JOHNSON
Cornell University

NBA 5420: Investment and Portfolio Management

Class 5: Factor Investing

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Factor investing

- The “in-between” view
  - Between passive investing and speculative investing

- Some aspects of markets are weakly predictable in the long-run if you look at well-defined risk factors

BASICS OF FACTOR MODELS

Asset returns are highly correlated

- Asset returns are correlated because the same common factors affect most firms
  - For example, there is evidence that "value", "size" and "momentum" factors affect returns
  - Another set of factors are macroeconomic:
    - For instance, a GDP factor would explain why when expectations about future GDP go up, cyclical firms such as autos have higher returns
    - Also money-supply changes, prices of raw materials, industry factors, etc.

A factor model specifies that

- A firm's return can be decomposed into:
  - A common factor (or factors)
  - A part specific to the firm (the idiosyncratic part)

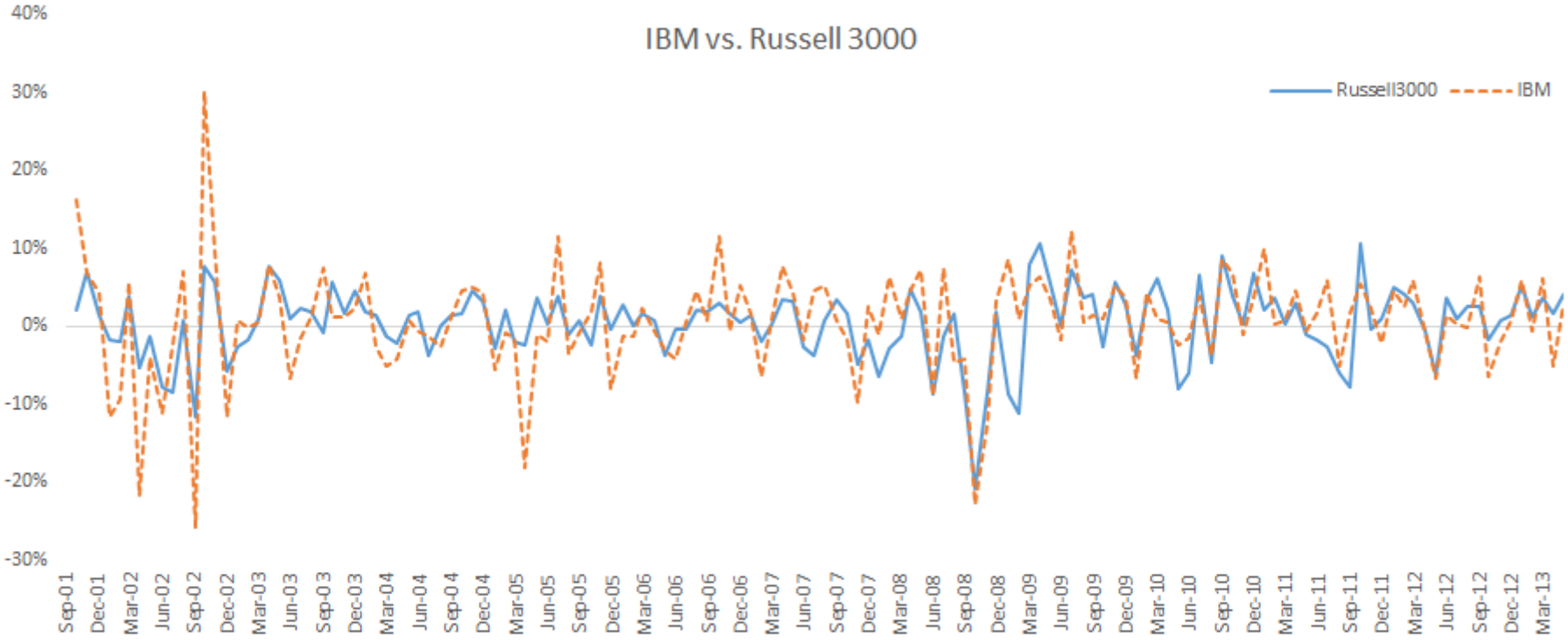
- For example, the CAPM (a one-factor model, with the factor being the market return) says:

$$R_i - r_f = \alpha_i + \beta_i \underbrace{(R_m - r_f)}_{\text{systematic}} + \underbrace{e_i}_{\text{idiosyncratic}}$$

Recall that R^2 of a regression is the % of variation explained by the regressors (RHS variables)

- So the R^2 from this regression will be the proportion of systematic risk
- $(1 - R^2)$ is the proportion of idiosyncratic risk

The market factor explains a lot



Run this regression for each stock i. Collect the β_i's for each stock i

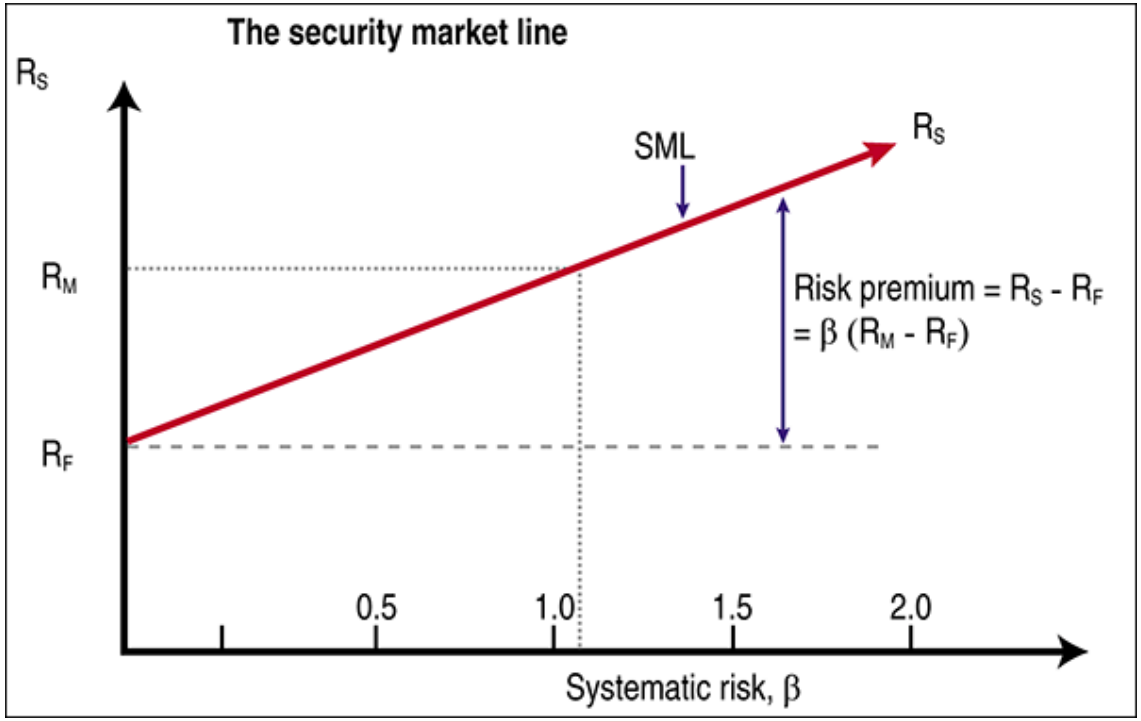
$$R_i - r_f = \alpha_i + \beta_i (R_m - r_f) + e_i$$

CAPM

CAPM predicts in the cross-section of stocks:

- Stocks with higher systematic risk (higher β_i) earn higher expected return

$$E(R_i - r_f) = \beta_i \, E(R_m - r_f)$$



CAPM procedure summarized

1. For each stock, regress stock returns on market returns in the time series to get β_i for each stock
   - As in the plot of IBM stock two slides back
   - This gets you IBM's "beta": β_{IBM}

2. Second, plot the cross-sectional average returns: plot β_i vs. average returns $E(R_i - r_f)$ for each stock i
   - As in the graph on the previous slide
   - Higher beta stocks should have higher average returns

CAPM

- In the CAPM, the market return r_M summarizes everything that is common to all firms and relevant to determine the rate of return on their stocks.

$$E(R_i - r_f) \quad = \quad \beta_i \, E\left(R_m - r_f\right)$$

where $\beta_i = \frac{Cov(r_i, r_M)}{Var(r_M)}$ = "correlation" of stock i with the market

- In general, β_i is asset i's *sensitivity to the factor*, also called the "factor loading" or "factor beta".
  - In the case of CAPM, where the common factor is the market return, the factor loading β_i is simply called the asset's "beta."

Three-factor models

- But maybe we need more than one factor
- In order to do arbitrage using APT (later in this presentation), factors need to be tradeable
  - Meaning these factors must be returns of actual portfolios of stocks
- Fama and French (1993) add 2 additional factors, “size” and “value”, to explain variability of individual stocks in the time series.
- The Fama-French Three-Factor Model:

$$\begin{aligned}(R_i - r_f) = \quad & \alpha_i + \beta_i^{mkt}(R_m - r_f) \\ & + \beta_i^{size}(R_{SMB}) \\ & + \beta_i^{value}(R_{HML}) + e_i\end{aligned}$$

Fama-French: "Size" & "Value" Factors

For the "value" factor R_{HML}:

- Each July 1, look at (Book / Market) for each stock.
  1. Top 30% of stocks by (Book/Market) go in the "high" (value-weighted) portfolio
  2. Bottom 30% of stocks by (Book/Market) go in the "low" (value-weighted) portfolio
  - Form a long-short portfolio with the long position in the "high" portfolio and the short position in the "low" portfolio

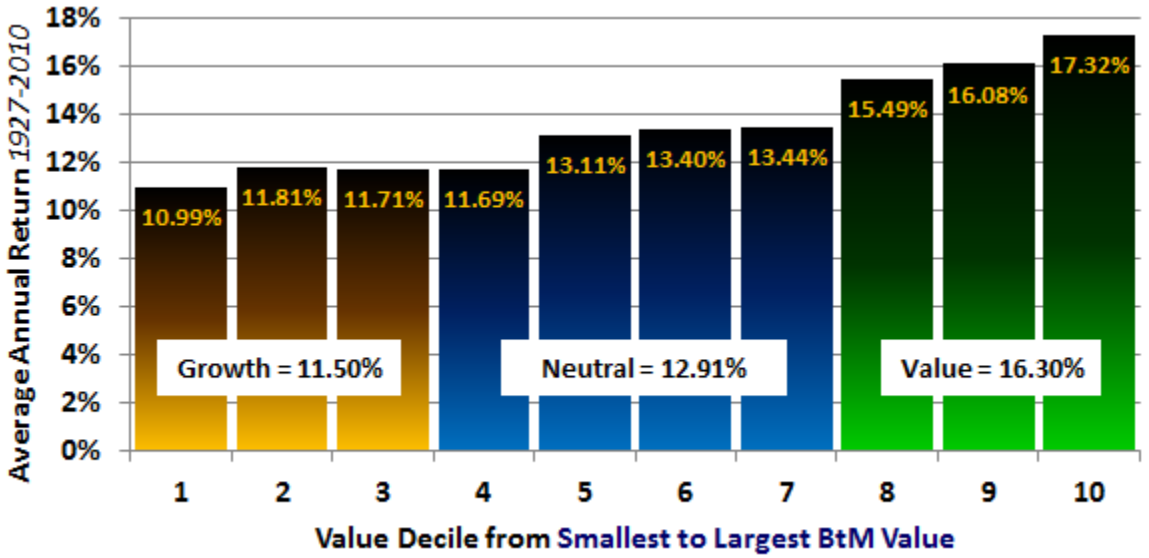
- Calculate the returns on this portfolio $R_{HML} = (R_{high} - R_{low})$. This is your "value" factor for the following year

For the "size" factor R_{SMB}:

- Do the same using Market Cap instead of (Book/Market)

Value beats growth

- "Value stocks" defined as high book to market
- "Growth stocks" defined as low book to market



"Value premium" = $E[R_{HML}]$ = 16.3 - 11.5 = 4.8%

Other factors

- Momentum:
  - Each July 1, sort stocks based on previous year's returns
    - Top 30% = stocks that went up the most
      = "winner" portfolio
    - Bottom 30% = stocks that went down the most
      = "loser" portfolio
  - Momentum portfolio returns = $R_{MOM} = R_{winner} - R_{lower}$
- Can do this to construct a variety of other factors:
  - Low volatility = $R_{LowVol} – R_{HighVol}$
  - "Quality" = $R_{HighEarningsStability} - R_{LowEarningsStability}$

What can we do with these factors?

1. Pick portfolios that beat the market
   - For example, “Value” and “Momentum” portfolios beat the market

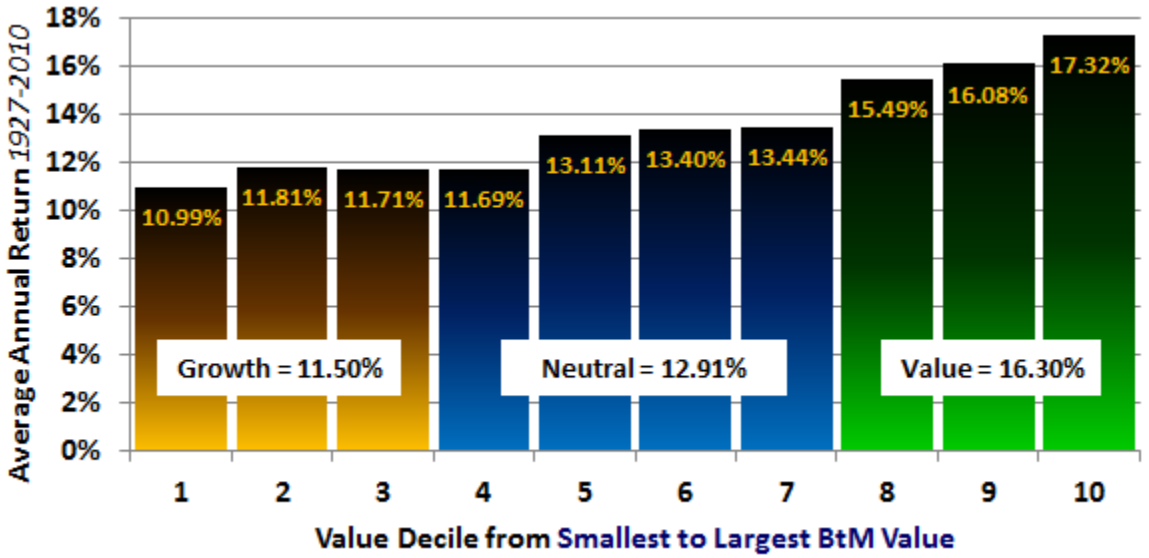
2. Arbitrage
   - Using “Arbitrage Pricing Theory (APT)”, we can find when individual stocks are mispriced relative to their underlying factors

3. Evaluate fund manager returns
   - Are fund managers earning higher returns by exposing themselves to various factors (i.e. beta)?
   - Or do they have skill (alpha)?

1. PICK PORTFOLIOS THAT BEAT THE MARKET

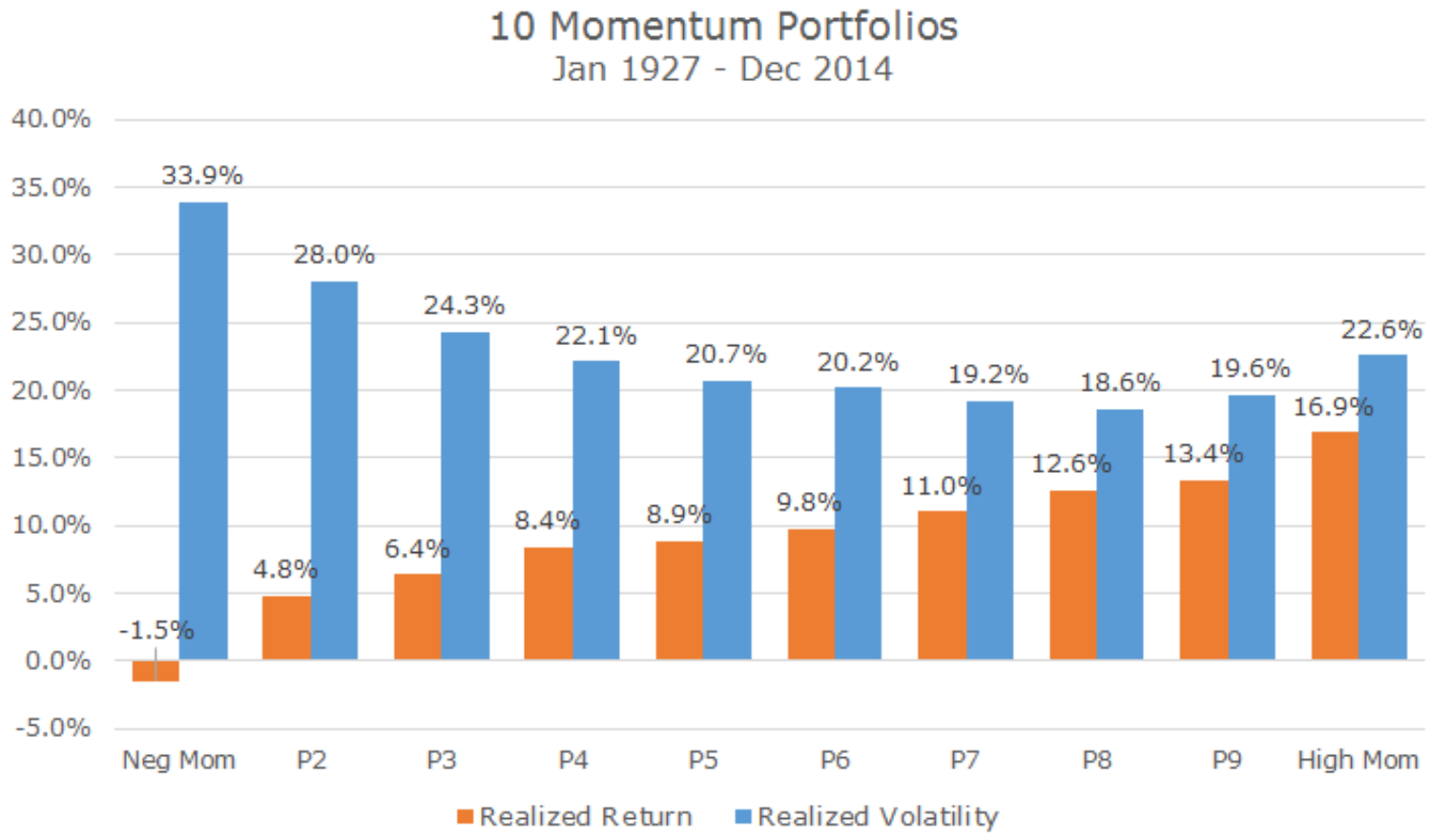
Value beats growth

- "Value stocks" defined as high book to market
- "Growth stocks" defined as low book to market



"Value premium" = $E[R_{HML}]$ = 16.3 - 11.5 = 4.8%

Momentum outperforms



"Momentum premium" = $E[R_{MOM}]$ = (12.6 + 13.4 + 16.9)/3 – (6.4 + 4.8 – 1.5)/3
= 11.1%

Returns to factor portfolios

Mean returns on Factor Portfolios

Value-weighted portfolios formed on Top 20% minus Bottom 20%

Monthly data, NYSE and Amex, May 1968 - December 1993 (308 months)

	Mean monthly returns	Std Dev monthly returns	T-Stat	Up-Market Months	Down-Market Months
"Value" = Book value to market Cap	0.0059	0.0379	2.73	-0.0007	0.0137
Cash Flow to Market Cap	0.0055	0.0297	3.25	-0.0012	0.0135
Dividends to Market Cap	0.0008	0.0372	0.38	-0.0168	0.0219
Earnings to Market Cap	0.036	0.0269	23.49	-0.0023	0.0106
"Size" = Market Cap	-0.0034	0.0511	-1.17	-0.009	0.0035
Momentum (sorting on past 6 month returns)	0.0064	0.0416	2.70	0.0053	0.0077
Momentum (sorting on past 5 years returns)	-0.0046	0.0415	-1.95	-0.0013	-0.0086
Sensitivity to Growth Rate of Industrial Production	-0.0025	0.0201	-2.18	-0.0027	-0.0023
Sensitivity to (Junk Bond Yield - AAA Corporate Yield)	0.0019	0.0297	1.12	0.0074	-0.0045
Sensitive to inflation-adjusted short-term interest rates	0.0012	0.0253	0.83	0.0034	-0.0014

[Sensitivity is measured by first regressing stocks relative to these measures in the time series
Sort stocks by the resulting betas]

Based on results in Chan, Karceski, Lakonishok (1998)

“Style” investing

- Two ways to take advantage of factors (which is called “style” investing):
  1. You can either buy the portfolio offered by a fund managers
     - e.g., Vanguard small-cap growth fund
  2. Or you can run a factor model regression (e.g., the Fama-French model) on each stock
     - Pick stocks that have high (or low) beta for the characteristic you want

Why do factor portfolios outperform?

- The rational view (Fama and French)
  - Factors represent **priced risks**
    - e.g., value stocks are “riskier” than growth stocks
  - The problem is, no one can detect these risks
    - Value stocks don’t have higher obvious risk:
      - return volatility, cash flow volatility, tail risk, etc.
    - So value does seems to outperform on a risk-adjusted basis

- The behavioral view (Lakonishok, Shleifer & Vishny)
  - Growth stocks are **“glamor”** stocks (think: Google & Twitter) vs. Value stocks (think: IBM & Caterpillar)
    - “Glamor” stocks are over-priced (and thus underperform)
    - Value stocks are boring and underpriced (and thus overperform)
  - Momentum is generally considered a behavioral phenomenon, but it’s underpinnings are still unclear

2. ARBITRAGE

Arbitrage Pricing Theory

- If you think a particular factor model is "correct"
  - Then assets or portfolios with the same loadings should also have the same expected returns
  - If not, it's an arbitrage opportunity

- So the following situation with assets B and AC cannot happen under no-arbitrage

$$\begin{cases} r_{Bt} = 0.02 + 1.5F_t & \Rightarrow E[r_{Bt}] = \underbrace{0.02}_{\text{different}} + \underbrace{1.5E[F_t]}_{\text{same}} \\ r_{ACt} = 0.05 + 1.5F_t & \Rightarrow E[r_{ACt}] = \overbrace{0.05}^{\text{from}} + \overbrace{1.5E[F_t]}^{\text{as}} \end{cases}$$

  - B must be over-priced (expected return too low)
  - AC must be under-priced (expected return too high)
  - So short B and buy AC

3. BENCHMARK FUND MANAGERS

Benchmarking Fund Managers

- Are fund managers earning higher returns by exposing themselves to various factors (beta)?
  - Or do they have skill (alpha)?

Why this is important

- In a future class, we'll study a paper that shows that hedge funds seem to earn higher returns:
  - But this is done by **exposing themselves to tail risk**
- Thus, their **trading strategies effectively mimic selling insurance** (e.g., swaps, put options)
  - Collecting high premiums most of the time (and outperforming the market)
  - But they tank during bad times

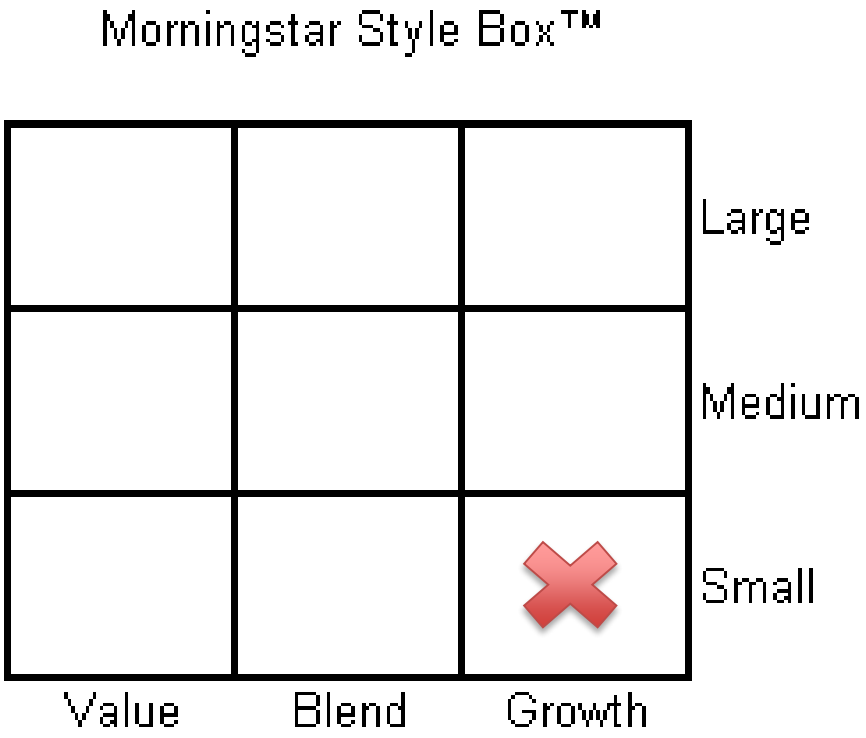
Factor models in Excel

- Let's do a practice example in Excel
  - Problem Set has you do more of this

- Recall the (Fama-French + Momentum) model

$$\begin{aligned}(R_p - r_f) = \quad & \alpha_p + \beta_i^{mkt}(R_m - r_f) \\ & + \beta_p^{size}(R_{SMB}) \\ & + \beta_p^{value}(R_{HML}) \\ & + \beta_p^{momentum}(R_{MOM}) + e_p\end{aligned}$$

Morningstar diagrams



TIME SERIES PREDICTABILITY

Time Series Predictability

- Previous slides about **cross-sectional** returns:
  - Why Stock A (a value stock) has higher returns than Stock B (a growth stock)

- Next part about **predicting the market as a whole** (e.g., the S&P 500 index)
  - "Market timing"
  - Evidence for weak predictability using:
    - dividend yield, book to market, etc.

Predictive regressions

- In the time series, regress future (K-period-ahead) market excess returns on the predictor variable

$$\log(R_{t+K}^{mkt} - r_f) \quad = \alpha + \beta(predictor_t) + \quad e_t$$

- A few things to note:
  - Log returns are used in the time series, because it effectively compounds returns made using this trading strategy
  - Popular predictor variables include:
    1. Dividend yield = D_t / P_t
    2. Earnings to Price ratio = E_t / P_t
       - D_t or E_t can be smoothed out over the last 12 mo.
    3. Book to market = $BookEquity_t$ / $MktCap_t$

Dividend yield and returns

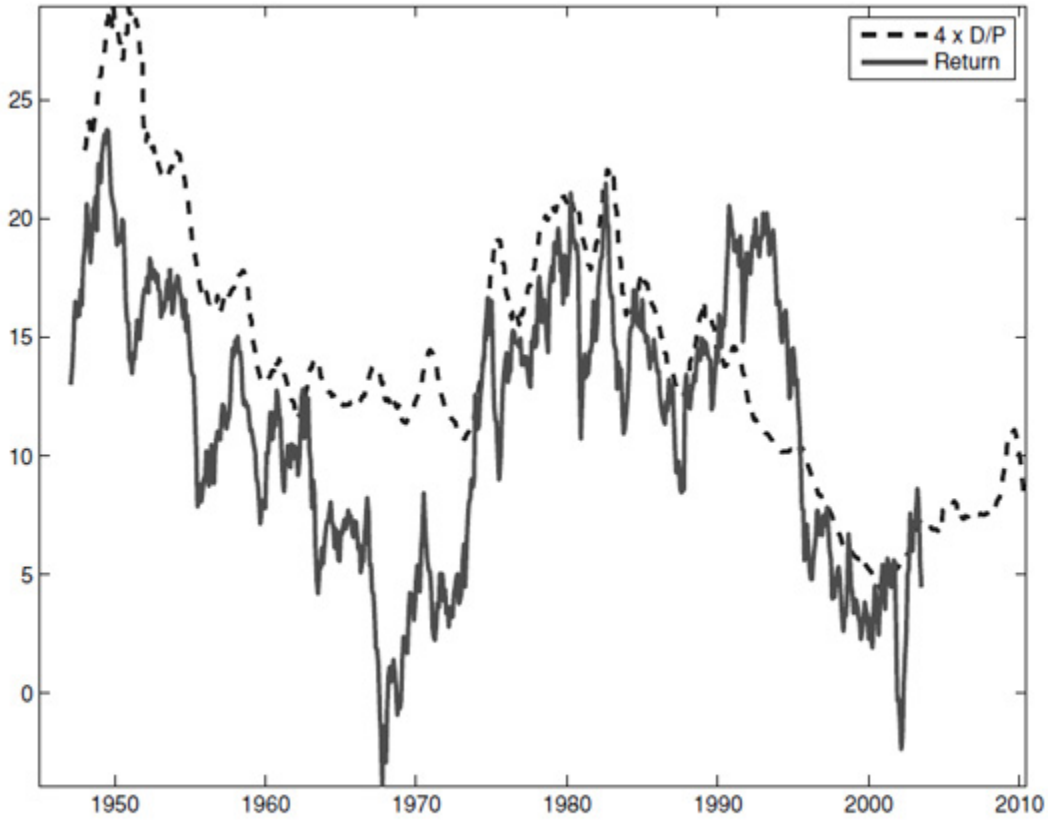


Figure 1. Dividend yield and following 7-year return. The dividend yield is multiplied by four. Both series use the CRSP value-weighted market index.


Price-Earnings Ratio
(based on 10-year trailing earnings)
Price-Earnings Ratio
50
45
40
35
30
25
20
15
10
5
0
1860
1880
1900
1920
1940
1960
1980
2000
2020
1901
1921
1929
1966
1981
2000
24.2

Why it might work

- P/E ratio is mean-reverting in the long run
- So if P/E is high now, then either
  1. P has to decrease in the future, or
  2. E has to increase
- But, empirically:
  - E generally stable and only weakly predicted by P/E
  - So it's P that has to fall

Rational vs. behavioral debate

- The rational explanation: “discount rates”
  - E/P or D/P reflects a time-varying “discount rate”
  - So when E/P is low (meaning, P is high), that just means that investors require lower returns for a given amount of risk
- The behavioral explanation: “sentiment”
  - Low E/P and D/P reflect over-optimism in the market and over-valuation of equity (P) relative to fundamentals (E or D)

Other predictive variables

Predictive Regression Estimation Results, monthly observations from 1951:01 to 2011:12

Predictor variable:	Coefficient	T-Stat	R^2
Log dividend-price ratio	0.78	[1.98]**	0.58%
Log dividend yield	0.84	[2.13]**	0.67%
log earnings-price ratio	0.43	[0.97]	0.20%
log dividend-earnings ratio	0.59	[0.93]	0.17%
realized daily volatility	7.41	[2.45]***	0.73%
book-to-market ratio	0.54	[0.75]	0.10%
net equity issuance	0.66	[0.06]	0.00%
3-mo tbill rate, past 12 year avg	0.11	[1.90]*	0.56%
long-term govt bond yield	0.08	[1.25]	0.23%
long-term govt bond return	0.13	[2.05]**	0.76%
long-term govt bond yield - 3-mo tbill rate	0.20	[1.74]*	0.44%
AAA corp bond yield - long-term govt bond yield	0.16	[0.37]	0.03%
AAA corp bond return - long-term govt bond return	0.16	[0.89]	0.26%
inflation rate	0.10	[0.18]	0.01%

Results taken from: https://research.stlouisfed.org/wp/2010/2010-008.pdf

Using data from Amit Goyal's web page at http://www.hec.unil.ch/agoyal/

$$\log(R_{t+K}^{mkt} - r_f) = \alpha + \beta(predictor_t) + e_t$$

Some issues

- Hindsight is 20/20
  - Just because these predictor variables worked in the past doesn't mean they'll continue to work in the future
  - Possible data mining issues
  - Arguably poor "out-of-sample" predictability

- Even if there's long-run predictability in expected returns, short-run market timing is still difficult
  - "It is too dangerous and crazy to short. You could have shorted the market in March of 1929 and lost everything."

    George Soros (*The Economist*, 5/6/2000)