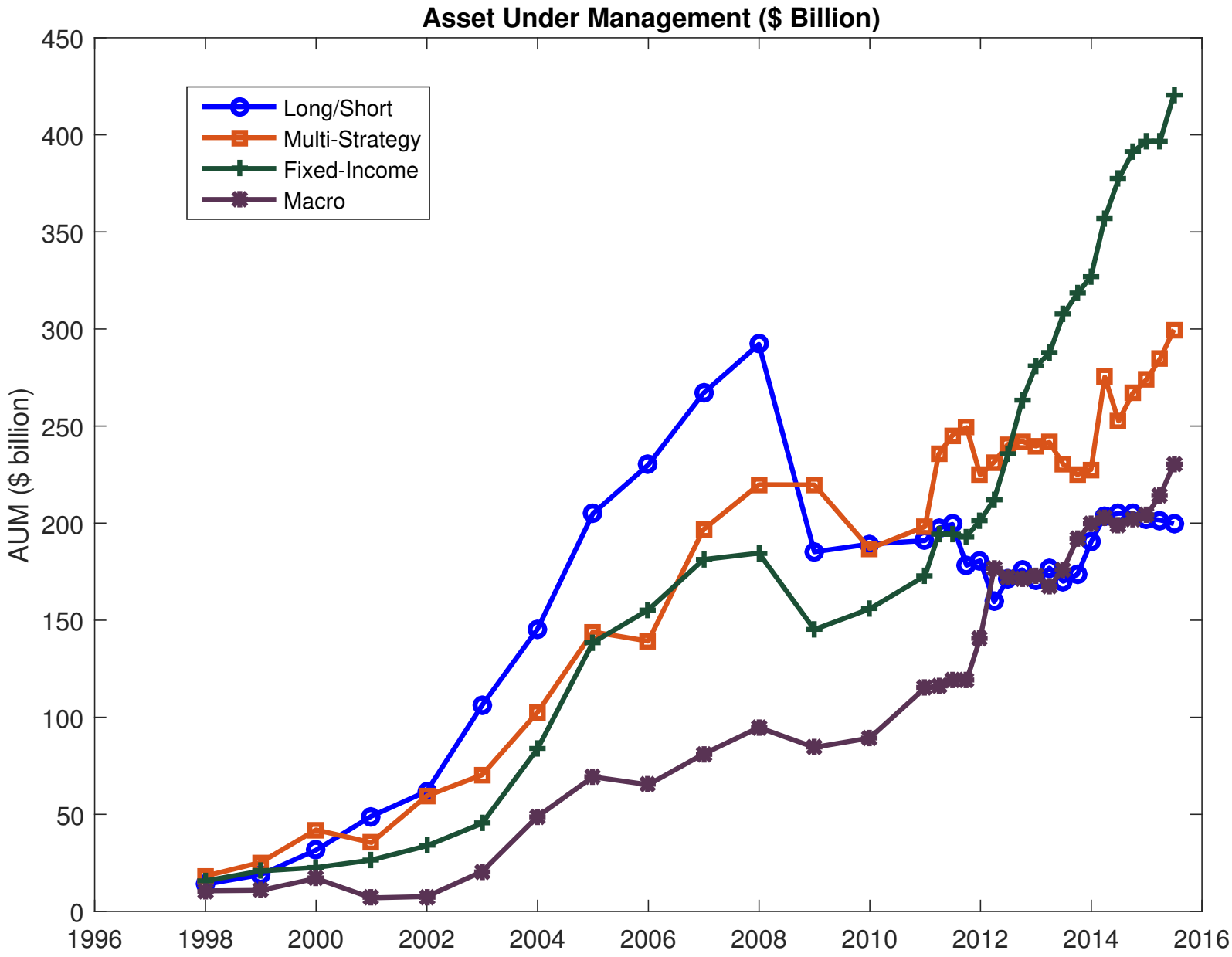
Source: Prof. Kent Daniel and Bob Litterman

The growth of the hedge fund industry



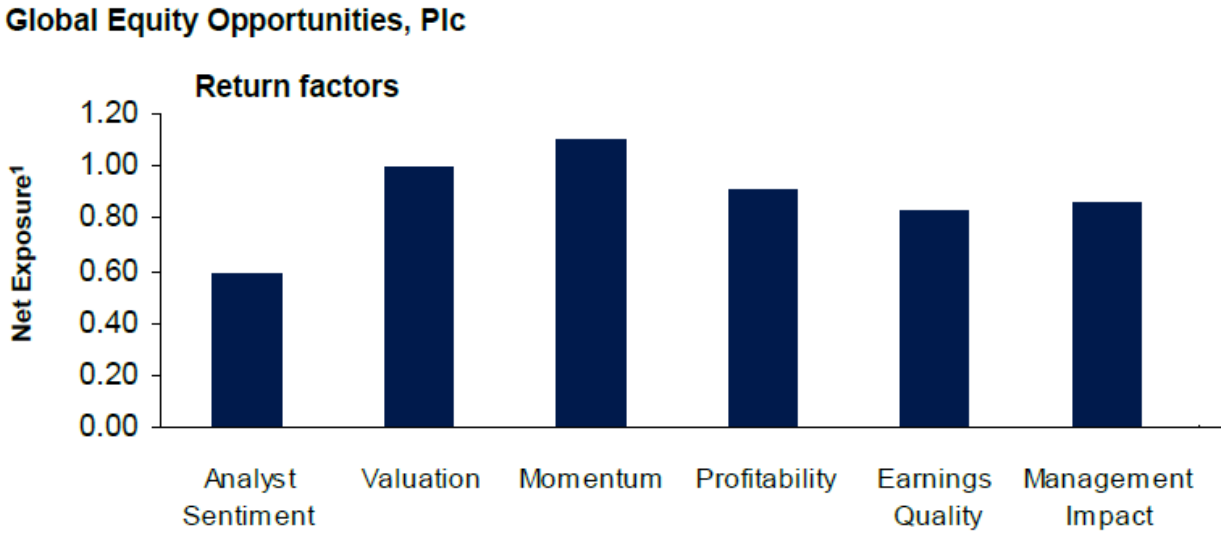
Source: BarclayHedge

The growth of the hedge fund industry, a few selected styles



GSAM's Global Equity Opportunities

- Up to June 2007, the average annual return was 15%, and volatility 10%.
- $10\%/\sqrt{52}$: 1.4% per week.
- In July 2007, down by -15%.
- From August 1 through 10, down by -30%.



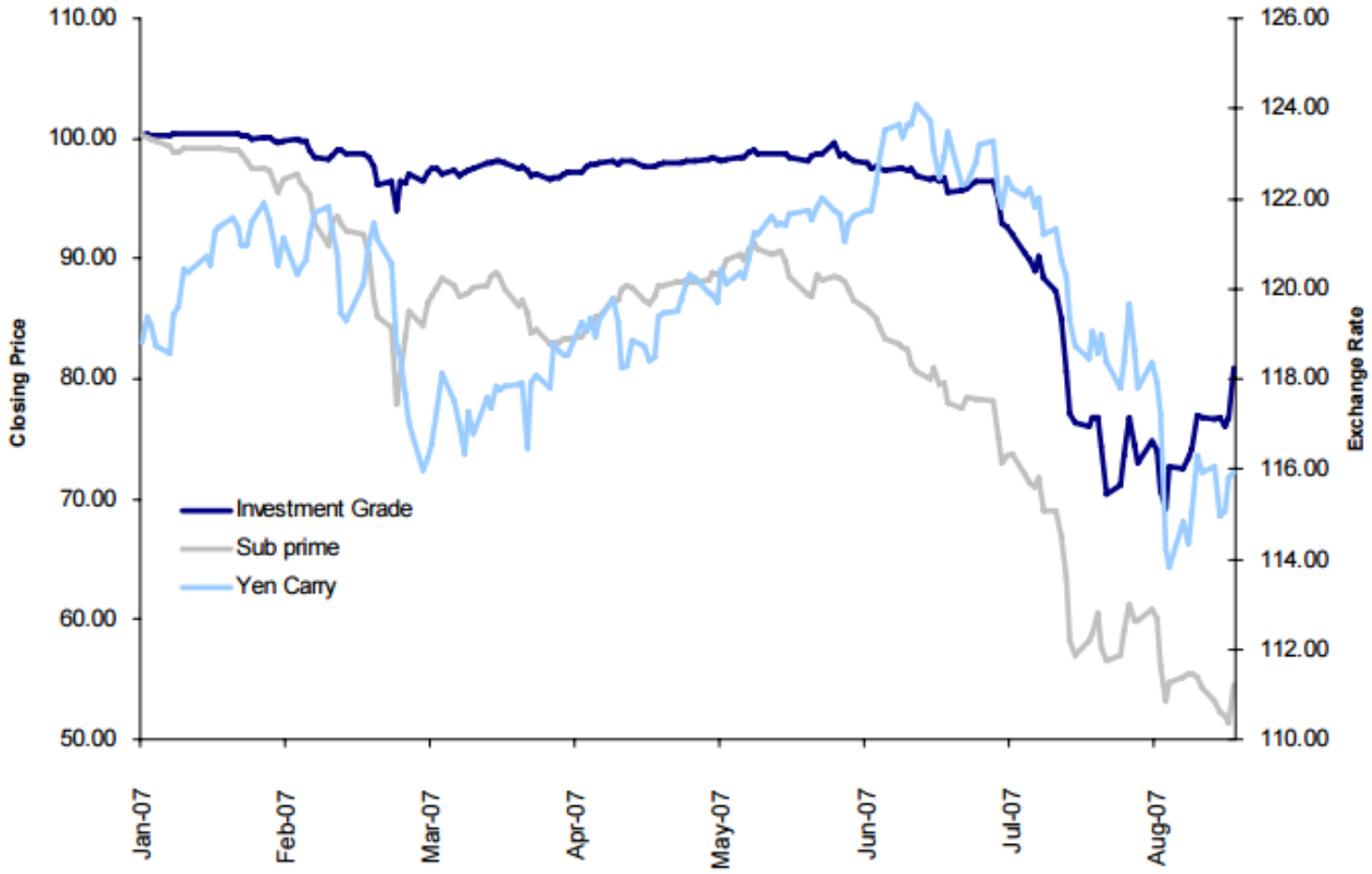
Source: Prof. Kent Daniel and Bob Litterman

Crowded Trades and Over-Used Signals:

- By now, the well-established patterns such as value, size, and momentum have become common knowledge among money managers.
- Having a lot of institutional size money invested on the same set of well established trading strategies has become a problem for this space.
- Over-used signals in a over-crowded space: factor investing creates unwanted "quant risk."
- The 2007 quant meltdown is such an example. Lesson learned:
  - Cannot be too big: whale.
  - Cannot be too crowded: every runs for the exit.
  - Cannot be too transparent: front running.

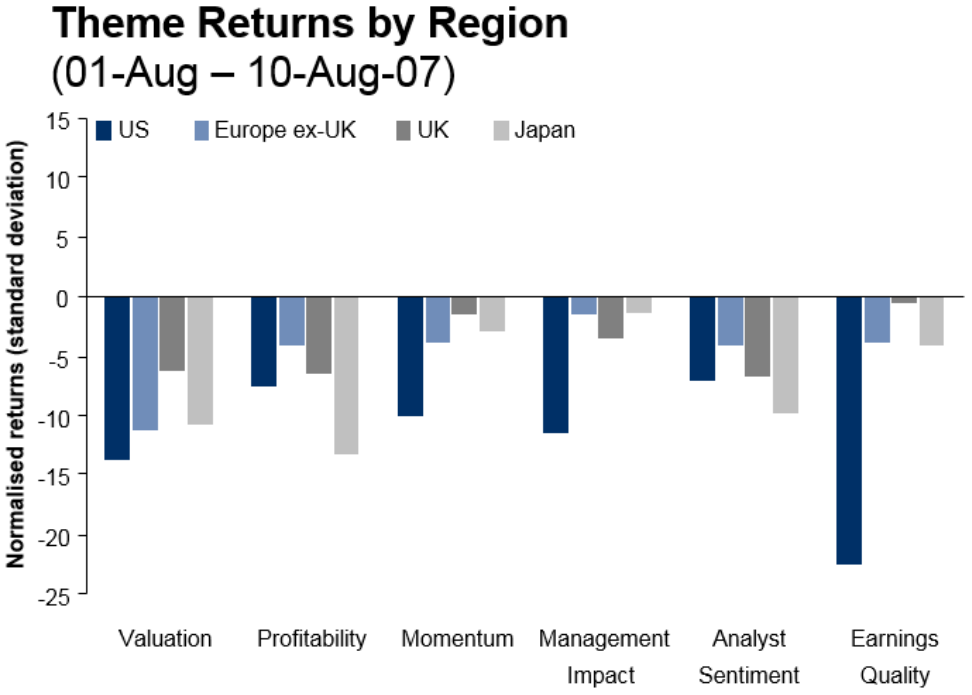
Disruptions outside of quant investing:

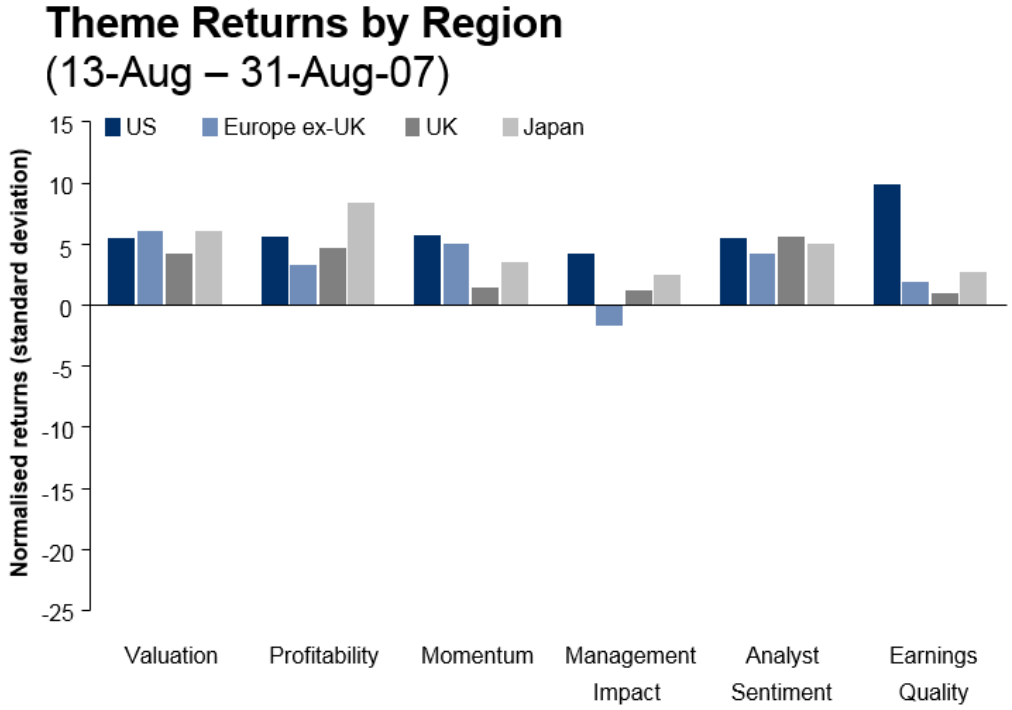
- Sub-prime mortgage market disruption (ABX BBB-Tranch).
- Spillover to investment-grade credit markets.
- Spillover to yen carry trade (USD/Yen exchange rate).



Contagion in Quant Factors:

- Multi-strategy hedge funds, with losses in illiquid mortgage and credits, used the liquid holdings in their quant strategies to raise more cash.
- The meltdown affected virtually all quant factors in every major region. A 20-sigma drawdown for GSAM's Global Equity Opportunities Fund:





What Next?

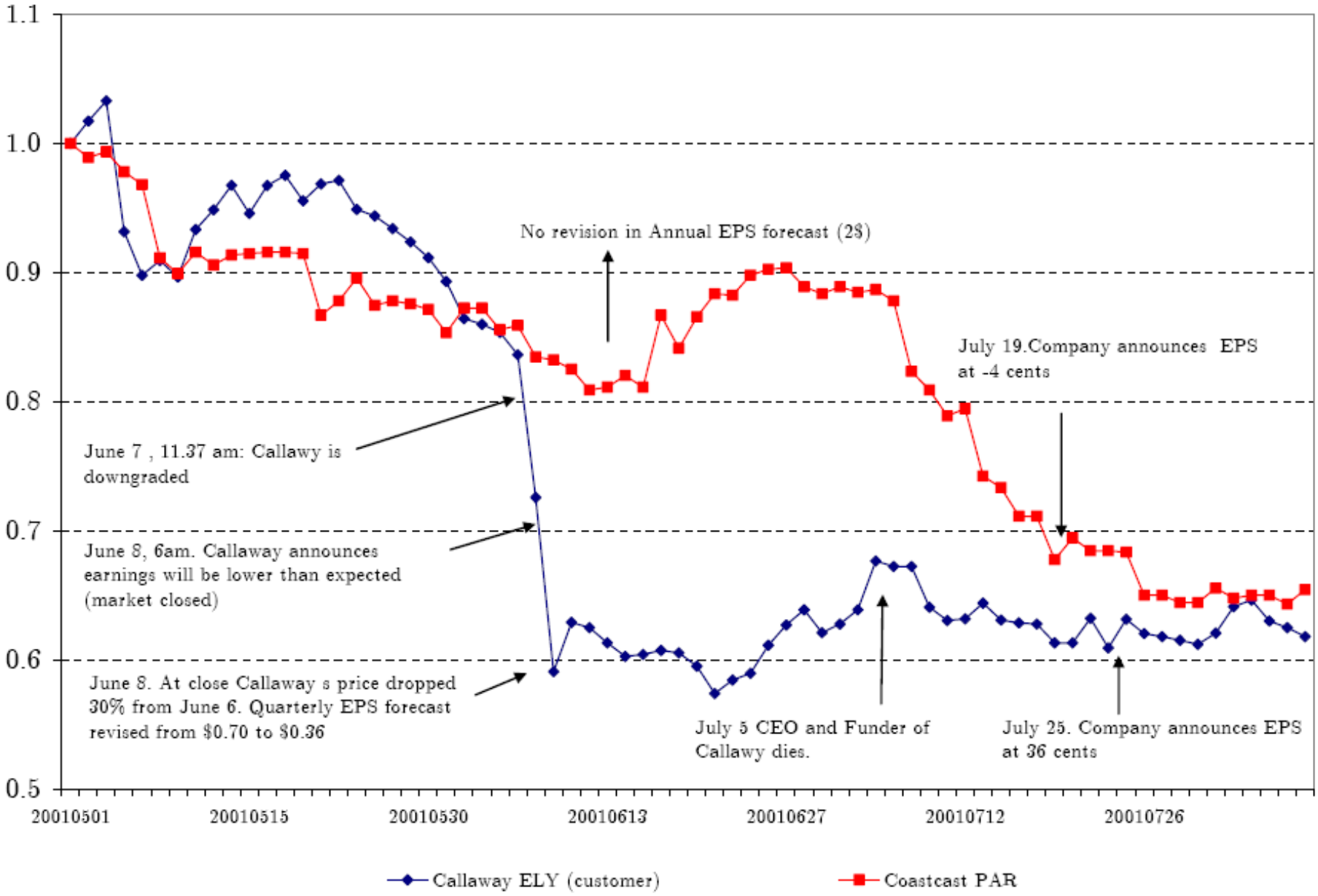
- The search for new quant signals is still on, but this area is just not as exciting and creative as it was 10 or 15 years ago.
- An alpha that looks good on paper does not necessarily translate to real alpha. Transaction costs: price impact, especially when trading an institutional-size portfolio; and short-sale constraints.
- Some quant signals work only in small to medium stocks, but not large cap stocks. Some worked in the past, but have since disappeared.
- The push to equity mutual funds and ETFs is on going. Since 200907, AQR offers momentum funds for large-cap (AUM: $1B) and small-cap (AUM: $432M); Since 201304, Blackrock offers iShares momentum factor ETF ($870M).
- In this long-only space, a large portion of the risk exposure comes not from the quant signal, but from the market risk.

Portfolio returns of stocks, sorted by their options trading volume (put/call ratio)

	day relative to portfolio formation										
	0	+1	+2	+3	+4	+5	+6	+7	+8	+9	+10
Panel A: average daily returns of PC-ranked portfolios (in basis points)											
low PC	31.4	25.0	15.5	12.1	11.4	10.2	9.3	6.9	8.7	7.2	7.8
PC 2	28.6	27.2	12.1	8.3	6.8	6.1	7.3	3.7	4.2	4.6	3.9
PC 3	15.5	12.5	7.1	6.1	5.4	5.6	4.6	4.6	5.2	6.4	3.6
PC 4	13.0	-0.3	3.1	2.1	6.4	4.7	5.2	6.4	6.1	5.1	7.2
high PC	-5.9	-14.6	-6.1	-0.8	-0.7	1.4	3.2	4.3	4.0	4.3	3.7
Panel B: average daily returns of low-PC minus high-PC (in basis points)											
	37.4	39.6	21.6	12.9	12.1	8.8	6.2	2.6	4.7	2.9	4.1
t-stats	19.77	23.79	13.11	8.18	7.77	5.50	3.86	1.67	2.94	1.80	2.62

"The information in option volume for future stock prices" by Pan and Poteshman, *Review of Financial Studies,* 2006.

The economic link between customers and suppliers



Portfolio returns of suppliers, sorted by past returns of their customers

Value weights	xret	alpha	MKT	SMB	HML	UMD	R^2
Q1 (low)	-0.596 [-1.42]	**-0.821** [-2.93]	**0.989** [14.31]	**0.384** [4.47]	**-0.318** [-3.10]	**-0.235** [-3.88]	0.626
Q2	-0.157 [-0.41]	**-0.741** [-3.28]	**1.057** [17.57]	**0.307** [4.10]	-0.115 [-1.28]	-0.022 [-0.42]	0.658
Q3	0.125 [0.32]	-0.488 [-1.89]	**1.063** [16.81]	**0.309** [3.92]	-0.09 [-0.96]	-0.029 [-0.52]	0.633
Q4	0.313 [0.79]	-0.193 [-0.72]	**1.039** [14.43]	**0.217** [2.42]	-0.15 [-1.40]	-0.076 [-1.20]	0.564
Q5 (high)	**0.982** [2.14]	**0.556** [1.99]	**0.982** [13.80]	**0.681** [7.69]	**-0.363** [-3.43]	-0.056 [-0.90]	0.650
L/S	**1.578** [3.79]	**1.376** [3.13]	-0.007 [-0.07]	0.296 [1.26]	-0.045 [-0.28]	0.179 [1.93]	0.041

"Economic links and predictable returns" by Cohen and Frazzini, *Journal of Finance,* 2008.

Currency Carry Trade

- Take long position on "asset/target" currencies with high interest rates.
- Borrow from "funding" currencies with low interest rates.
- The Japanese Yen is the most often used funding currency (Yen Carry).
- Two drivers for returns:
  - The interest rate differential (positive carry).
  - Gain/loss in the spot market when unwind the trade.
- On average, currency carry trade is a profitable trading strategy, but is sensitive to the liquidity condition of the global markets.
- Large losses in currency carry were often incurred during global sell-off of risky assets (flight to quality). Accompanied with the large losses in currency carry is the sudden strengthening in Yen (or other funding currencies) as carry traders seek to unwind their trades.

A Portfolio Approach to Currency Carry

- Let's use USD as an anchor and calculate portfolio returns from the perspective of a US investor: in month t, borrow in USD and buy the foreign currency; in month t+1, unwind the trade.
- Let i^* and i be the foreign and US one-month risk-free rates. At month t, sort all currencies by interest rate differentials $i^* - i$ into 6 groups:
  - group 6: funding currencies with the lowest interest rates
  - group 1: target currencies with the highest interest rates.
- Calculate the realized return in month t+1, and equal weight all currencies within each of the 6 groups.
- The number of available currencies varies over time. For the period from 1987 through 2011, the sample starts with 17 currencies and reaches a maximum of 34 currencies. Since the launch of Euro in January 1999, the sample covers 24 currencies.

Portfolios Returns of Currency Carry

	Portfolio Rank	exret (%)	CAPM beta	CAPM alpha (%)
"target" currency	1	0.79 [4.56]	0.19 [3.08]	0.69 [3.22]
	2	0.35 [2.39]	0.17 [3.64]	0.26 [1.55]
	3	0.28 [2.14]	0.12 [2.36]	0.22 [1.39]
	4	0.15 [1.21]	0.08 [1.91]	0.11 [0.77]
	5	-0.05 [-0.38]	0.07 [1.53]	-0.08 [-0.58]
"funding" currency	6	-0.18 [-1.37]	0.01 [0.24]	-0.18 [-1.30]

Monthly Data from January 1987 through December 2011