FNCE90056:
Investment Management

Week 11 - Lecture 10: Portfolio Performance Evaluation

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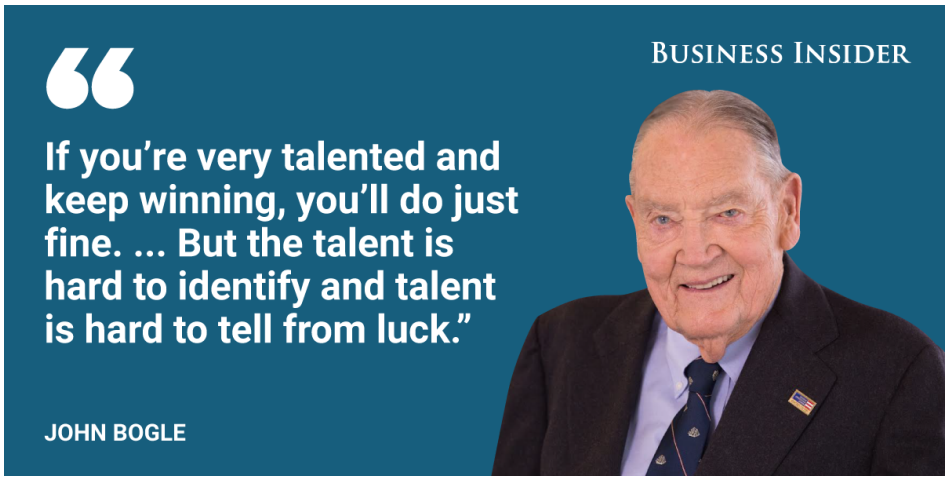
Introduction

Today



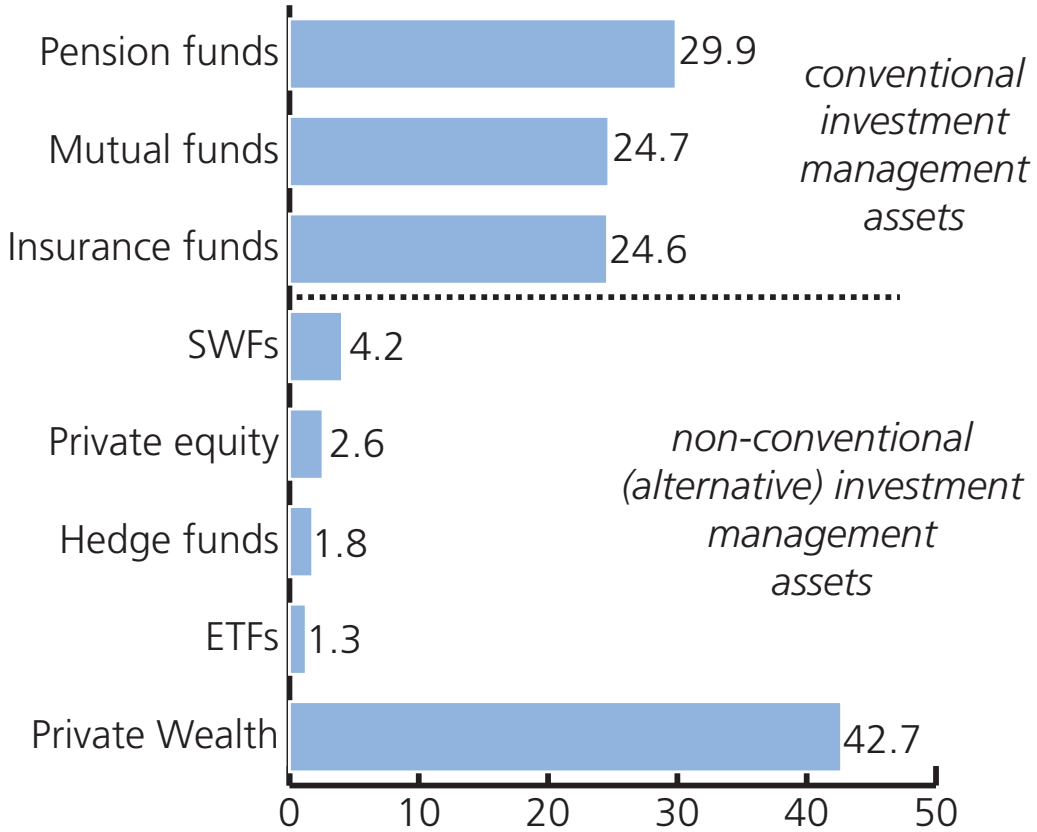
In 1975, John Bogle of the Vanguard Group started the First Index Investment Trust, later to become the Vanguard Index 500 fund, the first index mutual fund for retail investors. Index funds were initially developed for institutions as John McQuown and David Booth at Wells Fargo and Rex Sinquefield at American National Bank independently set up the first passive index fund in 1973. Later, Booth and Sinquefield would found Dimensional Fund Advisors based on the ideas of passive investing.

- Is it worth paying the fees for an active manager of either a mutual fund or a hedge fund?
- Or should we just invest passively?
- In this lecture, we will discuss how we assess a portfolio manager's ability.

The landscape

Global fund management industry

assets under management, $ trillion, end-2010

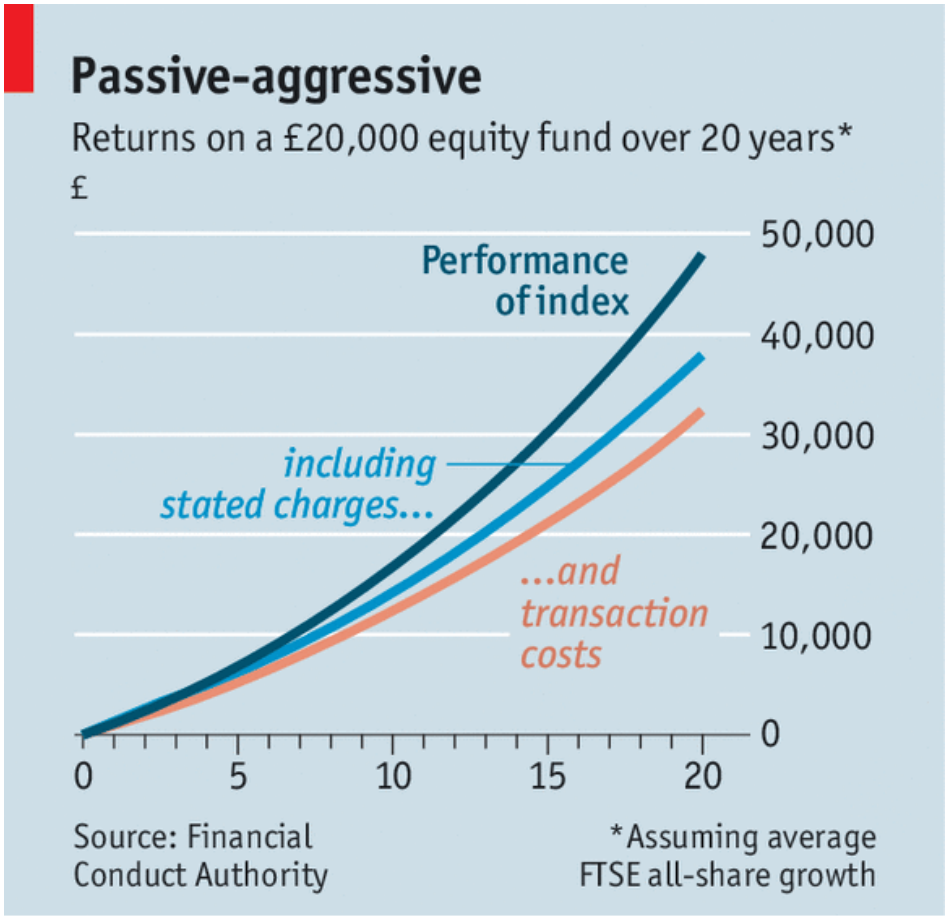


[1] Around one-third of private wealth is incorporate in conventional investment management

Source: TheCityUK estimates

- At the end of 2011, assets in the global fund management industry totaled around $117 trillion.
- A substantial fraction of this money is actively managed.
- For example in 2010, roughly 90% of the money in U.S. mutual funds was actively managed.

Management fees



- Active mutual funds have considerably higher fees than passive mutual funds.
  - Equity funds: Fidelity Contrafund (0.92%), Vanguard 500 Index (0.17%)
  - Bond funds: PIMCO Total Return Fund (0.46%), Vanguard Total Bond Market Index (0.22%)
- What about hedge funds? The standard fees are 2% of assets under management plus 20% of profits.

Expense Ratios for Selected Investment Objectives*

Percent, 2010

Investment objective	10th percentile	Median	90th percentile	Average *Asset-weighted*	Average *Simple*
Equity funds	**0.80**	**1.40**	**2.25**	**0.84**	**1.47**
Aggressive growth	**0.89**	**1.45**	**2.27**	**0.99**	**1.54**
Growth	0.76	1.29	2.15	0.89	1.39
Sector funds	0.93	1.56	2.43	0.98	1.65
Growth and income	0.55	1.18	2.00	0.54	1.25
Income equity	0.73	1.20	1.94	0.83	1.27
International equity	0.95	1.53	2.38	0.99	1.61
Hybrid funds	**0.62**	**1.21**	**2.00**	**0.83**	**1.27**
Bond funds	**0.50**	**0.92**	**1.70**	**0.64**	**1.04**
Taxable bond	0.49	0.95	1.78	0.65	1.06
Municipal bond	0.53	0.87	1.60	0.62	1.02
Money market funds	**0.16**	**0.29**	**0.52**	**0.26**	**0.32**

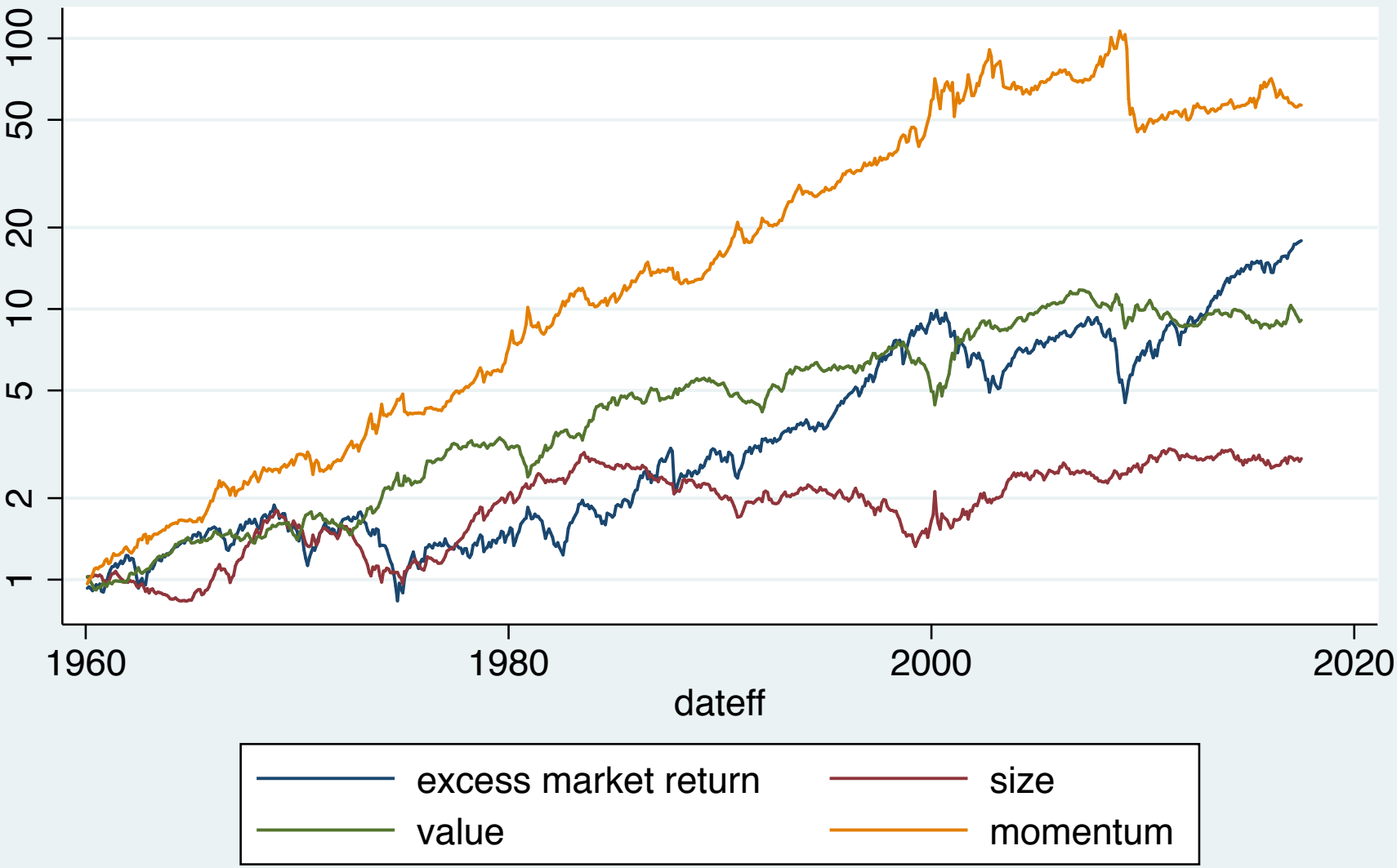
* Data exclude mutual funds available as investment choices in variable annuities and mutual funds that invest primarily in other mutual funds.

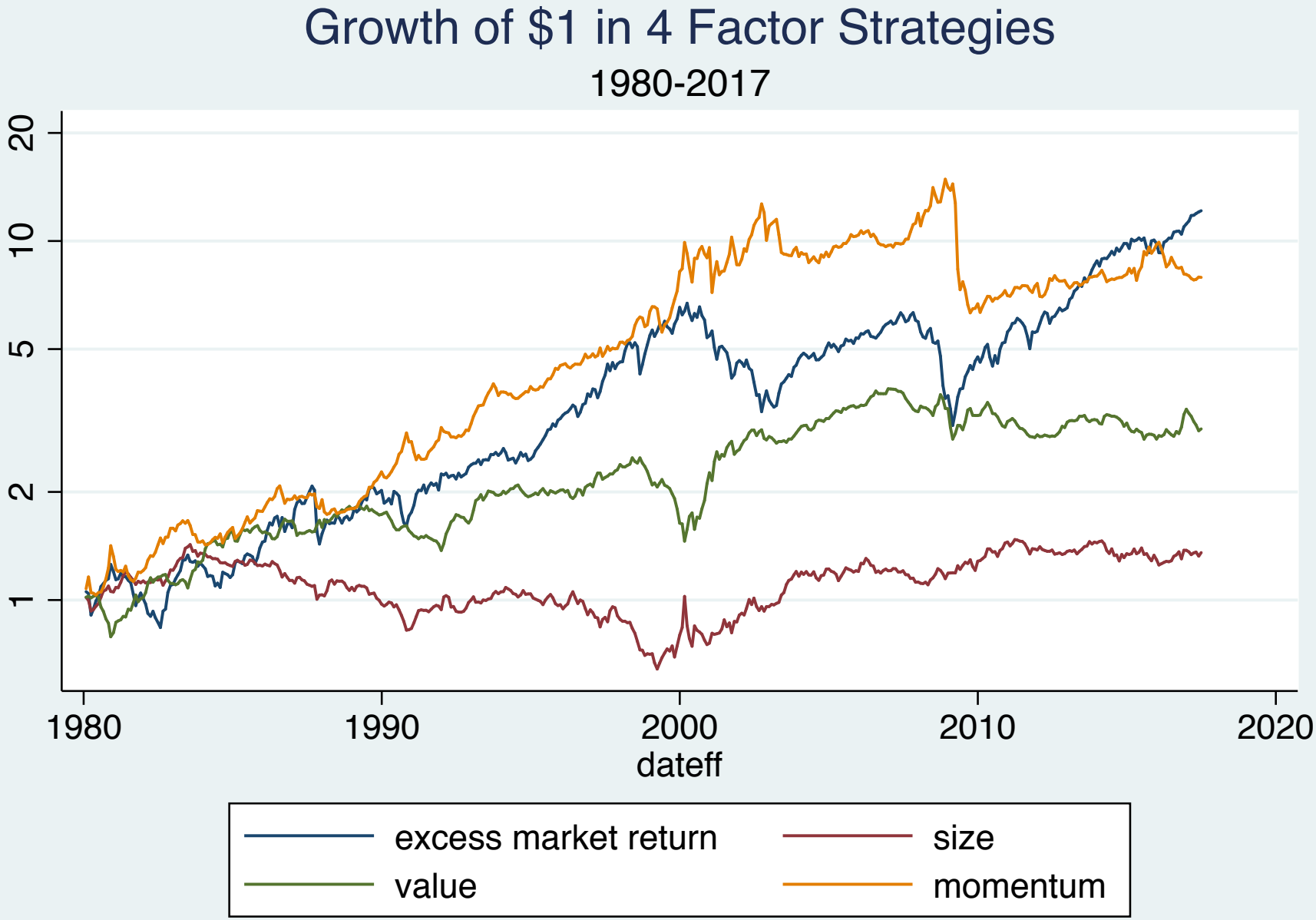
Sources: Investment Company Institute and Lipper

Do fund managers add value?

- In deciding where to invest money, and how much to pay the fund, it is crucial to be able to determine how much value fund managers add.

- We should only pay a manager for getting high returns if we could not have gotten those returns with an implementable *ex ante* strategy.
  - If we could have levered up an index fund and gotten those returns, we should not pay the manager.
  - If we could have used other *ex ante* rules and gotten the same returns, we should not pay the manager:
    1. buying small stocks (size strategy)
    2. buying high book-to-market stocks (value strategy)
    3. buying past winners (momentum strategy)


Growth of $1 in 4 Factor Strategies
1960-2017
1
2
5
10
20
50
100
1960
1980
2000
2020
dateff
excess market return
size
value
momentum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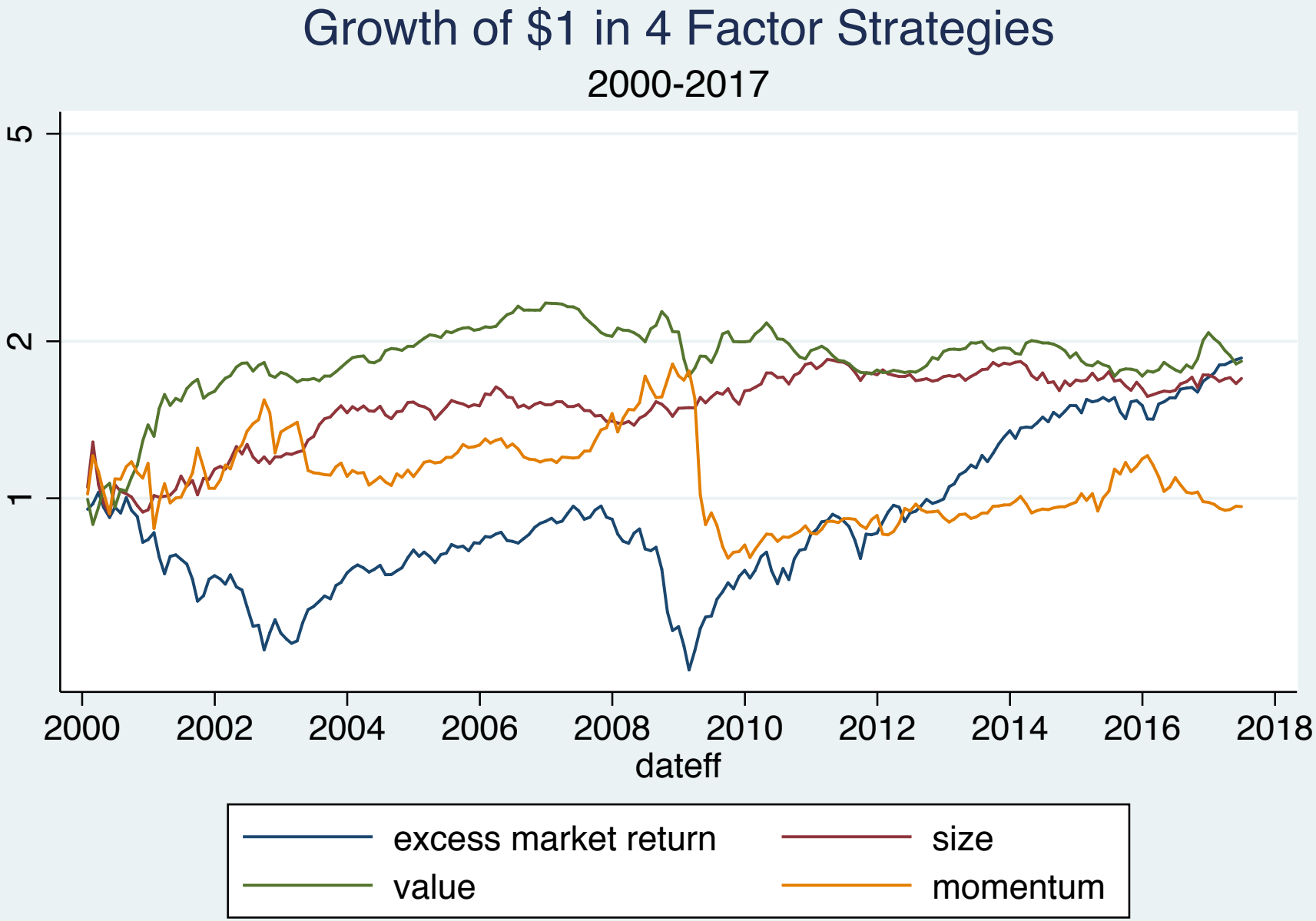

Growth of $1 in 4 Factor Strategies
2000-2017
5
2
1
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
dateff
excess market return
size
value
momentum

Return-based Performance Metrics

Return-based performance metrics

- We should only pay the manager for generating higher risk-adjusted returns than we could otherwise obtain by trading mechanical, passive, strategies.
- A fund manager can do this in a variety of ways:
  1. Stock picking
     - ★ This presumes the ability to predict future stock returns.
     - ★ This is often what we imagine fund managers are doing.
  2. Market/factor timing
     - ★ This presumes the ability to predict future market/factor returns.
  3. Economies of scale & access to markets
     - ★ For example, BlackRock, Dimensional Fund Advisors, and Vanguard provide products that largely capitalise on them being the low cost provider of a particular risk exposure.
     - ★ Suppose you want to buy European small cap stocks. A managed fund could end up being your best option due to market access problems.

Return-based performance metrics

The relative performance of a fund manager can be measured using historical returns.

"Abnormal" performance can be defined with respect to:

- a benchmark portfolio
- a universe of similar funds
- a market return adjustment
- a return-to-risk measure

We will focus on measures that account for risk.

Return-based performance metrics

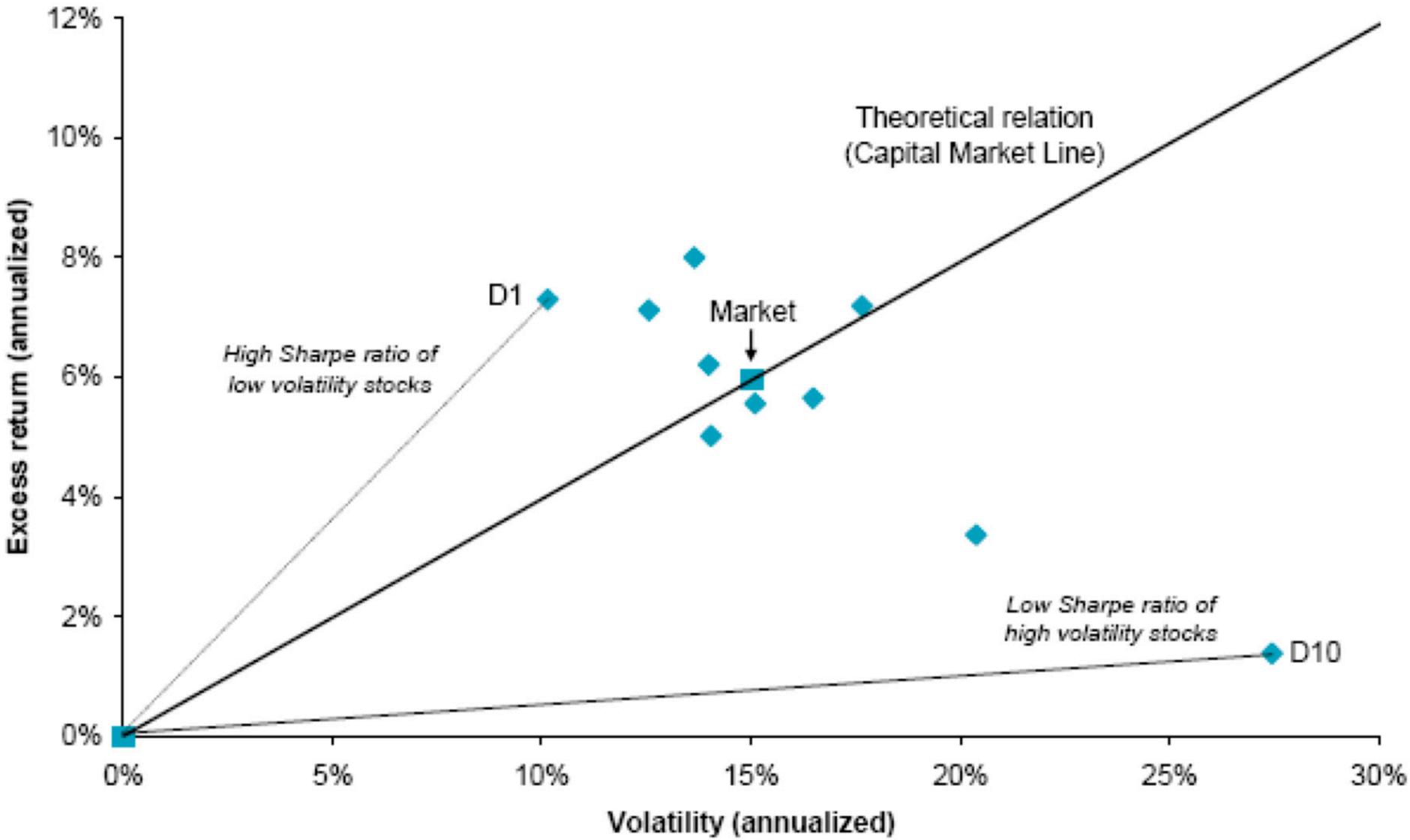
- Sharpe ratio
- M^2
- α
- Information ratio

Sharpe ratio (1966)

- The Sharpe ratio measures the return to (total) volatility trade-off.
- The Sharpe ratio is computed by dividing the average portfolio excess return over the sample period by the portfolio's volatility over that period:

$$\text{SR} = \frac{\bar{r}_p - \bar{r}_f}{\sigma_p} \tag{1}$$

- From mean-variance portfolio choice, the appropriate measure of total risk is standard deviation.


12%
10%
8%
6%
4%
2%
0%
Excess return (annualized)
0%
5%
10%
15%
20%
25%
30%
Volatility (annualized)
Theoretical relation
(Capital Market Line)
D1
Market
High Sharpe ratio of
low volatility stocks
Low Sharpe ratio of
high volatility stocks
D10

M^2 (1997)

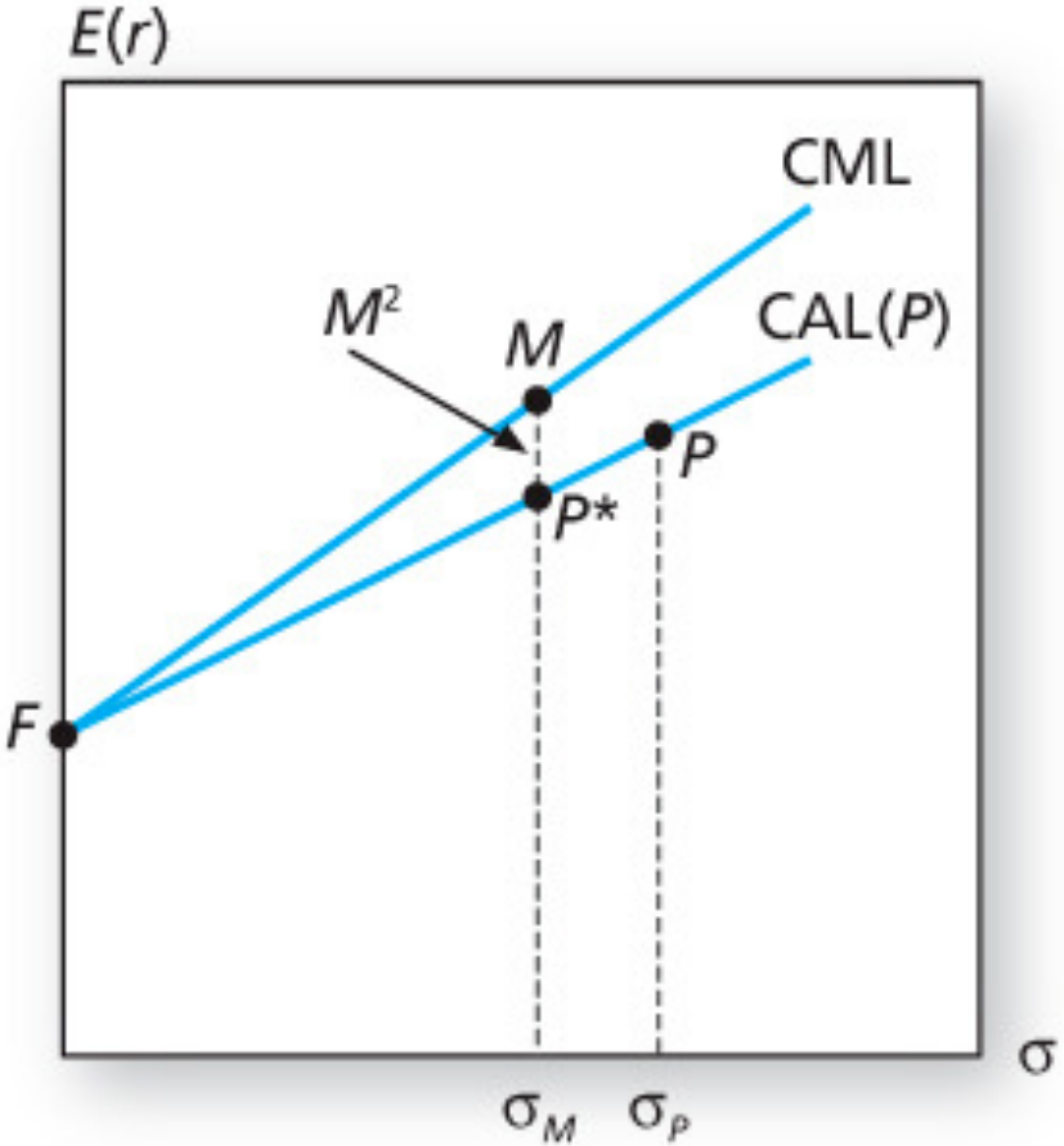
Named after Nobel-prize winner **Franco Modigliani** and his granddaughter **Leah Modigliani**, who developed it.

The Sharpe ratio can be used to measure performance, but it's hard to interpret how much better a Sharpe ratio of e.g. 0.74 is versus 0.69.

A variant of the Sharpe ratio, M^2, focuses on total volatility as a risk measure, but its risk-adjusted measure of performance has the easy interpretation of a differential return relative to a benchmark.

Take the managed portfolio P that you are evaluating and mix it with a position in T-bills such that the overall portfolio (P plus T-bills) has the same volatility as a benchmark portfolio M (typically the S&P 500). This new portfolio is P^* and its return is r_{P^*}. Then compute

$$M^2 = \bar{r}_{P^*} - \bar{r}_M \tag{2}$$



Thus, M^2 is the return difference between a managed portfolio, P^*, leveraged to match the volatility of a passive index, M, and the return on that index.

It is a return, and can be easily interpreted. But also, as we show below, M^2 is a linear transformation of the Sharpe ratio, and therefore yields identical fund rankings as the Sharpe ratio.

M^2 preserves the same ranking of funds as the Sharpe ratio

The excess return on portfolio P^* can be represented by:

$$r_{P^*} - r_f = w r_P + (1-w) r_f - r_f = w(r_P - r_f) \tag{3}$$

Taking variances, and setting them equal to that of the market:
$\sigma_M^2 = \sigma_{P^*}^2 = w^2 \sigma_P^2$, so $w = \frac{\sigma_M}{\sigma_P}$, and $\bar{r}_{P^*} - r_f = \frac{\sigma_M}{\sigma_P}(\bar{r}_P - r_f)$.

$$\begin{aligned}
M_P^2 &\equiv \bar{r}_{P^*} - \bar{r}_M && (4)\\
&= (\bar{r}_{P^*} - r_f) - (\bar{r}_M - r_f) && (5)\\
&= \frac{\sigma_M}{\sigma_P}(\bar{r}_P - r_f) - (\bar{r}_M - r_f) && (6)\\
&= \left(\frac{\bar{r}_P - r_f}{\sigma_P} - \frac{\bar{r}_M - r_f}{\sigma_M} \right) \sigma_M && (7)\\
&= (\mathrm{SR}_P - \mathrm{SR}_M)\, \sigma_M && (8)
\end{aligned}$$

So M^2 still ranks the portfolios by their Sharpe ratios, but this transformation measures the average return difference from the market (with the same volatility), which is easier for economic interpretation.

Risk-adjusted metrics for non-diversified portfolios

- If a large fraction of your money is tied up in one particular fund, computing a Sharpe ratio or M^2 for that fund and comparing against other funds or the market would be one reasonable performance evaluation measure.
- The Sharpe ratio, or M^2, is not appropriate for funds that you are considering as part of a larger portfolio, or when you are deciding how much to compensate managers.
- In this case, you will want to use a measure which looks at the value added relative to the portfolio you are currently holding.
- Two alternative measures are useful in this case:
  1. Jensen's α
  2. appraisal/information ratio

Jensen's α (1968)

- This measure simply asks how the average return of the fund compares to the average return according to an asset pricing model such as the CAPM, the Fama-French model, or the Carhart model.
- The α for a fund P with respect to the CAPM is

$$\alpha_P = \mathbb{E}[r_P - r_f] - \beta_M \mathbb{E}[r_M - r_f] \tag{9}$$

- The α for a fund P with respect to a multifactor model is

$$\alpha_P = \mathbb{E}[r_P - r_f] - \beta_1 \mathbb{E}[F_1] - \beta_2 \mathbb{E}[F_2] - \ldots - \beta_K \mathbb{E}[F_K] \tag{10}$$

Estimating α

- Usually, we estimate α with a simple OLS regression.
- If our benchmark risk-return model is the Carhart model, run the regression:

$$\begin{aligned} r_{p,t} - r_{f,t} = \alpha_p &+ \beta_{p,m}(r_{m,t} - r_{f,t}) \\ &+ \beta_{p,SMB}\, r_{SMB,t} + \beta_{p,HML}\, r_{HML,t} \\ &+ \beta_{p,MOM}\, r_{MOM,t} \\ &+ \epsilon_{p,t} \end{aligned} \tag{11}$$

- Note that the Carhart model nests the CAPM and the Fama-French models.
- Statistically, we will then ask if the estimate of α_p is different from zero.
- How much data? Typically 5 years of monthly data.

Regression example

Regression produces estimated values, $\hat{\alpha}$ for α, and $\hat{\beta}$ for β, where our risk-return model here is the CAPM:

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.4692
R Square	0.2201
Adjusted R Square	0.2067
Standard Error	0.0953
Observations	60

ANOVA

	df	*SS*	*MS*	*F*
Regression	1	0.1486	0.1486	16.3731
Residual	58	0.5265	0.0091	
Total	59	0.6751		

	Coefficients	*Std. Error*	*t-Stat*	*P-value*
Intercept	0.0277	0.01340	2.0645	0.0434
S&P500	1.2554	0.31020	4.0464	0.0002

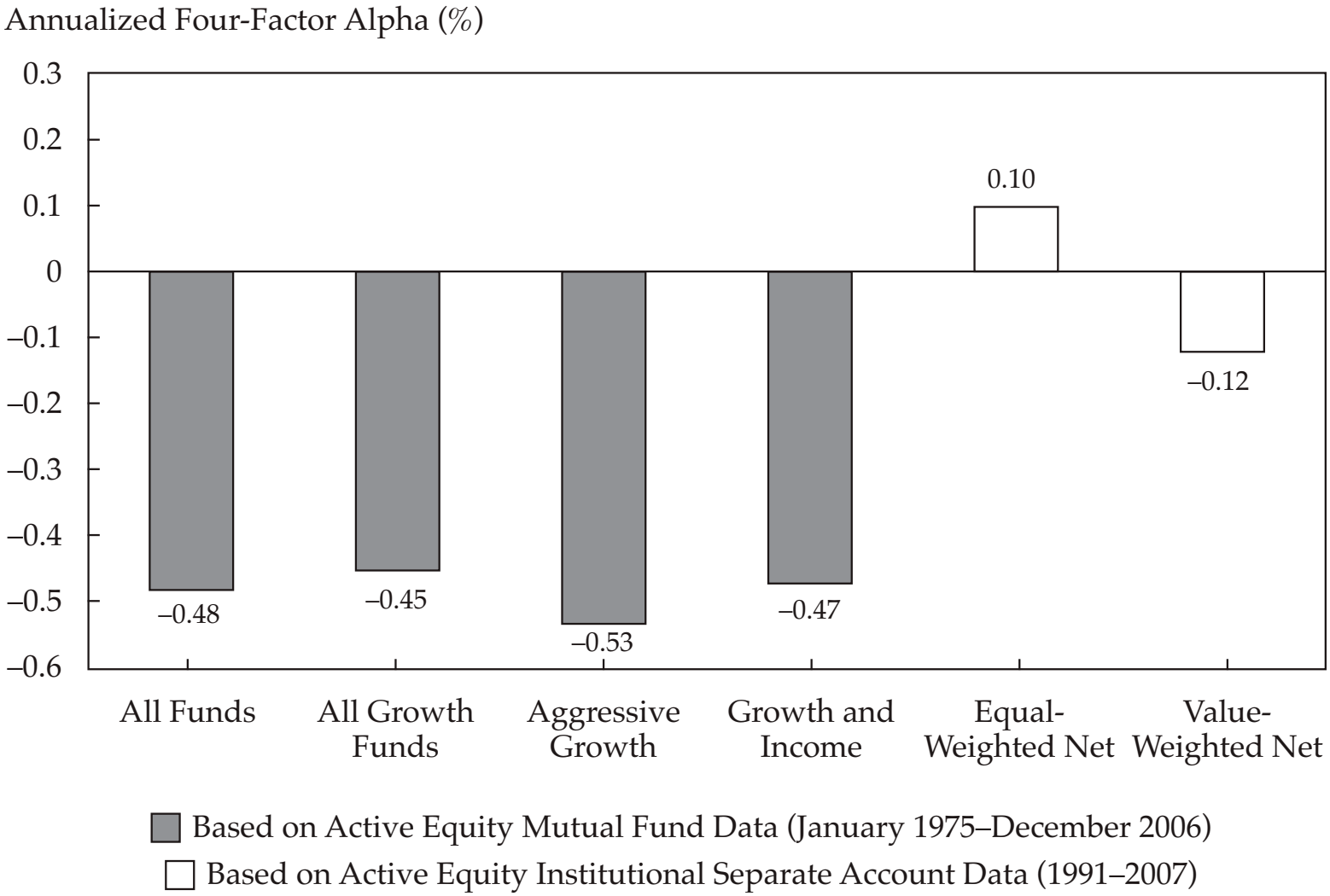
The regression also tells us how reliable the estimates are.

Regression can also tell us what the manager might be doing. What might it mean if R^2 is 0.98? 0.10?

Interpreting α

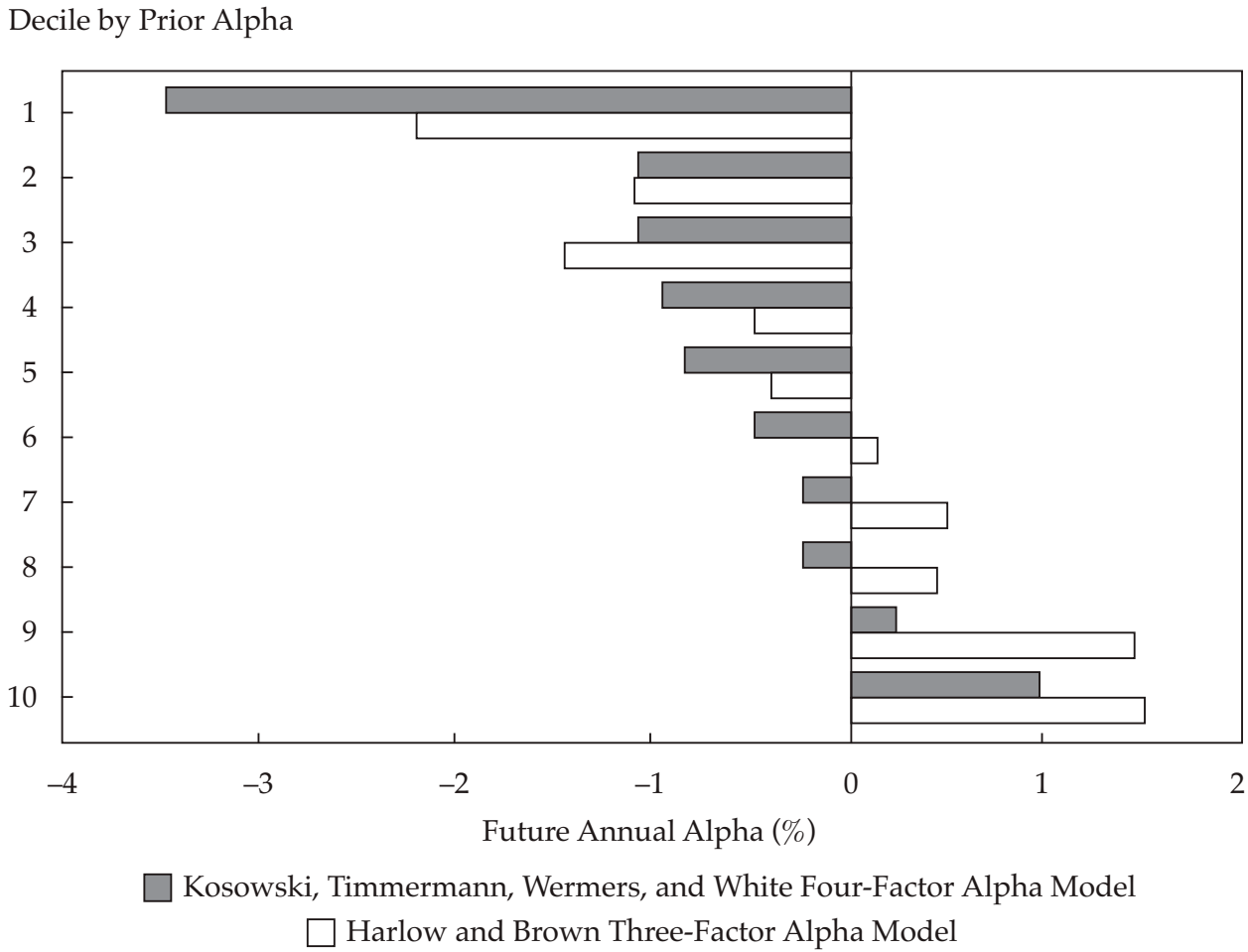
- The risk-return model you use to compute α assumes you can generate those returns without the fund manager.
- For example, if you cannot easily trade momentum, then you should not use the Carhart model to adjust for risk.
- Jensen's α can be interpreted as the maximum you should be willing to compensate a fund manager.
  - α is a return, above the level you would expect to earn given your risk exposures (βs).
  - If a fund has a pre-expense monthly α of 0.2%, this means we should be willing to pay up to 0.2% per month or approximately 2.4% annually in expenses.
  - Of course, if you compensate the manager this much, your after-expense α would be zero.

Average fund α's



Sources: Barras, Scaillet, and Wermers (2010) for mutual fund data; Busse, Goyal, and Wahal (2010) for ISA data.

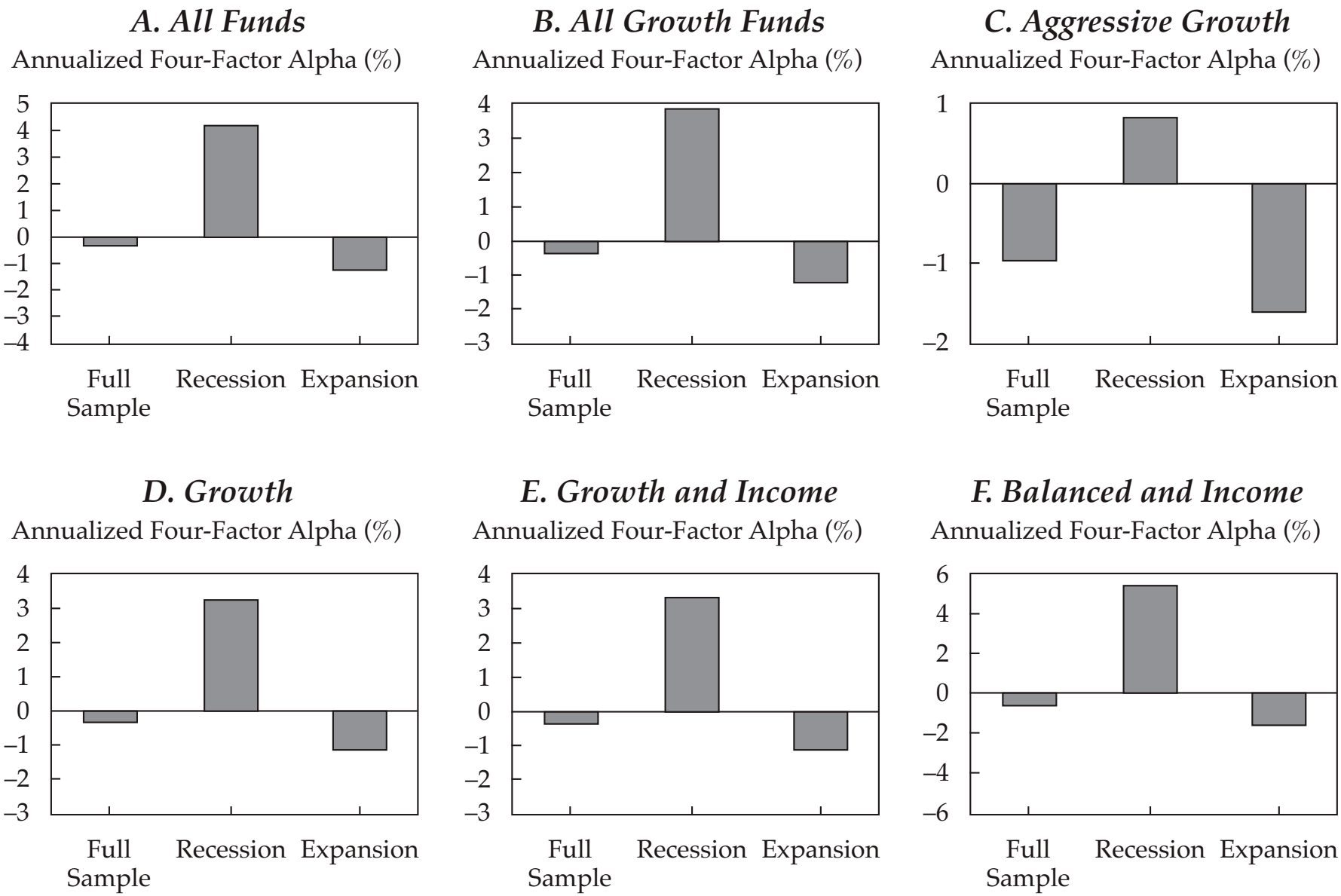
Persistence of mutual fund α's



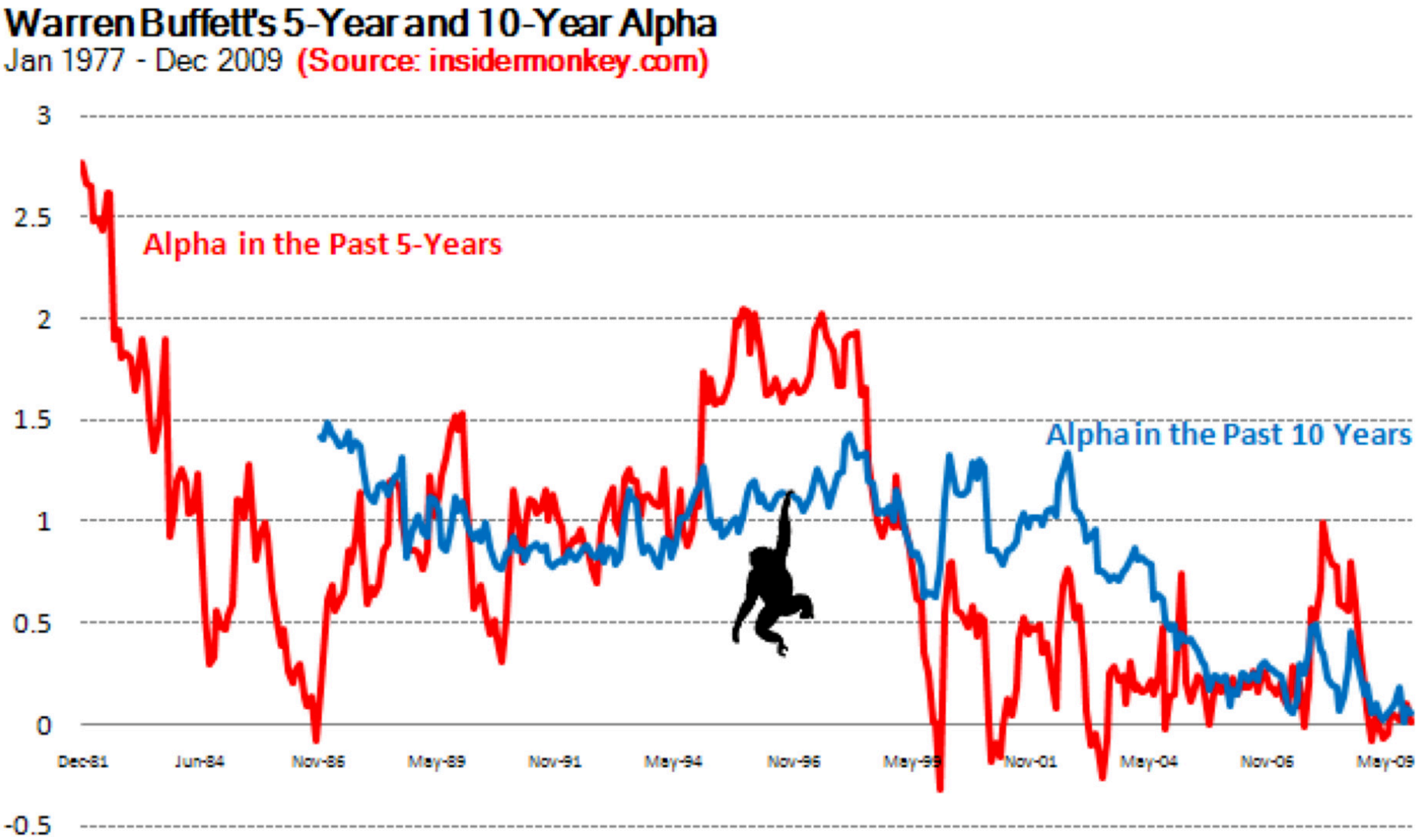
Notes: Harlow and Brown (2006) used a three-factor alpha methodology and rebalanced quarterly over 1979–2003. Using a four-factor alpha methodology with a three-year ranking period and a bootstrapping technique to model non-normality, Kosowski, Timmermann, Wermers, and White (2006) rebalanced annually over 1978–2002.

Sources: Harlow and Brown (2006); Kosowski, Timmermann, Wermers, and White (2006).

Conditional mutual fund α's



Example: Berkshire Hathaway's α



Issues

- The appropriate performance measure is related to the preferred risk measure (e.g. standard deviation versus β).
- Many observations are required to mitigate the effect of randomness (**sampling error**) from the evaluation process because portfolio returns are noisy (high idiosyncratic volatility).
  - We are essentially trying to estimate the mean of a distribution when the variance of the distribution is unknown, and potentially large.
- The shifting mean and variance of actively managed portfolios, including many hedge funds, complicates performance evaluation. For example, if a portfolio manager "times" the market, that portfolio's β can change significantly through time.
- Finally, it is important to understand the **principal-agent dynamic** between investors and fund managers. Given the compensation contract of a fund manager, he or she will act in her own best interest, not that of the investor.

Information ratio

- One issue with Jensen's α is that it does not adjust for the amount of idiosyncratic risk in the portfolio being considered.
- The less idiosyncratic risk, the more of the fund we can add to a diversified portfolio without driving up the variance too much.
- This motivates using the information, or appraisal, ratio:

$$\text{IR}_P = \frac{\alpha_P}{\sigma_P^\epsilon} \tag{12}$$

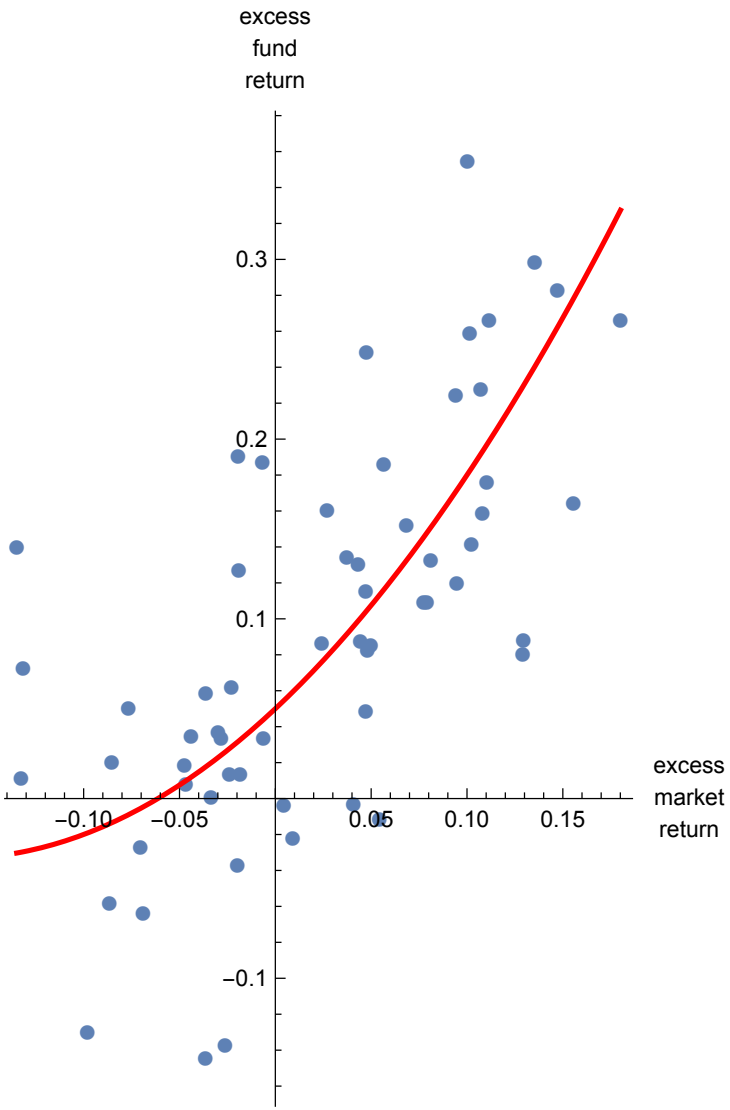
where σ_P^ϵ is the standard deviation of the residuals from the regression in (11).

Market Timing

Changing risk exposures

- If a manager can time the market, then the manager will want to take on more market risk ($\beta \uparrow$) when the market is expected to go up and less ($\beta \downarrow$) when the market is expected to go down. For such a manager, β is therefore a function of time $\rightarrow \beta_t$.
- This can be achieved by shifting the mix across asset classes (equity, bonds, cash) or among stocks in an equity fund.
- The performance measures we have examined so far are not suitable for evaluating a fund manager who times the market since they do not allow for time-variation in beta risk exposure.
- We need evaluation measures that account for nonlinearity between portfolio and benchmark returns.

Treynor and Mazuy quadratic model (1966)

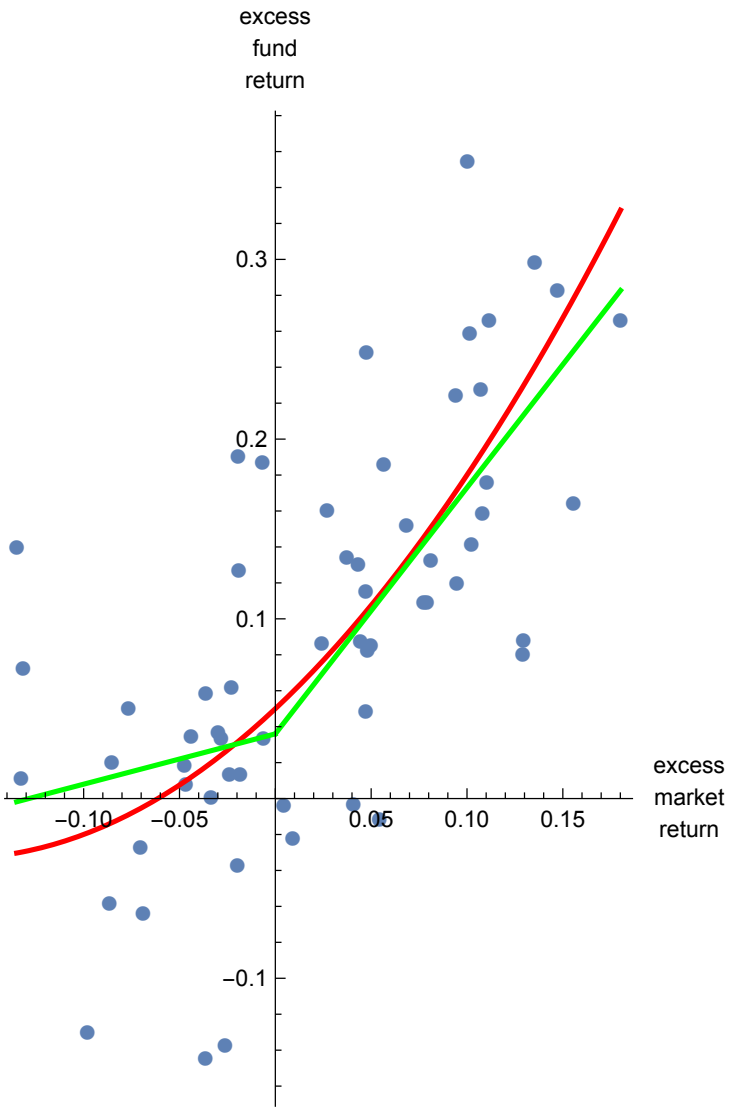


- Extend the usual market model regression with a quadratic term:

$$r_{it} - r_{ft} = \alpha_i + \beta_i(r_{mt} - r_{ft}) + \gamma_i(r_{mt} - r_{ft})^2 + \epsilon_{it} \quad (13)$$

- Timing skill exists if $\gamma_i > 0$

Henriksson and Merton (1981) model



- Segment the sample into up and down markets and for each segment, estimate a β:

$$r_{it} - r_{ft} = \alpha_i + \beta_i^{up}(r_{mt}^{up} - r_{ft}) + \beta_i^{down}(r_{mt}^{down} - r_{ft}) + \epsilon_{it} \quad (14)$$

- Timing skill exists if $\beta^{up} > \beta^{down}$
- In a multifactor setting, you can test if the portfolio manager has timing ability based on the factors.

Style Analysis

Style analysis

- Any performance measure can be gamed.
- Consider a fund manager who claims to provide index exposure only.
  - He could buy futures on the index.
  - Invest the remaining assets on a momentum strategy that has zero correlation with the index.
- Would an α uncover this?
- Instead, we could estimate β's for the fund in question with respect to benchmark portfolios. This will implicitly reveal the fund's objective.
- This approach, known as *style analysis*, was originally proposed by Bill Sharpe in 1992.

Return decomposition

- Style analysis decomposes a managed portfolio's return into two components:
  1. Return due to style,
  2. Return due to selection.
- The style return is simply the return that could have been generated by holding a passive style portfolio (growth, value, etc.).
- The selection return equals the difference between the fund's return and a passive mix of the same style as the fund.
- In other words, it captures the skill of the manager beyond the passive styles.

Implementing a style analysis

- To conduct a style analysis:
  1. Construct a portfolio of style benchmarks $r_1, \ldots, r_K$ that you think encompass all asset classes in which the manager might be investing.
  2. Run a style regression:

$$r_{p,t} = \underbrace{\alpha_p}_{\text{Selection}} + \underbrace{\beta_1 r_{1,t} + \cdots + \beta_K r_{K,t}}_{\text{Style}} + \epsilon_{p,t} \tag{15}$$

- The style component $\beta_1 r_{1,t} + \cdots + \beta_K r_{K,t}$ captures the returns one could achieve just by investing in passive benchmarks.
- The selection component α_p gives the manager's contribution.

What are the appropriate style benchmarks?

- Style benchmarks depend on the application, but here is a common set:
  1. Cash - 30 or 90 day T-Bill
  2. Bonds - Barclays Capital Aggregate Bond Index
  3. International Equity - MSCI EAFE (excludes the U.S. and Canada)
  4. U.S. Large Growth - Russell Top 200 Growth
  5. U.S. Large Value - Russell Top 200 Value
  6. U.S. Mid-Cap Growth - Russell Mid-Cap Growth
  7. U.S. Mid-Cap Value - Russell Mid-Cap Value
  8. U.S. Small Growth - Russell 2000 Growth
  9. U.S. Small Value - Russell 2000 Value

- Depending on the fund's mandate, one might also include:
  - Momentum or other "anomaly" portfolios,
  - Dynamic strategies with option-like payoffs.

Example: Fidelity Contrafund, Fidelity Magellan, and Berkshire Hathaway

FCNTX : Composition - 02/14

Stocks	94.77%
Foreign Stocks	9.22%
Cash	5.66%
Bonds	0.01%
Foreign Bonds	0.00%
Preferred	0.00%
Convertible	0.33%
Other	-0.77%
Foreign Hedged	0.00%

FCNTX : Style Analysis - 02/14

Large Growth	94.66%
Large Value	0.00%
Small Growth	0.00%
Small Value	0.00%
Foreign Stock	0.00%
Emerging Market	0.00%
Precious Metals	4.27%
Intermediate Bond	0.00%
High Yield Bond	0.00%
Foreign Bond	0.00%

FMAGX : Composition - 02/14

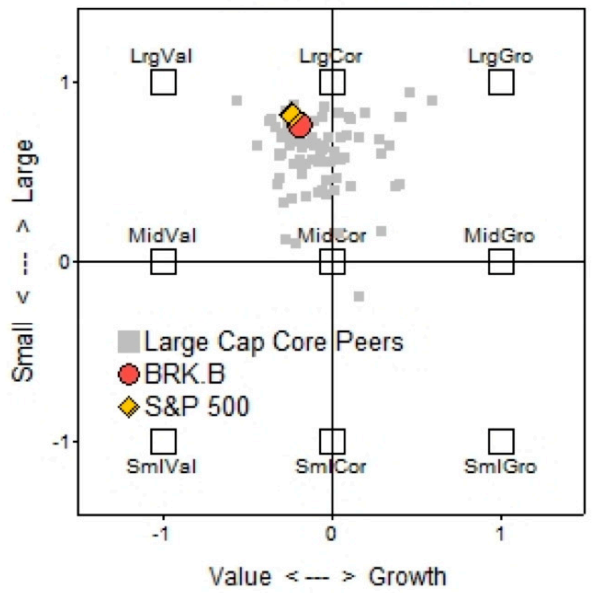
Stocks	96.08%
Foreign Stocks	9.61%
Cash	5.00%
Bonds	0.00%
Foreign Bonds	0.00%
Preferred	0.25%
Convertible	0.13%
Other	-1.45%
Foreign Hedged	0.00%

FMAGX : Style Analysis - 02/14

Large Growth	61.27%
Large Value	19.42%
Small Growth	0.00%
Small Value	0.00%
Foreign Stock	3.73%
Emerging Market	4.62%
Precious Metals	0.00%
Intermediate Bond	9.74%
High Yield Bond	0.00%
Foreign Bond	0.00%

BRK.B: US Style Exposure

(average, last 5 years)



Peer Group: 102 funds determined by exposure analysis to be large-cap core; institutional share class.

Discussion of style analysis

- Strengths
  1. Can handle any strategy for which indexes exist.
  2. Uses only return information (available at high frequency).
  3. Helps detect "alpha porting" (targeting benchmark betas, then adding alpha) even though perhaps never mentioned by the fund.

- Weaknesses
  1. Style is an average over time, not a snapshot.
  2. Problematic if applied to rapid style rotators.
  3. Style analysis is only as good as the appropriate selection of benchmarks.
  4. Statistical performance testing is difficult, especially if benchmarks are highly correlated.
  5. Not immune to gaming (example: return smoothing, window dressing).

Summary

- The basic idea behind performance measurement is to determine how well the fund manager did relative to a comparable "benchmark" portfolio.
- What if you're not sure what the comparable benchmark is? Style analysis can provide an answer.
- By selecting appropriate benchmarks, the manager's contribution or α can be evaluated relative to these benchmarks.
- The manager should not be rewarded for following strategies that are common knowledge.
- Little evidence that fund managers on average outperform the market.