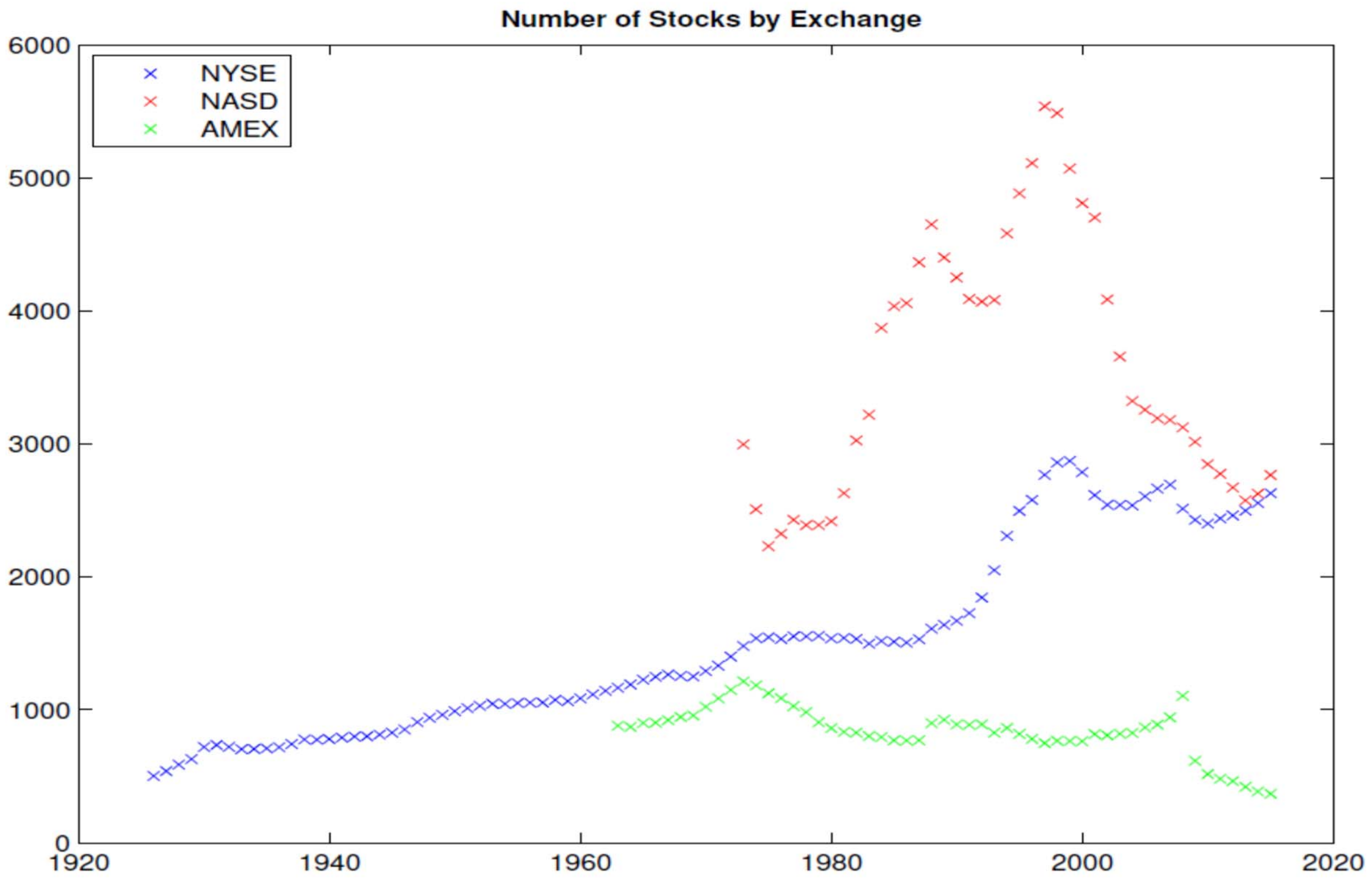
Lecture 4

Moving Beyond the CAPM - Equity Returns in Cross Section (Part 1)

In Search of Alpha

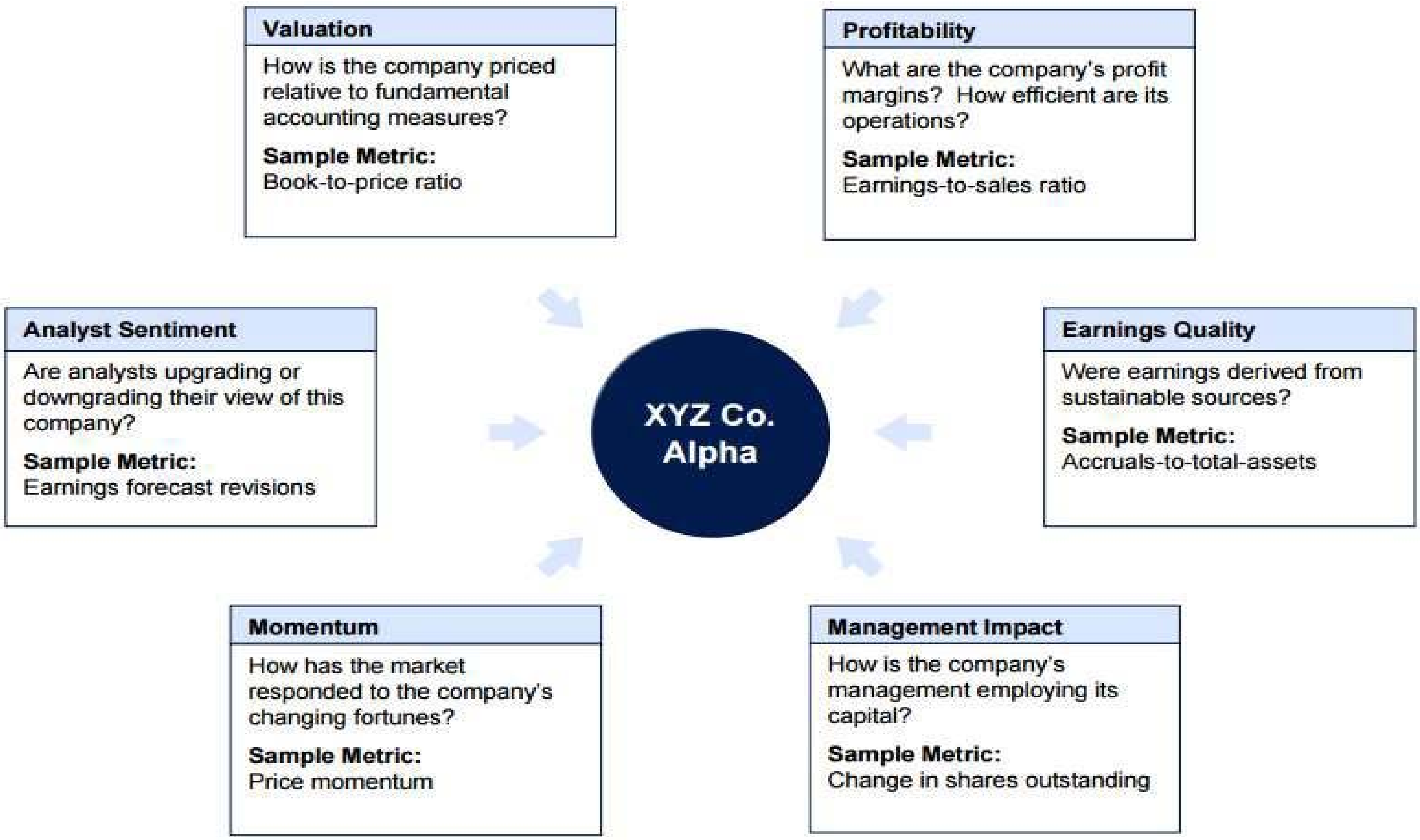
- According to Theory
  - The CAPM: No way.
  - Believers of market efficiency: no true alpha, only beta in disguise.
  - Behavioral finance: true alpha caused by behavioral biases.
- In Practice
  - Stock picking: understand your stock, focus on the stories.
    (Examples: Warren Buffett, Peter Lynch)
  - 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

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.


Valuation
How is the company priced relative to fundamental accounting measures?
Sample Metric:
Book-to-price ratio
Profitability
What are the company's profit margins? How efficient are its operations?
Sample Metric:
Earnings-to-sales ratio
Analyst Sentiment
Are analysts upgrading or downgrading their view of this company?
Sample Metric:
Earnings forecast revisions
XYZ Co. Alpha
Earnings Quality
Were earnings derived from sustainable sources?
Sample Metric:
Accruals-to-total-assets
Momentum
How has the market responded to the company's changing fortunes?
Sample Metric:
Price momentum
Management Impact
How is the company's management employing its capital?
Sample Metric:
Change in shares outstanding

Statistical treatment of data in practice – key observations

1. When working with a single time series (asset or portfolio), calculate standard error of estimates using Newey-West standard errors

2. If you have the standard error for an estimate, the estimate divided by the standard deviation is a t-statistic and in finance applications there are enough degrees of freedom that it is effective normally distributed (z-statistic).

3. Can report standard error, t-stat, or p-value. They all have the same information content. Magic number is t-stat bigger than 2 (really 1.96), equiv. p-value<.05.

4. Single time series of excess returns regressed against just a constant with Newey-West standard errors will give you the estimated mean return adjusted for serial correlation (std. errors almost always go up when using Newey-West)

5. To test differences in returns between the time series returns of two portfolios, calculate the difference and regress this against a constant (again use Newey-West)

Statistical treatment of data in practice – key observations (continued)

6. If you regress portfolio time-series return against any contemporaneous measured variable(s), the constant will be the unexplained part of the return on the slopes will be the explained part of the return.

7. Sometimes constant in this regression is called alpha. If take difference in returns across portfolio as dependent variable and run regression than you have a test for differences in mean returns holding constant control variables

8. We will often say “returns” when we mean “excess returns”

9. Lesson from last class, returns and alphas for different portfolios sorted by estimated past betas do not line up well with CAPM predictions

Searching for alpha or risk factors - univariate sorts

1. Create portfolios by sorting all stocks or assets in database by some characteristic that you believe may be related to returns (e.g., firm size)

2. Typical sorts based on terciles, quintiles, deciles, etc. Sometimes these percentiles are calculated from a subset of the sample (NYSE stocks rather than all stocks)

3. In each period, assign stocks into a portfolio based on where the firm stands at that point in time using current or lagged information [e.g., for quintiles based on mktcap, SIZE1 (smallest), SIZE2, SIZE3, SIZE4, SIZE5 (largest)]

4. Each period (say monthly), re-sort, construct portfolio, calculate (excess) return of portfolio over next period. This creates a time series of returns for each portfolio.

5. In calculating return of portfolio, must decide on weighting scheme (equally-weighted or value-weighted or some combination thereof)

Searching for alpha or risk factors - univariate sorts (continued)

6. Mean of the time series of returns for the portfolio can be calculated as estimated constant in regression with no controls, with statistical significance adjusted for serial correlation as discussed above

7. Mean differences in returns for two portfolios can also be calculated the same way. It is typical to look at mean returns of all groups and then to test the difference between the highest and the lowest.

8. A significant pattern across the groups and/or differences between highest and lowest suggests a possible source of alpha or a new risk factor

9. Can follow the same process but control for other variables (e.g., market excess returns) in the regressions. You would then look for patterns in the constant and test for differences. In this case you are looking for alpha or a risk-factor holding constant known sources of risk (i.e., market excess returns).

Average Returns of Portfolios Sorted on β, *MktCap*, and *BM*

This table presents the average excess returns of equal-weighted portfolios formed by sorting on each of β, *MktCap*, and *BM*. The first column of the table indicates the sort variable. The columns labeled 1 through 7 present the time-series average of annual one-year-ahead excess portfolio returns. The column labeled 7-1 presents the average difference in return between portfolios 7 and 1. t-statistics testing the null hypothesis that the average portfolio return is equal to zero, adjusted following Newey and West (1987) using six lags, are presented in parentheses.

Sort Variable	1	2	3	4	5	6	7	7-1
β	16.47	13.89	14.55	12.79	11.99	10.92	10.43	−6.04
	(4.55)	(5.74)	(5.83)	(6.73)	(6.57)	(6.06)	(3.43)	(−1.31)
MktCap	29.08	16.85	12.16	10.12	8.47	9.25	8.19	−20.89
	(7.00)	(5.48)	(4.55)	(5.23)	(5.97)	(5.93)	(4.32)	(−4.80)
BM	7.61	6.65	11.06	13.55	13.74	17.50	25.21	17.59
	(3.47)	(4.21)	(6.67)	(7.43)	(6.51)	(6.37)	(8.77)	(8.28)

Searching for alpha or risk factors - bivariate sorts

1. Perhaps in the above chart size and book-to-market are highly negatively correlated so they are both really picking up the same pattern

2. Sort on both characteristics.
   - (A) Unconditional sort, pick size terciles and BM terciles and create 3x3 = 9 bins which each stock gets assigned to at the start of each period.
   - (B) Conditional sort, first pick 3 size groups based on terciles, then divide each size tercile into terciles based on BM

3. Go look at the mean excess returns of these 9 portfolios and search for patterns and differences between groups (again use Newey-West standard errors)

4. Equal-weighting versus value-weighting issue within each portfolio still remains

5. Can also look at alphas after controlling for some determinants of returns (e.g., market excess return)

Bivariate Independent-Sort Portfolio Analysis—Control for *MktCap*

This table presents the results of bivariate independent-sort portfolio analyses of the relation between *BM* and future stock returns after controlling for the effect of *MktCap*. Each month, all stocks in the CRSP sample are sorted into five groups based on an ascending sort of *MktCap*. All stocks are independently sorted into five groups based on an ascending sort of *BM*. The quintile breakpoints used to create the groups are calculated using all stocks in the CRSP sample. The intersections of the *MktCap* and *BM* groups are used to form 25 portfolios. The table presents the average one-month-ahead excess return (in percent per month) for each of the 25 portfolios

Panel A: Equal-Weighted Portfolios

	MktCap 1	*MktCap* 2	*MktCap* 3	*MktCap* 4	*MktCap* 5	*MktCap* Avg	*MktCap* 5-1	*MktCap* 5-1 CAPM α
BM 1	1.12	−0.09	0.04	0.29	0.37	0.34	−0.75	−0.68
							(−1.96)	(−1.83)
BM 2	1.25	0.38	0.60	0.61	0.50	0.67	−0.75	−0.71
							(−2.41)	(−2.33)
BM 3	1.65	0.76	0.77	0.72	0.60	0.90	−1.05	−1.13
							(−2.99)	(−2.48)
BM 4	1.52	0.84	0.87	0.88	0.65	0.95	−0.87	−0.82
							(−3.48)	(−3.35)
BM 5	1.73	1.06	0.96	0.96	0.70	1.08	−1.03	−1.02
							(−3.94)	(−3.89)
BM Avg	1.46	0.59	0.65	0.69	0.56		−0.89	−0.87
							(−3.24)	(−3.16)
BM 5-1	0.61	1.15	0.92	0.67	0.34	0.74		
	(2.31)	(4.80)	(3.83)	(2.89)	(1.72)	(3.65)		
BM 5-1 CAPM α	0.80	1.31	1.09	0.83	0.46	0.90		
	(3.21)	(5.51)	(4.66)	(3.45)	(2.33)	(4.51)		

Panel B: Value-Weighted Portfolios

	MktCap 1	*MktCap* 2	*MktCap* 3	*MktCap* 4	*MktCap* 5	*MktCap Avg*	*MktCap* 5-1	*MktCap* 5-1 CAPM α
BM 1	0.48	−0.07	0.08	0.30	0.35	0.23	−0.13	0.02
							(−0.32)	(0.04)
BM 2	0.76	0.37	0.59	0.61	0.43	0.55	−0.34	−0.24
							(−1.06)	(−0.78)
BM 3	1.01	0.75	0.79	0.70	0.45	0.74	−0.56	−0.52
							(−1.89)	(−1.64)
BM 4	1.09	0.87	0.87	0.89	0.53	0.85	−0.57	−0.50
							(−2.15)	(−1.96)
BM 5	1.31	1.05	0.95	0.96	0.55	0.97	−0.76	−0.72
							(−2.96)	(−2.86)
BM Avg	0.93	0.60	0.66	0.69	0.46		−0.47	−0.39
							(−1.66)	(−1.46)
BM 5-1	0.83	1.12	0.87	0.66	0.20	0.74		
	(3.10)	(4.58)	(3.57)	(2.83)	(1.04)	(3.65)		
BM 5-1 CAPM α	1.01	1.28	1.05	0.81	0.27	0.88		
	(3.92)	(5.22)	(4.39)	(3.39)	(1.38)	(4.40)		

Moving to regressions – Fama-MacBeth

1. What about trivariate sorts? Starts to get messy.

2. Impose regression structure and much easier to look at many characteristics that predict returns. Comes at a cost, you are imposing a functional structure on the data (typically linear)

3. Fama-MacBeth approach is the standard way to do this

4. In each period (say month), regress excess returns in next period (month) against control variables (say market beta, size, and BM). Can do this at the individual asset level or at the portfolio level. Since betas are estimated rather than known, usually use portfolios if beta is one of the characteristics in the model.

5. Overall estimated relation is average of coefficients over the entire set of regressions. Standard errors are just calculated based on the average of the time series (again, best to Newey-West adjust)

FM Regression Results

This table presents the results of FM regressions of future stock excess returns (r_{t+1}) on beta (β), size (*Size*), and book-to-market ratio (*BM*). The columns labeled (1), (2), and (3) present results for univariate specifications using only β, *Size*, and *BM*, respectively, as the independent variable. The column labeled (4) presents results from the multivariate specification using all three variables as independent variables. *t*-statistics, adjusted following Newey and West (1987) using six lags, are presented in parentheses.

	(1)	(2)	(3)	(4)
Intercept	14.97	23.23	9.83	21.74
	(5.55)	(5.32)	(5.94)	(4.75)
β	−2.73			0.96
	(−1.47)			(0.57)
Size		−2.29		−2.49
		(−3.69)		(−4.37)
BM			4.77	3.08
			(6.51)	(3.89)
Adj. R^2	0.011	0.009	0.005	0.023
n	5221	5584	4270	4261

Using this evidence to create risk factors

1. Any measurable contemporaneous or lagged characteristic that can predict returns can be used as the basis of constructing a risk factor

2. Create portfolios that pick up the returns to this characteristic.

3. SMB and HML are the two most famous/earliest risk factors of this type (after the market excess return or MKT/MKTRF). Basis of the Fama-French 3 Factor Model

4. Actual construction of the factors is a bit of a mess. Combination of equal and value weighting, sorting with a lag.

5. There is no correct choice, but given the 2^N problem, French has become the gatekeeper of the factors and his website provides all details. Widely used.

6. Any new profitable (or risky) portfolio trading rule should have positive alpha when regressed against the FF3 risk factors.

5x5 Portfolios -- FF3 vs. CAPM

s5 is smallest stocks with highest book-to-market
s5x is returns of this group minus risk free rate (excess returns)

. regress s5x mkt smb hml

s5x	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
mktexcess	.9743696	.0167245	58.26	0.000	.9415458	1.007193
smb	1.389856	.0264813	52.48	0.000	1.337883	1.441829
hml	.9366088	.0238982	39.19	0.000	.8897057	.9835118
_cons	.0630688	.0851536	0.74	0.459	-.104055	.2301926

. regress s5x mkt

s5x	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
mktexcess	1.402751	.0372423	37.67	0.000	1.329659	1.475843
_cons	.5740262	.2048304	2.80	0.005	.1720241	.9760284

3x3 Portfolios

shx = returns of smallest firms with highest book-to-market minus risk free

regress shx mkt smb hml

shx	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
mktexcess	1.029804	.0049742	207.03	0.000	1.020041	1.039566
smb	.9240932	.0078761	117.33	0.000	.9086355	.9395508
hml	.7852391	.0071078	110.48	0.000	.7712892	.799189
_cons	.0188853	.0253264	0.75	0.456	-.0308207	.0685912

blx = returns of largest firms with lowest book-to-market minus risk free

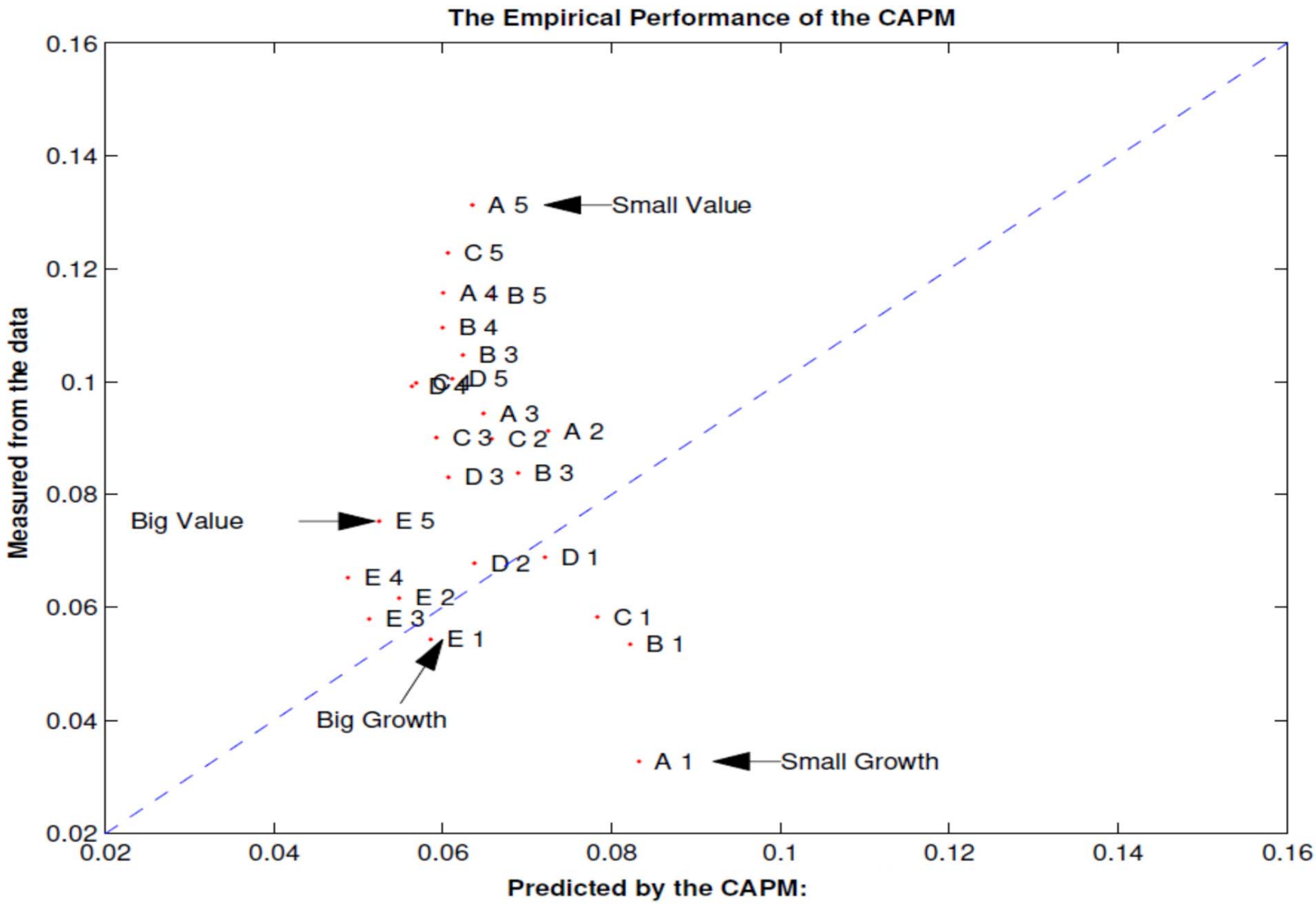
regress blx mkt smb hml

blx	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
mktexcess	1.021254	.0051017	200.18	0.000	1.011242	1.031267
smb	-.0975947	.0080779	-12.08	0.000	-.1134485	-.0817408
hml	-.221661	.00729	-30.41	0.000	-.2359684	-.2073536
_cons	.0610674	.0259755	2.35	0.019	.0100876	.1120473

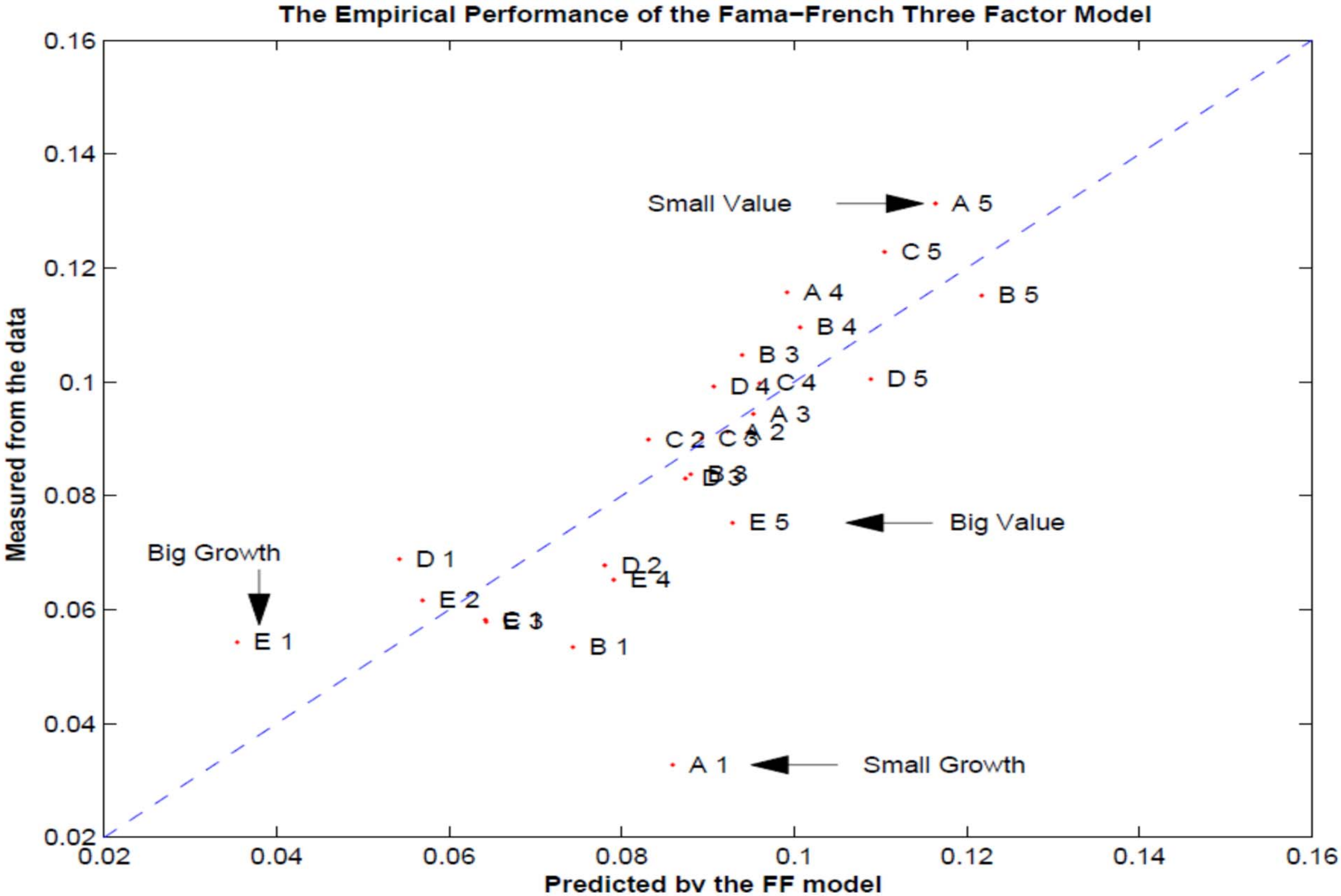
Visualizing the Evidence

1. Using this approach, you could look at alphas of any set of portfolios you construct based on a characteristic that you think may be related to returns

2. It is common to graph the mean return for the portfolio against the expected return from the regression model with the constant included. The vertical distance from a line with the slope of 1 is the graphical representation of the alpha of the portfolio.



The Empirical Performance of the CAPM
Measured from the data
Predicted by the CAPM:
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 4
D 5
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



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

Warnings on searching for factors

1. Data mining/snooping is a very big problem

2. Could try to look for sources of alpha over one time period (some will look like alpha just by chance) and then see if the rule works in a future period (or different market/country)

3. If source of alpha becomes publicly known and does not the disappear, that would tend to favor a risk explanation which means no free lunch

4. If source of alpha becomes publicly known and it does disappear, it maybe was a free lunch but it is not available any more!