EFM, Factor pricing & Anomalies

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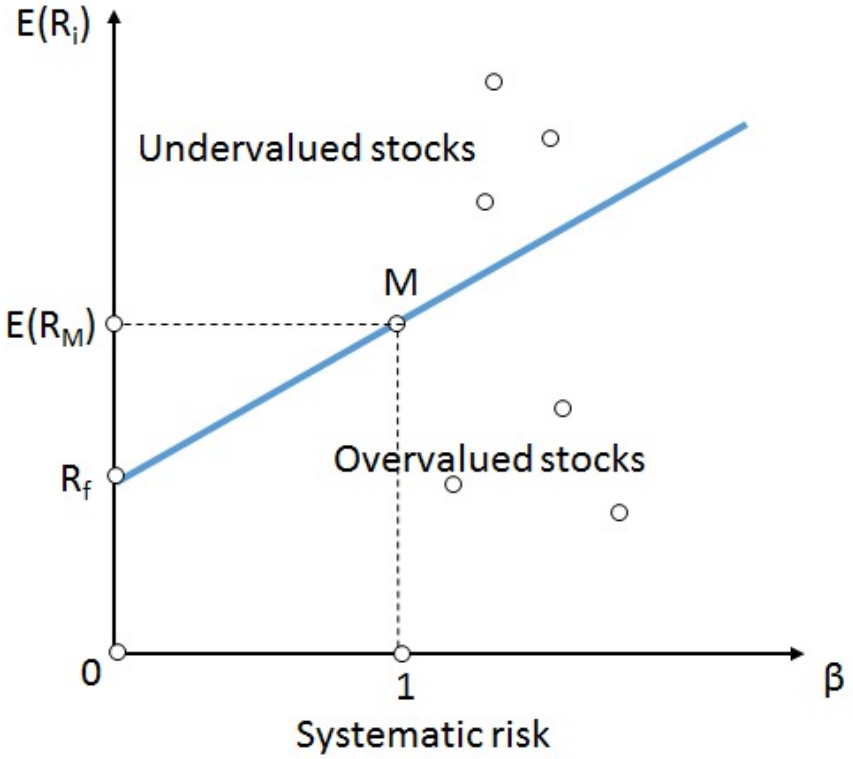
Why Should Capital Markets Be Efficient?

The premises of an efficient market

- A large number of competing profit-maximizing participants analyze and value securities, independently
- New information regarding securities comes to the market in a random fashion (min. no. of investors)
- Profit-maximizing investors adjust security prices rapidly to reflect the effect of new information

Conclusion: the expected returns implicit in the current price of a security should reflect its risk



Alternative Efficient Market Hypotheses (EMH)

- Random Walk Hypothesis – changes in security prices occur randomly
- Fair Game Model – current market price reflect all available information about a security and the expected return based upon this price is consistent with its risk
- Efficient Market Hypothesis (EMH) - divided into three sub-hypotheses depending on the information set involved

Efficient Market Hypotheses (EMH)

- Weak-Form EMH - prices reflect all **security-market** information
- Semistrong-form EMH - prices reflect all **public** information
- Strong-form EMH - prices reflect all **public and private** information

Weak-Form EMH

- Current prices reflect all security-market information, including the historical sequence of prices, rates of return, trading volume data, and other market-generated information : such as odd-lot transactions, block trades, and transactions by exchange specialists.
- This implies that past rates of return and other market data should have no relationship with future rates of return

Semistrong-Form EMH

- Current security prices reflect all public information, including market and non-market information
- This implies that decisions made on new information after it is public should not lead to above-average risk-adjusted profits from those transactions

Strong-Form EMH

- Stock prices fully reflect all information from public and private sources
- This implies that no group of investors should be able to consistently derive above-average risk-adjusted rates of return
- This assumes perfect markets in which all information is cost-free and available to everyone at the same time

Problems of EMH

- All investors perceive all available information in precisely the same manner – stock's fair market value ?

- Identical returns – no investor had any clear advantage over another

- No investor should ever be able to beat the market or the average annual returns that all investors and funds are able to achieve using their best efforts

Tests of the Semistrong Form of Market Efficiency

Two sets of studies

- Time series analysis of returns or the cross-section distribution of returns for individual stocks (Return prediction studies)

- Event studies that examine how fast stock prices adjust to specific significant economic events

Tests and Results of Semistrong-Form EMH

- Test results should include adjusted a security's rate of return

$$Ar_{it} = R_{it} - R_{mt}$$

where:

Ar_{it} = abnormal rate of return on security *i* during period *t*

R_{it} = rate of return on security *i* during period *t*

R_{mt} =rate of return on a market index during period *t*

Types of adjusted returns (Brown and Warner, 1985)

Tests and Results of Semistrong-Form EMH

- Time series tests for abnormal rates of return
- Assumption : the best estimate of future rates of return will be the long-run historical rates of return
  - short-horizon returns have limited results
  - long-horizon returns analysis has been quite successful based on (Future expectations)
    - dividend yield (D/P) (dividend yield (D/P) was a proxy for the risk premium on stock)
    - default spread (lower-grade and Aaa-rated long-term corporate bonds)
    - term structure spread (long-term Aaa yield and the yield on one-month Treasury bills)
  - Quarterly earnings reports may yield abnormal returns due to
    - unanticipated earnings change

Tests and Results of Semistrong-Form EMH

- Quarterly Earnings Reports
  - 31 percent of the total response in stock returns came before the announcement,
  - 18 percent on the day of the announcement, and 51 percent afterward
  - Unexpected earnings can explain up to 80% of stock drift over a time period
- These results suggest that the earnings surprise is *not* instantaneously reflected in security prices - against SEMH

Tests and Results of Semistrong-Form EMH

The January Anomaly

- Stocks with negative returns during the prior year had higher returns right after the first of the year
- Tax selling toward the end of the year has been mentioned as the reason for this phenomenon
- Such a seasonal pattern is inconsistent with the EMH

Tests and Results of Semistrong-Form EMH

- Other calendar effects
  - monthly effect, a weekend/day-of-the-week effect, and an intraday effect
  - All the market's cumulative advance occurs during the first half of trading months
  - Mean return for Monday was significantly negative. In contrast, the average return for the other four days was positive.
  - For *large* firms, the negative Monday effect occurred before the market opened (it was a weekend effect), whereas for *smaller* firms, most of the negative Monday effect occurred during the day on Monday (it was a Monday trading effect)

Tests and Results of Semistrong-Form EMH

- Predicting cross-sectional returns
  - All securities should have equal risk-adjusted returns

- Studies examine alternative measures of size or quality as a tool to rank stocks in terms of risk-adjusted returns

Tests and Results of Semistrong-Form EMH

- Price-earnings ratios and returns
  - Low P/E stocks experienced superior risk-adjusted results relative to the market, whereas high P/E stocks had significantly inferior risk-adjusted results
  - Publicly available P/E ratios possess valuable information regarding future returns
  - This is inconsistent with semistrong efficiency

Tests and Results of Semistrong-Form EMH

- Price-Earnings/Growth Rate (PEG) ratios
  - Studies have hypothesized an inverse relationship between the PEG ratio and subsequent rates of return. This is inconsistent with the EMH
  - However, the results related to using the PEG ratio to select stocks are mixed (Only for stocks with low betas and very low expected growth rates)

Tests and Results of Semistrong-Form EMH

- The size effect (total market value)
  - Several studies have examined the impact of size on the risk-adjusted rates of return
  - The studies indicate that risk-adjusted returns for extended periods indicate that the small firms consistently experienced significantly larger risk-adjusted returns than large firms
  - Firm size is a major efficient market anomaly
  - Could this have caused the P/E results previously studied?

Tests and Results of Semistrong-Form EMH

- The P/E studies and size studies are dual tests of the EMH and the CAPM
- Abnormal returns could occur because either
  - markets are inefficient or
  - market model is not properly specified and provides incorrect estimates of risk and expected returns

Tests and Results of Semistrong-Form EMH

- The impact of transactions costs of investing in small firms depends on frequency of trading
  - Daily trading reverses small firm gains
- The small-firm effect is not stable from year to year

Tests and Results of Semistrong-Form EMH

Neglected Firms

- Firms divided by number of analysts following a stock
- Small-firm effect was confirmed
- Neglected firm effect caused by lack of information and limited institutional interest
- Neglected firm concept applied across size classes

Tests and Results of Semistrong-Form EMH

- Ratio of Book Value of a firm's Equity to Market Value of its equity
  - Significant positive relationship found between current values for this ratio and future stock returns
  - Results inconsistent with the EMH
- Size and BV/MV dominate other ratios such as E/P ratio or leverage

Tests and Results of Semistrong-Form EMH

Event studies

- Stock split studies show that splits do not result in abnormal gains after the split announcement, but before
- Initial public offerings seems to be underpriced by almost 18%, but that varies over time, and the price is adjusted within one day after the offering
- Listing of a stock on an national exchange such as the NYSE may offer some short term profit opportunities for investors

Tests and Results of Semistrong-Form EMH

- Event studies (continued)
  - Stock prices quickly adjust to unexpected world events and economic news and hence do not provide opportunities for abnormal profits
  - Announcements of accounting changes are quickly adjusted for and do not seem to provide opportunities
  - Stock prices rapidly adjust to corporate events such as mergers and offerings
  - The above studies provide support for the semistrong-form EMH

Arbitrage Pricing Theory (APT)

- CAPM is criticized because of the difficulties in selecting a proxy for the market portfolio as a benchmark
- An alternative pricing theory with fewer assumptions was developed - expansive definition of systematic investment risk than that implied by the CAPM's single market portfolio.

Arbitrage Pricing Theory - APT

Three major assumptions:

1. Capital markets are perfectly competitive

2. Investors always prefer more wealth to less wealth with certainty

3. The stochastic process generating asset returns can be expressed as a linear function of a set of *K* factors or indexes

Assumptions of CAPM That Were Not Required by APT

APT does not assume

- A market portfolio that contains all risky assets, and is mean-variance efficient
- Normally distributed security returns
- Quadratic utility function

Arbitrage Pricing Theory (APT)

$$R_t = E_t + b_{i1}\delta_i + b_{i2}\delta_i + \ldots + b_{ik}\delta_k + \varepsilon_i$$

For i = 1 to N where:

R_i = return on asset i during a specified time period

E_i = expected return for asset i

b_{ik} = reaction in asset i's returns to movements in a common factor

δ_k = a common factor with a zero mean that influences the returns on all assets

ε_i = a unique effect on asset i's return (by assumption, is completely diversifiable in large portfolios and has a mean of zero)

N = number of assets

APT Factors of Chen, Roll and Ross (1986)

1. Industrial production
   (reflects changes in cash flow expectations)
2. Yield spread btw high risk and low risk corporate bonds (reflects changes in risk preferences)
3. Difference between short- and long-term interest rate (reflects shifts in time preferences)
4. Unanticipated inflation
5. Expected inflation (less important)

Note: The factors replicate market portfolio.

The Merits of Factor Models

- Without any structure one has to estimate
  - J expected returns $E[R^j]$ (for each asset j)
  - J standard deviations
  - J(J-1)/2 co-variances
- Assume that the correlation between any two assets is explained by systematic components/factors, one can restrict attention to only K (non-diversifiable) factors

  Advantages: Drastically reduces number of input variables
  Models expected returns (priced risk)
  Allows to estimate systematic risk
  (even if it is not priced, i.e. uncorrelated with SDF)
  Analysts can specialize along factors

  - Drawbacks: Purely statistical model (no theory)
    relies on past data and assumes stationarity

Factor Structure

- Definition of "factor structure:"

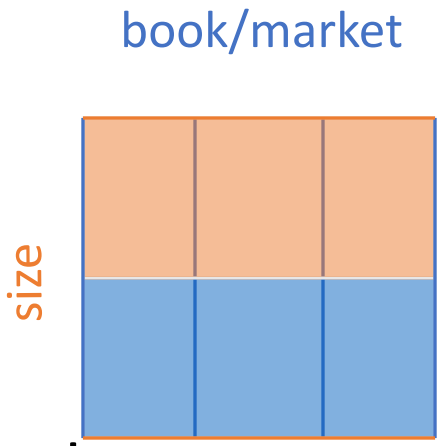
$$r_j = E[r_j] + \sum_{k=1}^{K} \beta_{jk} f_k + \epsilon_j \text{ (1), where}$$

$$\text{cov}(\epsilon_j, \epsilon_i) = 0 \text{ if } i \neq j, \; E[\epsilon_j] = 0 \text{ and}$$
$$\text{cov}(\epsilon_j, f_k) = 0 \text{ for each } (j, k).$$

- risk can be split in *systematic* risk and *idiosyncratic (diversifiable)* risk

Fama French Three Factor Model

- Form 2x3 portfolios
  - Size factor (SMB)
    - Return of small minus big
  - Book/Market factor (HML)
    - Return of high minus low



- For … $R_t^j - R_t^f = \alpha^p + \beta^p(R_t^m - R_t^f)$

  αs are big and βs do not vary much

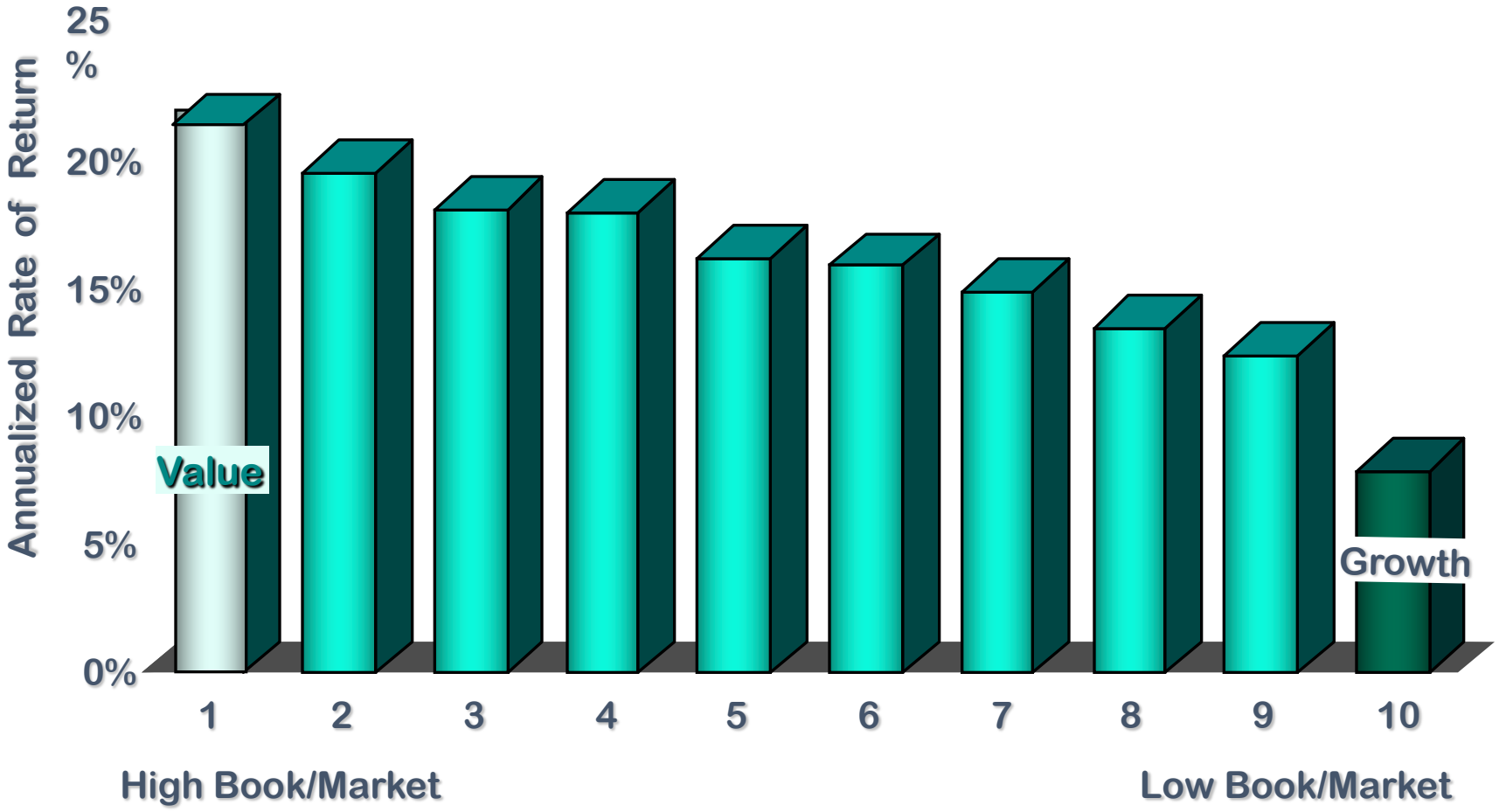
- For … $R_t^p - R_t^f = \alpha^p + \beta^p(R_t^m - R_t^f) + \gamma^p \text{SMB}_t^p + \delta^p \text{HML}_t^p$

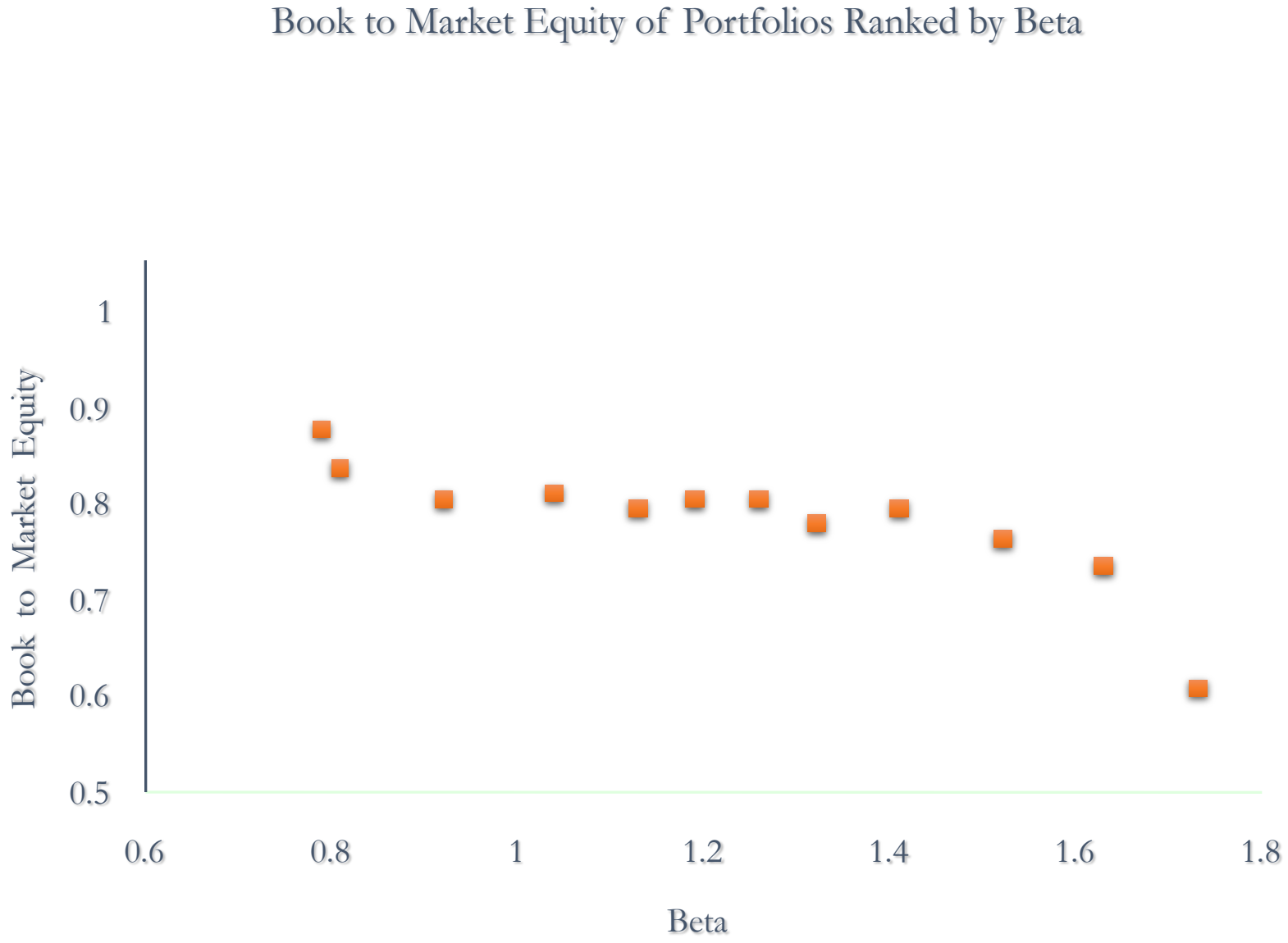
  (for each portfolio p using time series data

  a^ps are zero, coefficients significant, high R^2.

- Market efficiency Vs inefficiency

Book to Market as a Predictor of Return




Book to Market Equity of Portfolios Ranked by Beta
Book to Market Equity
1
0.9
0.8
0.7
0.6
0.5
0.6
0.8
1
1.2
1.4
1.6
1.8
Beta

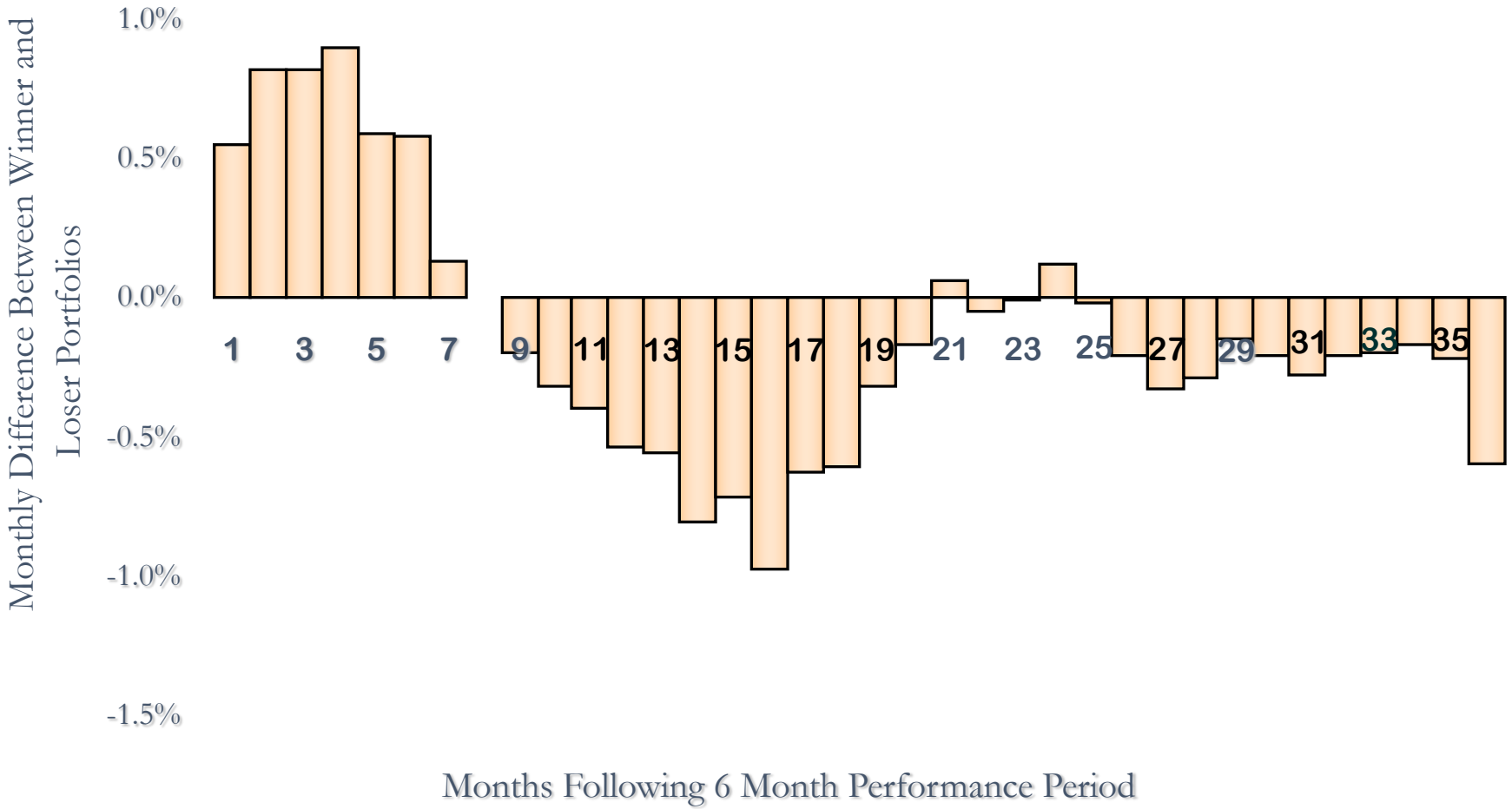
Adding Momentum Factor

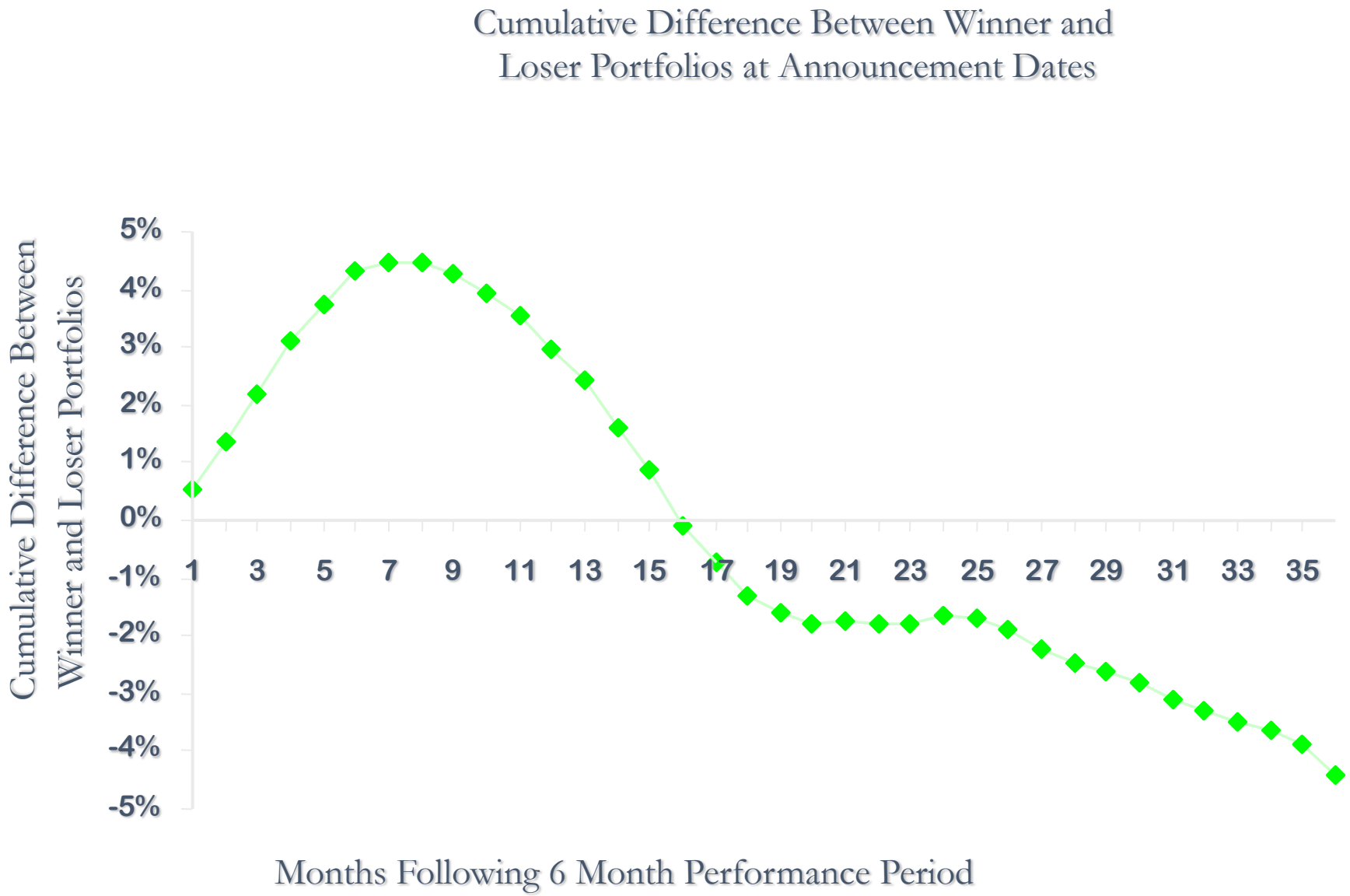
- Jegadeesh & Titman 1993 JF rank stocks according to performance to past 6 months

  - Momentum Factor (capacity for a price trend to sustain itself going forward)
  - Top Winner minus Bottom Losers Portfolios

- Relative strength trading strategies over 3- to 12-month horizons
- Past winners realize consistently higher returns around their earnings announcements in the 7 months following the portfolio formation date than do past losers.
- In each of the following 13 months past losers realize higher returns than past winners around earnings announcements.

Monthly Difference Between Winner and Loser Portfolios at Announcement Dates




Cumulative Difference Between Winner and Loser Portfolios at Announcement Dates
Cumulative Difference Between Winner and Loser Portfolios
5%
4%
3%
2%
1%
0%
-1%
-2%
-3%
-4%
-5%
1
3
5
7
9
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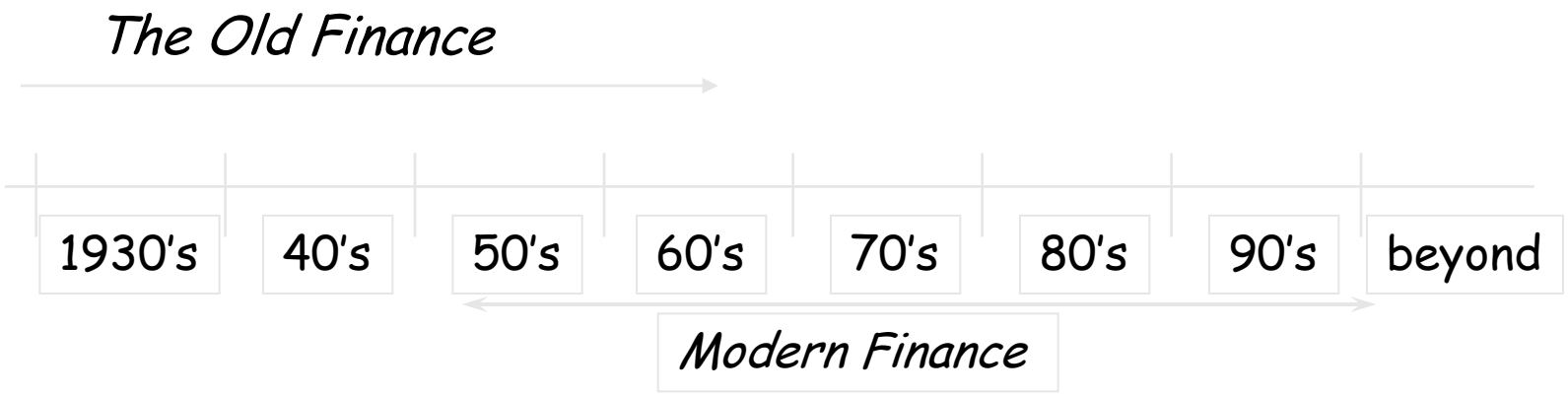
Months Following 6 Month Performance Period

Haugen's view: The Evolution of Academic Finance



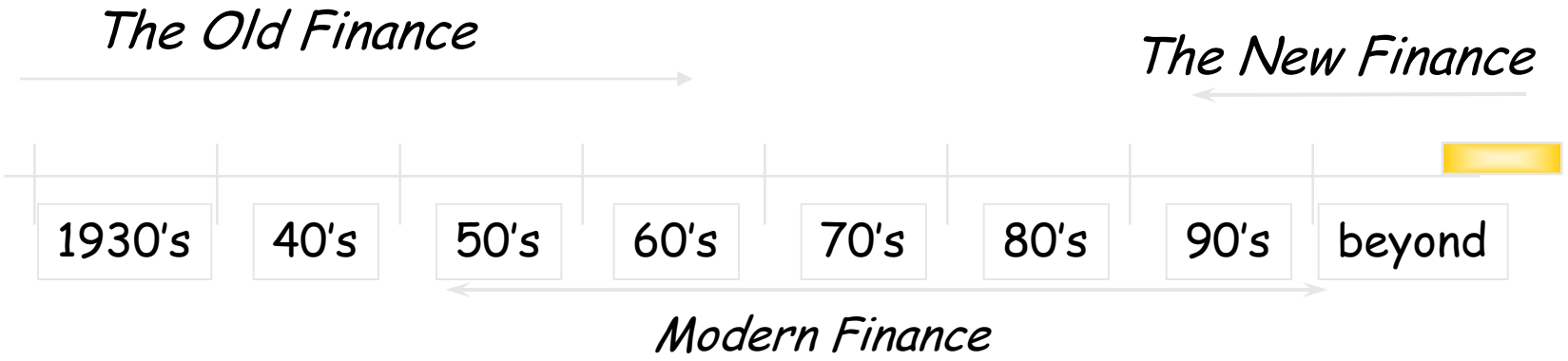
Modern Finance

Theme: Valuation Based on Rational Economic Behavior

Paradigms: Optimization (*Markowitz*) Irrelevance (*Modigliani & Miller*) CAPM (*Sharpe, Lintner & Mossen*) EMH (*Fama*)

Foundation: Financial Economics

Haugen's view: The Evolution of Academic Finance



The New Finance

Theme: Inefficient Markets

Paradigms: Inductive *ad hoc* Factor Models
Behavioral Models
Expected Return Risk

Foundation: Statistics, Econometrics, and Psychology

What Happens When you Data Mine 2 million Fundamental Quant Strategies

- Number of stock anomalies in the universe is much lower than originally thought (300+)
- Compustat universe of data points, and use every variable in the dataset to create over 2 million trading strategies — explicit data-mining!
- simply data-mined the entire universe of signals- Handful of trading strategies that are "anomalous" and most of these strategies make no economic sense!
- Fama and French 5-factor model plus momentum explain the cross-section of stock returns there is little to no evidence for additional anomalies.
- ML is great at combining the already well-known anomalies that the authors assume in the paper (such as Value and Momentum); however, ML – enhance frictional costs and increasing the chances of a data-mined result

$$R_{it} - R_{Ft} = a_i + b_i(R_{Mt} - R_{Ft}) + s_iSMB_t + h_iHML_t + r_iRMW_t + c_iCMA_t + e_{it}$$

The paper then examines the 156 variables in the Compustat library (listed in Appendix A1 of the paper) to create over 2 million trading signals.

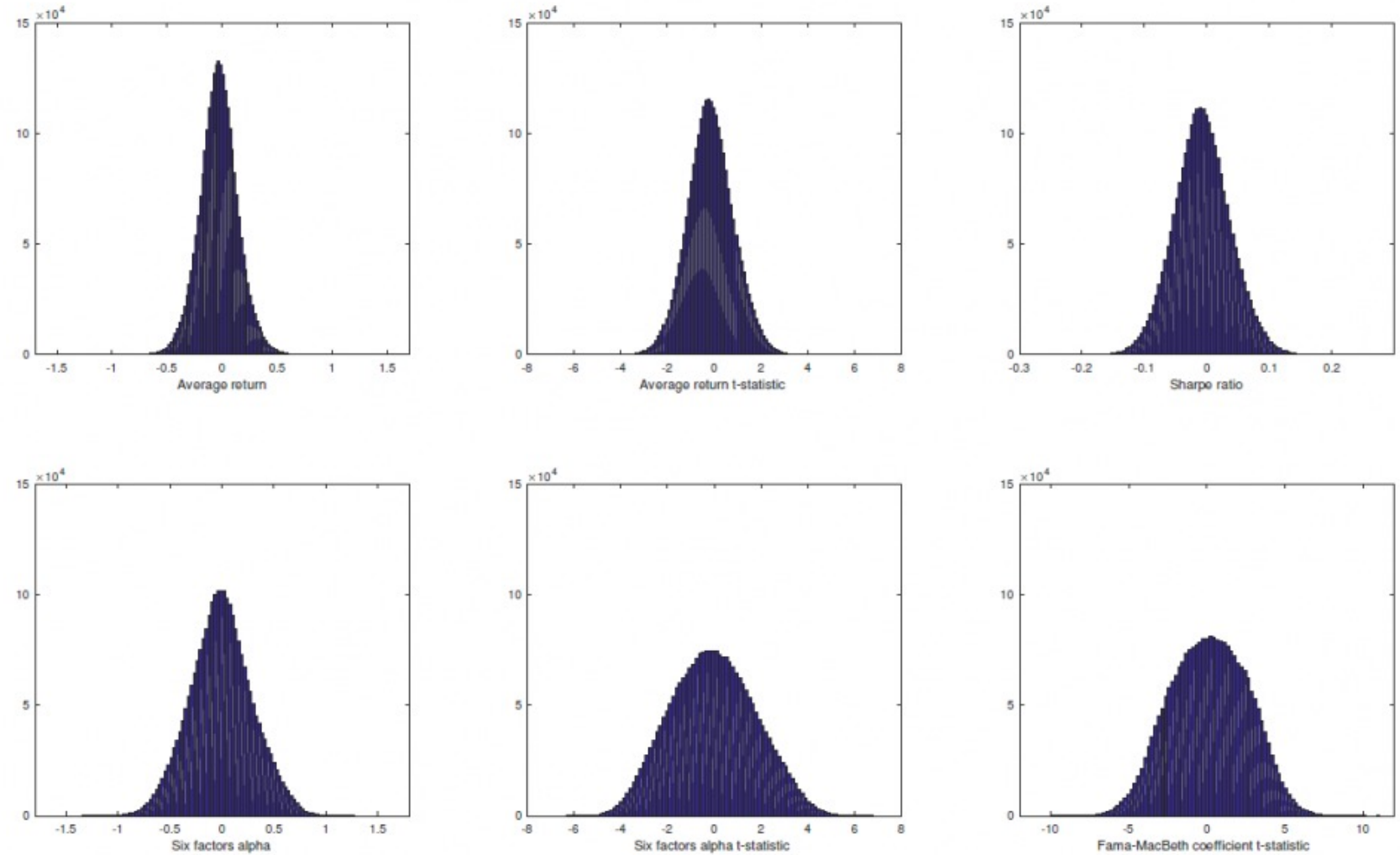
The study has already eliminated small and micro cap stocks from the tests, they form portfolios using a one-dimensional sort on each of the variables.

The portfolios are rebalanced annually, creating long/short portfolios that go long the top decile on each measure, and short the bottom decile.
The paper tests these 2 million portfolios by

(1) regressing the L/S portfolio returns against the Fama and French 5-factor model plus the momentum factor and
(2) Examining Fama-MacBath (FM) regressions.

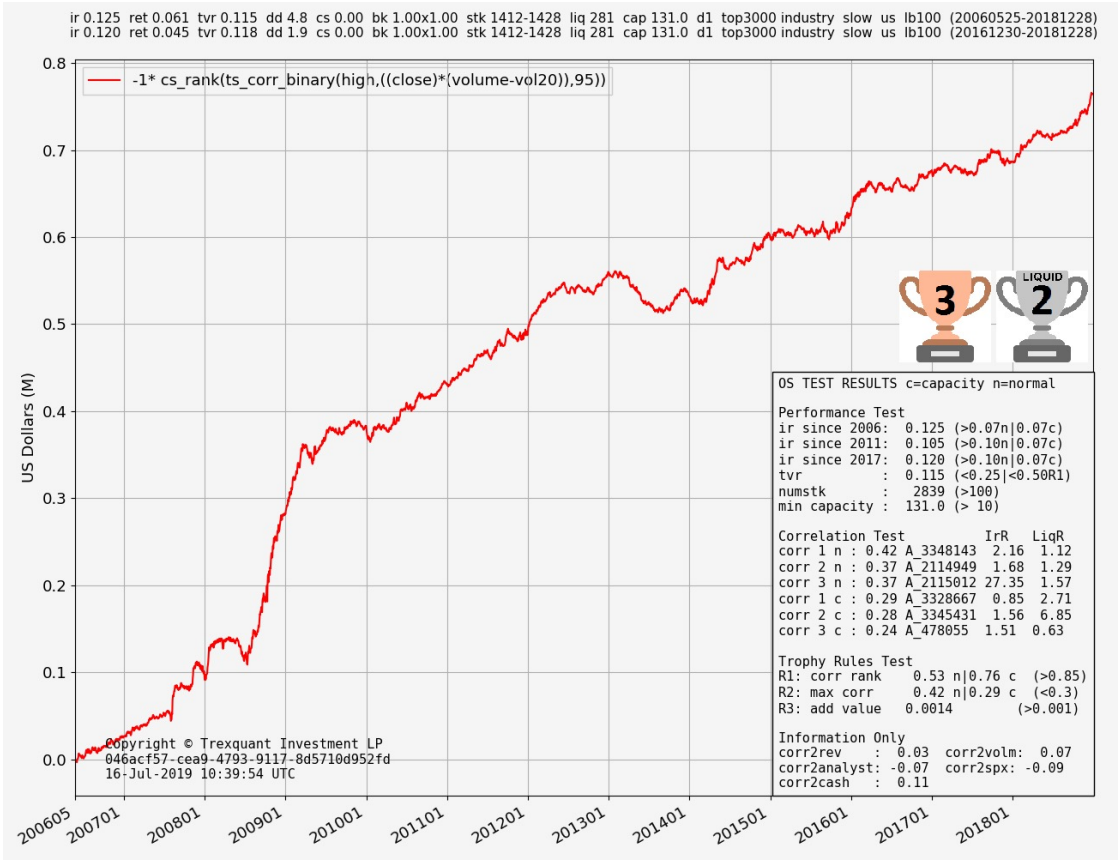
Figure 1: Empirical distributions of portfolios returns

We construct trading strategies as described in the text. The figure shows cross-sectional histograms for average returns, alphas, Sharpe ratios, average return t-statistics, alpha t-statistics, and Fama-MacBeth regression coefficients. Alphas are computed relative to the Fama and French (2015) five-factor model augmented with a momentum factor. All returns and alphas are reported in monthly percentages. The sample period is 1972 to 2015.



Example

Idea 1 : Correlation between high and (close * difference in volume in last 20 day)



Thank you