Capital Asset Pricing Model & Mutual Fund Performance Studies – Review and Evidence

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Version: 25 Januar, 2002

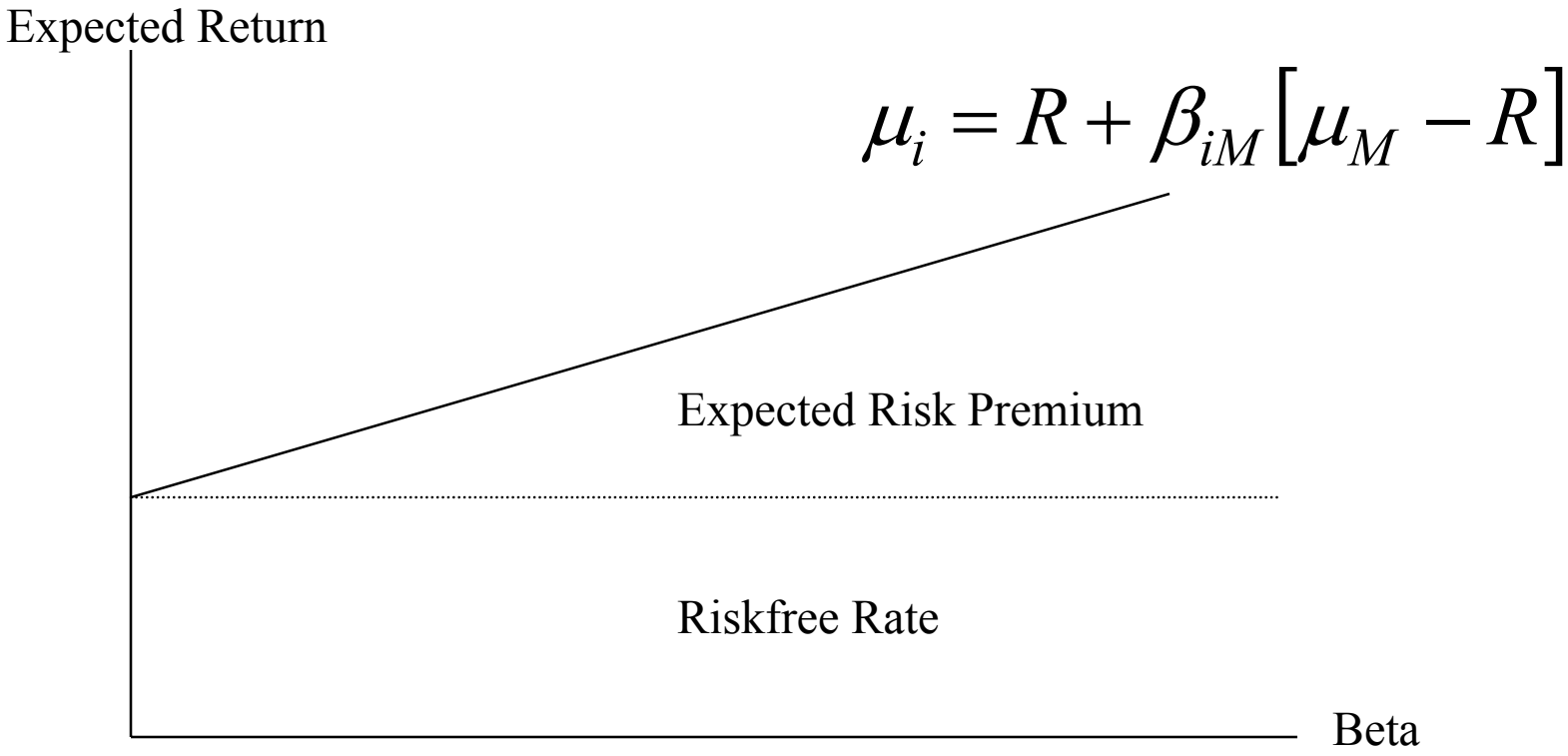
The Basic Paradigm: “Market Efficiency”

- Information affects prices
- Prices “reflect” information
- This makes only sense in the context of incomplete, or heterogeneous information
- So, information aggregation is the issue
- Are competitive price systems able to aggregate information, *all* information? What information?
- Costs of information processing, the free-rider problem, and the impossibility of informationally efficient markets (or better: a fully revealing price system) in equilibrium

Market Efficiency – The history

- The Martingale model: Bachelier 1900
- The empirical record on Random Walks: Cowles, Kendall, Cootner, Fama …
- Random Walk and predictability: Samuelson 1965, 1972
- The Fama definition 1970
- Grossman/ Stiglitz 1976: Information aggregation and competitive price systems
- Grossman/ Stiglitz 1980, Ippolito 1989: Costly information, and the impossibility of informationally efficient markets
- Market efficiency and volatility bounds: Present value relations and discouting

The CAPM


Expected Return
$\mu_i = R + \beta_{iM}[\mu_M - R]$
Expected Risk Premium
Riskfree Rate
Beta

Who has developed the CAPM?

- Jack Treynor 1961 unpublished
- William Sharpe 1964
- John Lintner 1965
- Ian Mossin 1966
- Michael Jensen 1968

CAPM – Econometric issues

- How to estimate expected returns?
- Estimated instead of true betas (Miller/ Scholes 1972)
- Specification of market portfolio (Roll 1977, Stambaugh 1982)
- Time variation of betas
- Time variation of expected risk premia
- Time horizon, no riskless asset (Black 1972)
- Nominal or real returns?
- Non-normality of returns

CAPM – Classic tests

The basic test methodologies:

- Ex ante CAPM must be transformed to an ex post test equation
- Tests for individual stocks vs. beta-grouped portfolios
- Test strategy 1: Time-series regressions
- Test strategy 2: Cross-sectional regression based on average returns
- Test strategy 3: Time-series of cross-sectional regressions

Black/ Jensen/ Scholes 1972

$$R_{it} - R_{ft} = \alpha_i + \beta_i \left[R_{Mt} - R_{ft} \right] + \varepsilon_{it}$$

PF	β	Überrendite [%]	α	ρ
1	1.56	2.13	-0.083	0.96
2	1.38	1.77	-0.194	0.99
3	1.25	1.71	-0.065	0.99
4	1.16	1.63	-0.017	0.99
5	1.06	1.45	-0.054	0.99
6	0.92	1.37	0.059	0.98
7	0.85	1.26	0.046	0.98
8	0.75	1.15	0.081	0.98
9	0.63	1.09	0.197	0.96
10	0.49	0.91	0.201	0.90
Markt	1.0	1.42		

Fama/McBeth 1973

$$R_{it} = \gamma_{0t} + \gamma_{1t}\beta_i + \gamma_{2t}\beta_i^2 + \gamma_{3t}\sigma_{ei} + \eta_{it}$$

Periode	γ_0 [%]	γ_1	γ_2	γ_3
1935-40	0.09	0.016	-0.003	0.003
1941-45	0.15	0.007	0.001	0.177
1946-50	0.11	0.014	-0.004	-0.031
1951-55	0.23	0.028	-0.011	-0.044
1956-60	1.03	-0.005	-0.002	0.098
1961-68	-0.17	0.009	0.001	0.096
1935-68	0.20	0.011	-0.003	0.052

CAPM – Extensions I

- No riskfree asset : Zero-beta CAPM. Black 1972
- Non-traded assets: Mayers 1972
- Intertemporal CAPM, Non-stationarities: Merton 1973
- Dividends, taxes: Litzenberger, Scholes, …
- Foreign exchange risk: Solnik 1974
- Inflation and PPP risk: Friend/ Landskroner/Losq 1975, Sercu 1980, Adler Dumas 1983
- Investment restrictions: Stulz 1983

CAPM – Extensions II

- Short-sale restrictions: Ross 1975
- Heterogeneous expecations: Williams 1977
- Consumption risk: Breeden 1979, Stulz 1981
- LPMs instead of variances: Harlow/ Rao 1989

CAPM – Roll's 1977 critique

- There is a linear pricing relationship between the expected returns of any portfolios and their betas to *any* MV-frontier portfolio
- Linear pricing relationships do not tell us anything about the underlying economic equilibrium! They hold by no-arbitrage alone.
- If the market portfolio is not *ex ante* efficient, then the relationship between risk and expected return is not necessarily linear.
- Any test of market efficiency is at most a test about the *ex ante* efficiency of the market portfolio.

CAPM – Anomalies

- P/E: Basu 1977
- Size: Banz 1981
- Dividend yields and the Dow Theory: Fama/French …
- Value-growth: Capaul/ Rowley/ Sharpe
- Seasonalities (January, day of the week, …): Keim, Reinganum, etc.

Some Fama-French results

Beta

Size

	Durch-schnitt	tief-Beta	2	3	4	5	6	7	8	9	hoch-Beta
Durch-schnitt	1.3	1.3	1.3	1.4	1.3	1.3	1.3	1.2	1.2	1.3	1.1
klein	1.5	1.7	1.6	1.8	1.6	1.5	1.5	1.4	1.6	1.5	1.4
2	1.3	1.3	1.4	1.4	1.4	1.7	1.6	1.4	1.3	1.3	1.1
3	1.2	1.1	1.3	1.2	1.7	1.3	1.1	1.3	1.4	1.3	0.8
4	1.3	1.3	1.1	1.5	1.1	1.3	1.1	1.4	1.2	1.4	1.0
5	1.3	1.3	1.4	1.4	1.5	1.4	1.2	1.1	1.3	1.2	1.1
6	1.2	1.1	1.5	1.3	1.2	1.2	1.2	1.2	1.0	1.1	1.0
7	1.1	1.0	1.2	1.3	1.1	1.2	1.1	1.2	0.6	1.3	0.8
8	1.1	1.1	1.1	1.4	1.2	1.3	1.0	1.2	1.0	1.0	0.9
9	1.0	1.0	0.9	1.0	1.1	1.1	1.2	0.9	0.8	0.9	0.6
gross	0.9	1.0	0.9	1.1	0.9	0.9	0.9	1.0	0.7	0.7	0.6

Datengrundlage: Zeitperiode 1963-90, monatliche Durchschnittsrenditen in % auf 1 Kommastelle gerundet
Quelle: Fama/ French 1992, Tabelle I

Fama-French Controversy I

- The Fama-French observation: if we control for size (capitalization), the positive relationship between beta and return disappears.
- There is a joint B/M and size effect upon returns.
- What measures the B/M ratio?
- What measures size?

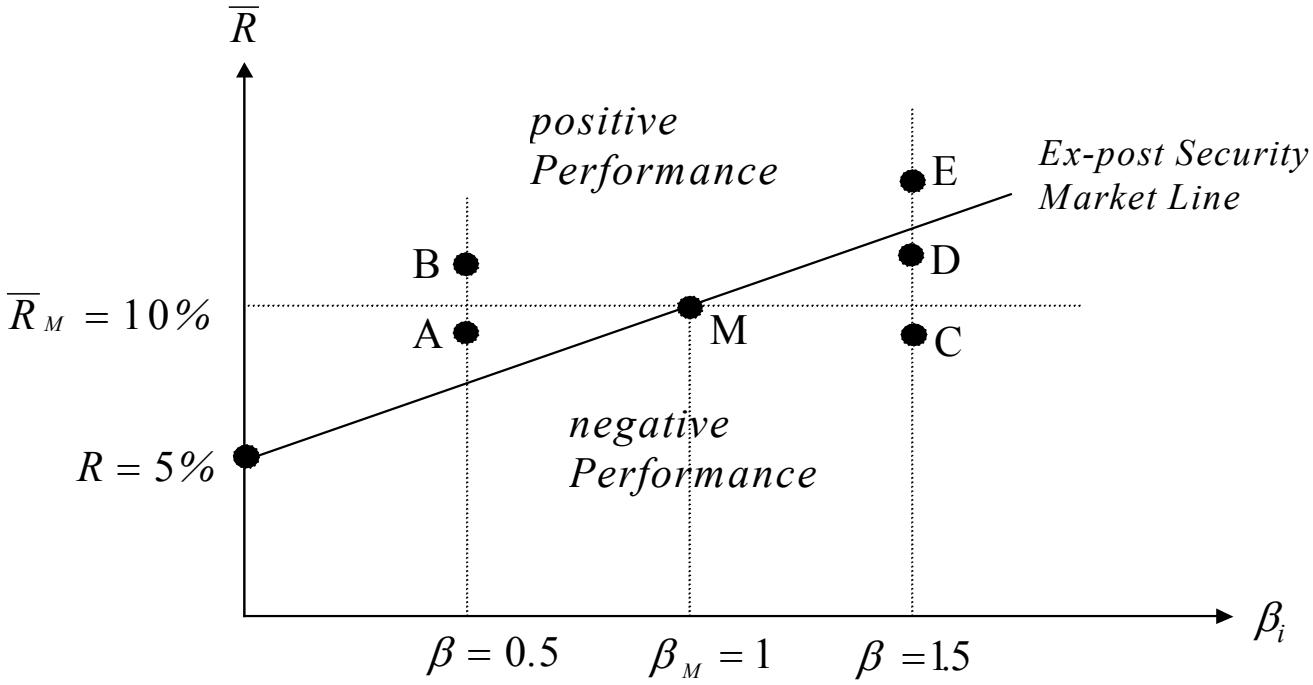
Fama-French Controversy II

- Misinterpretation of the results, time period: Black 1993
- Inefficiency of market portfolio: Roll/Ross 1994 JF
- Multifactor model: Fama/French 1996 JF
- Outliers and trimmed regressions: Knez/Ready 1997 JF
- The “alpha” factor: Ferson/ Sarkissian/ Simin 1999 JFM

Asset Pricing – New methodologies

- Multivariate tests: Gibbons 1982, Shanken 1985, etc.
- APT-tests: Roll/Ross 1980, Dybvig/ Roll 1985, Roll/ Ross 1984, Grinblatt/T itman 1985, …
- Volatility and rational bounds: Shiller 1980, LeRoy/Porter, Marsh/ Merton, Cochrane, …
- Time-series / Euler tests: Hansen/ Singleton 1982, 1983, …
- Conditional CAPM: Ferson/ Harvey 1991 etc., Harvey 1991
- Behavioral and experimental models: DeBondt/Thaler …

Performance Measurement: Jensen`s Alpha



Other risk-adjusted performance measures

- The Sharpe ratio:
  Excess return in relation to total volatility

- The Treynor ratio:

  Excess return in relation to beta

- The appraisal ratio (Black/ Treynor):

  Alpha divided by specific risk

The Alpha in relation to Sharpe Ratios

A positive alpha requires

$$\bar{R}_i > R + \underbrace{\rho_{iM}\frac{\sigma_i}{\sigma_M}}_{Beta\ of\ Portfolio}\left(\bar{R}_M - R\right)$$

which can be written as

$$\underbrace{\frac{\bar{R}_i - R}{\sigma_i}}_{\substack{Sharpe\ Ratio\\ of\ Portfolio}} > \rho_{iM} \times \underbrace{\frac{\bar{R}_M - R}{\sigma_M}}_{\substack{Sharpe\ Ratio\\ of\ Benchmark}}$$

The diversification effect is the major difference between Sharpe ratio comparisons and positive Alphas

The logic of the Appraisal ratio

- Performance measurement assumes active strategies, i.e. ex ante deviations from the benchmark.
- Therefore, alpha must be related to the active risk - the specific risk or tracking error - of the portfolio.
- Equivalently, we can judge the manager-specific, i.e. non-market performance - that is $\alpha+\varepsilon$ - by its Sharpe Ratio. But that Sharpe Ratio is the Appraisal Ratio!
- Problem: With a portfolio arbitrarily close to the benchmark, i.e. by minimizing the tracking error, the ratio can be inflated to infinity - but this could contradict the portfolio strategy.

Performance Measures and T-Stats

- Sharpe Ratio is proportional to a t-stat whether the strategy‘s excess return is different from zero. Without knowledge of the relevant benchmark, this is a sensible hurdle each strategy should master. Proportionality factor is $\sqrt{T}$. Both measures lead to identical rankings (using the same number of observations, T)!
- Appraisal Ratio is proportional to t-stat whether alpha is different from zero. Proportionality factor from OLS is $\sqrt{T\sum\left(R_M-\overline{R}_M\right)^2/\sum R_M^2}$ Both measures lead to identical rankings (using the same observations)!

Performance – Early Tests

- The Friend/ Brown/ Herman/ Vickers 1962 SEC study: 152 funds 1953-58, negative risk-adjusted performance of 20 bp, but costs of active management are approx. 100 bp, i.e. no overall inefficiency of the industry! No relationship between turnover and expenses.

Performance – Classic tests

- Treynor/ Mazuy 1966 – negative performance, funds waste resources
- Sharpe 1966 - negative performance, funds waste resources
- Jensen 1968 - negative performance, funds waste resources

Performance – Other Tests

- Friend/ Blume/ Crockett 1970 – positive alpha, contradict the classic studies
- McDonald 1974 – small success in selectivity and timing
- Carlson 1977 – contradicts Sharpe and Jensen
- Mains 1977 – slightly positive alpha on average
- Kon/ Jen 1979 - …evidence clearly inconsistent with Jensen
- Shawky 1982 – zero performance, after costs
- Ippolito 1989 – renowned for focus on trading, information and management costs and results which contradict Sharpe and Jensen. Alas, the results are biased due to data error

Performance – Econometric issues

- Timing/ tactical asset allocation – implies a nonlinear relationship between beta and returns: Henriksson/Merton 1981, Veit/ Cheney 1982, Kon 1983, Henriksson 1984, …
- Changing beta – missinterpretation of alphas: Grinblatt/Titman …
- Data mining and survivorship: Brown/ Goetzman/ Ibbotson/ Ross 1992, Brown/Goetzman 1995, Blake/ Elton/ Gruber 1996
- Sensitivity of results relative to benchmarks: Lehmann/Modest 1987
- Using funds holdings data: Grinblatt/ Titman 1984
- Factor models vs. equilibrium models, conditional and unconditional

Performance – Practical issues

- Volatility is a bad risk measure if *options* are in the portfolio (hedge funds, structured products)
- Many funds are *illiquid* (hedge f., private eq., bond f.)
- *Sharpe ratio* is used as marketing tool – but it is of limited value to evaluate individual assets/asset classes in a portfolio context
- Check the *statistical significance* of alphas, and translate it to a time-horizon measure
- *Low correlation* is used to promote diversification – but it understates effective portfolio downside risk
- Is performance *persistent*?
- *Survivorship* bias

Tactical Asset Allocation: Bias in alpha

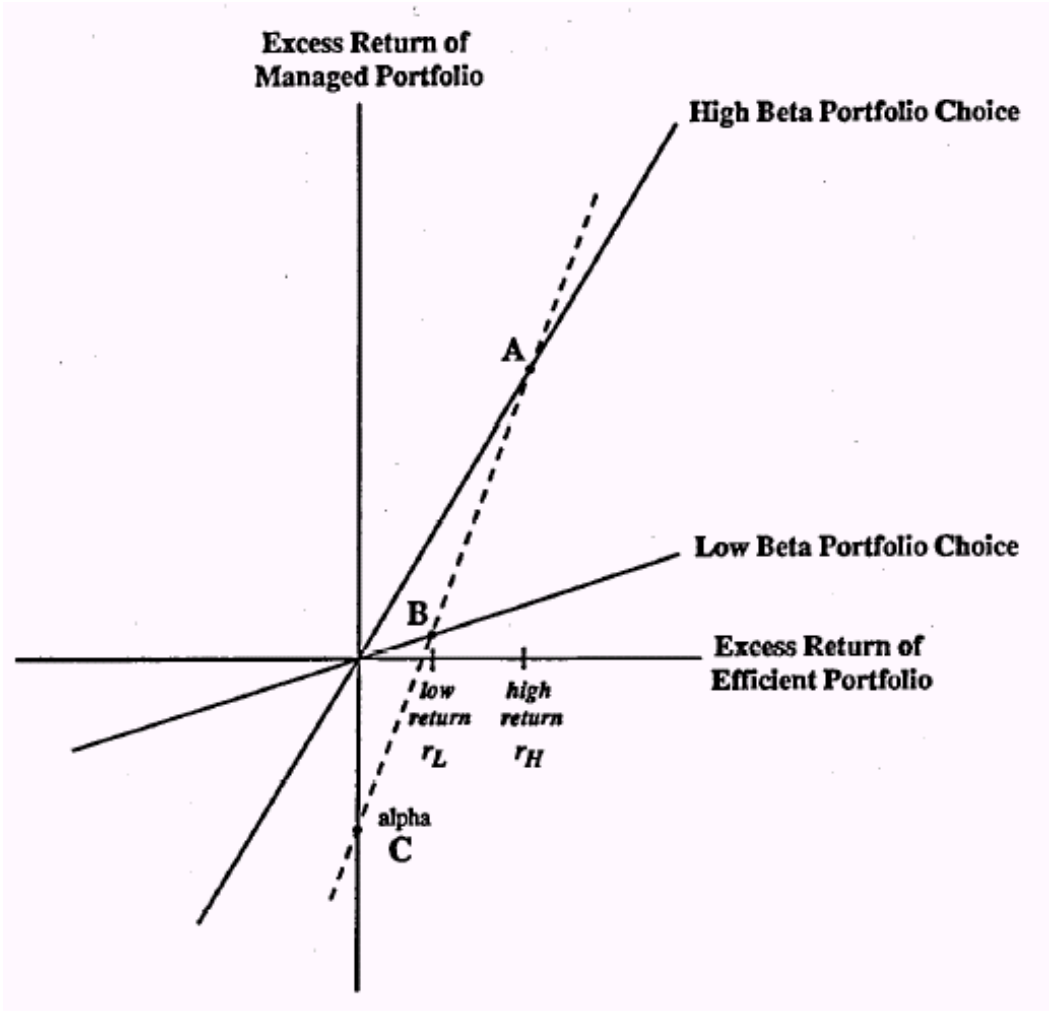


Figure 1
An example of negative Jensen measure for a market timer

The misuse of the Sharpe Ratio

- The Sharpe Ratio (proposed by William Sharpe in 1966) is defined as the expected or realized excess return divided by the standard deviation of the asset
- Correlation coefficients and diversification effects are not reflected in the Sharpe Ratio
- The Sharpe Ratio is relevant *only* if an asset (class) is held individually or in combination with the riskless asset
- However, maximizing the Sharpe Ratio is reasonable for entire portfolios – this yields the Tangency portfolio
- The size of the Sharpe Ratio for an individual asset (asset class) does not tell too much about the optimal weight in a diversified portfolio

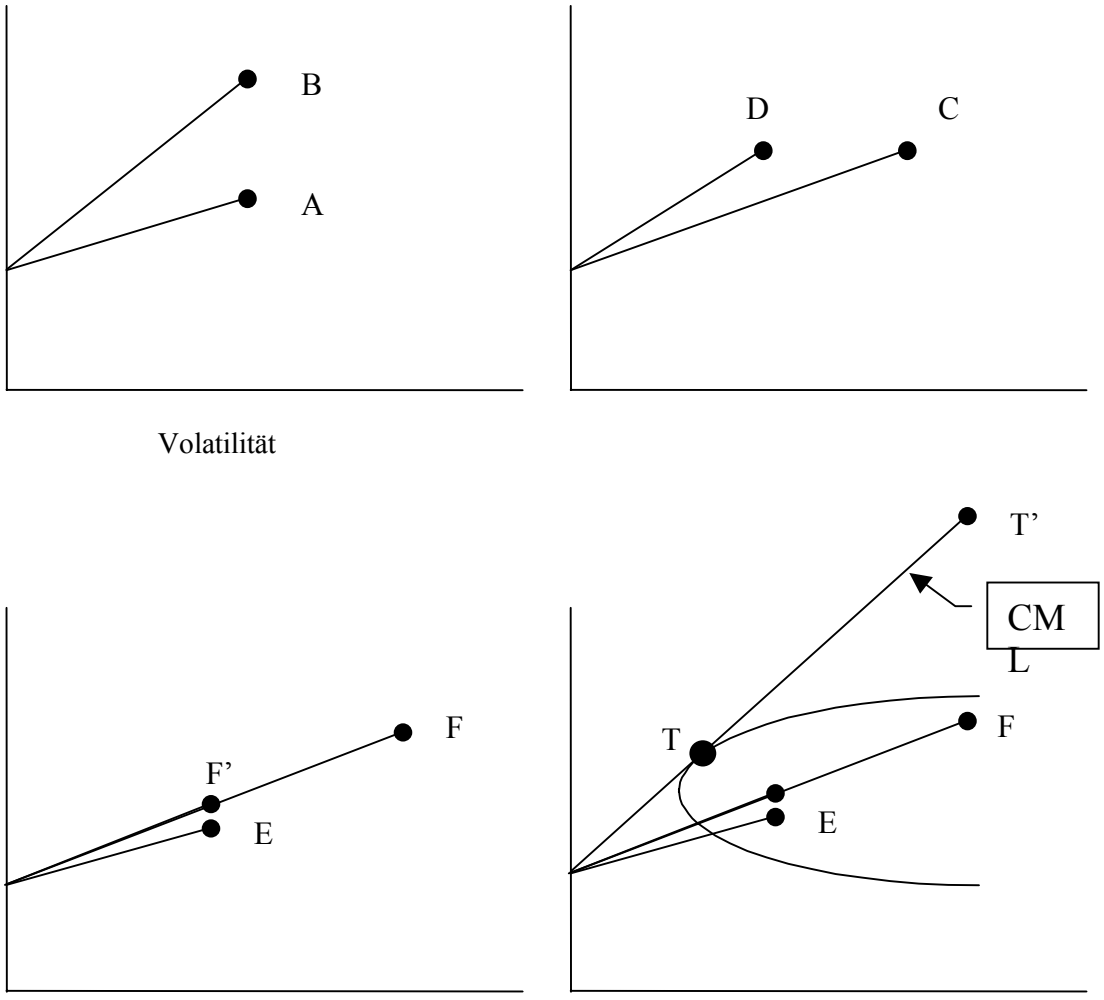
Numerical Example on the misuse of the Sharpe Ratio

	Erwartete Rendite	Volatilität	Sharpe Ratio	Korrelationskoeffizient			
				CH Aktien	CH Bonds	INT Aktien	INT Bonds
CH-Aktien	9%	18%	0.2778	1			
CH-Bonds	5%	5%	0.2000	0.3	1		
INT-Aktien	11%	22%	0.3182	0.5	0.1	1	
INT-Bonds	7%	12%	0.2500	0	0.4	0.2	1
Tangentialp.	*7.7%*	*9.1%*	*0.407*				

Struktur des Tangentialportfolio

CH-Aktien	CH-Bonds	INT-Aktien	INT-Bonds
20.46%	24.80%	19.51%	35.22%

Zugrundeliegende Annahmen: siehe Tabelle 1


B
A
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Volatilität
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Persistence

153 funds	1985-87 winners	1985-87 losers	
1982-84 winners	52	25	77
1982-84 losers	25	52	76
	77	76	153

Winner/loser: defined relative to median

Brown/Goetzman/Ibbotson/Ross (1992), Table 1

Tests on persistence

- Cross product ratio: (52x52)/(25x25) = 4.24
- Under the null, it should be 1.00, t-test clearly rejects

- Chi-square test (expected against actual values squared): Test statistic is 18.35
- Under the null, it should be zero, χ^2-test clearly rejects

- And finally: a simple regression of subsequent alphas

Survivorship Bias

The Brown/ Goetzman/ Ibbotson/ Ross (1992) simulation:

- Returns are generated by a market model – allowing for dispersion in betas and unsystematic risk
- Four-year returns are simulated over two subsequent time periods
- In each of the four years, the managers in the lowest percentile indicated by the cutoff value are expluded from the sample
- The experiment is repeated 20‘000 times.
- Winner/loser: defined relative to median

The results of the simulation

Cutoff Level	*Avg. Chi square statistic*	*Avg. Cross product ratio*	*Avg. Cross sectional t-test*	*Avg. Ann. excess return*
No cutoff	1.04	1.01	0.004	0.00%
5%	1.64	1.16	2.05	0.44%
10%	3.28	1.37	3.36	0.61%
20%	7.13	1.92	4.68	0.80%

Brown/ Goetzman/ Ibbotson/ Ross (1992)

Survivorship Bias: Empirical estimates

The Elton/ Gruber/ Blake (1996) paper

- Analyze 361 funds that exist in 1976
- 106 merged, 216 survived, 39 restriced to public
- 207 funds had more than 15 mio assets u.m.
- Question 1: How to define „survival“: „not merge“ vs. „not merge and keeping the same investment policy throughout the sample“
- Question 2: How to calculate the performance of non-surviving funds. Traditional approach vs. „follow the money“
- Time period investigated: 1977-1993, Wiesenberger database
- Three index model: Market, small stocks, bond yield

Survivorship Bias: Results

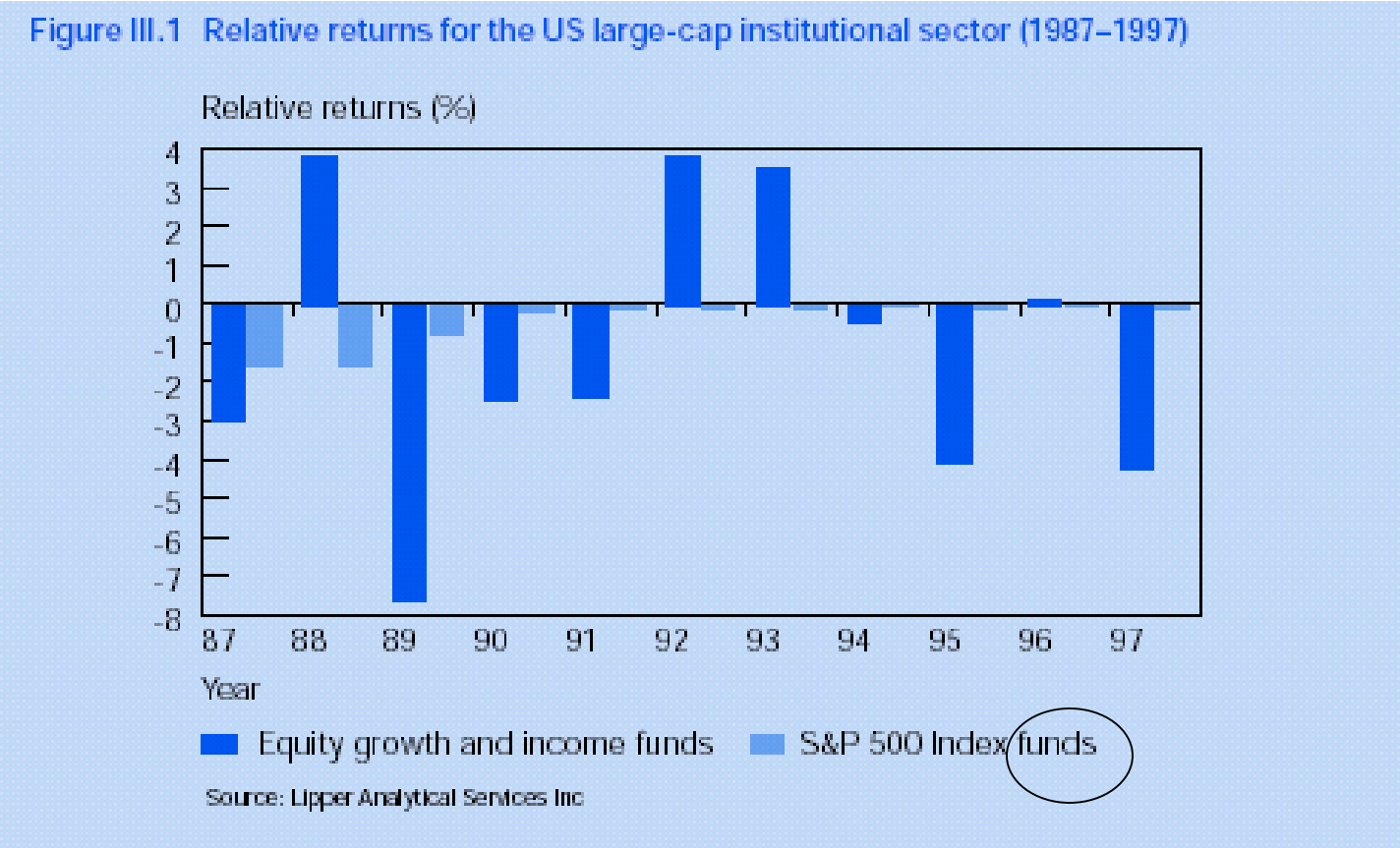
Question 2	Question 1	Survivorship Bias
Traditional approach*	Did not merge	0.91% p.a.
	... and no change in investment policy	0.73% p.a.
Follow the money**	Did not merge	0.77% p.a.
	... and no change in investment policy	0.71% p.a.

*Returns of non-surviving funds calculated up to and including the month of „death“.

**Assuming investing the money equally in all existing funds

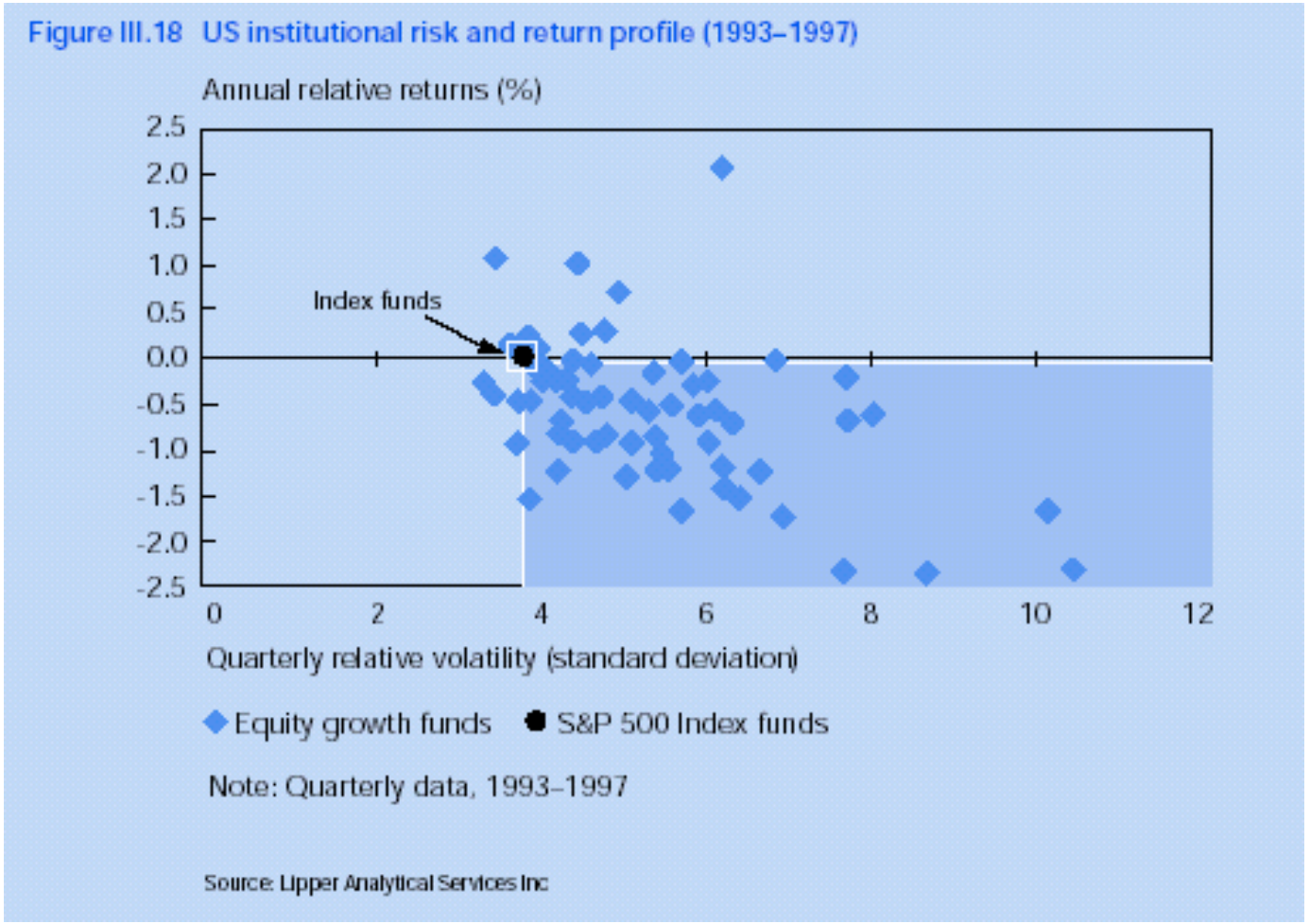
Elton/ Gruber/ Blake (1996)

Active versus passive investing

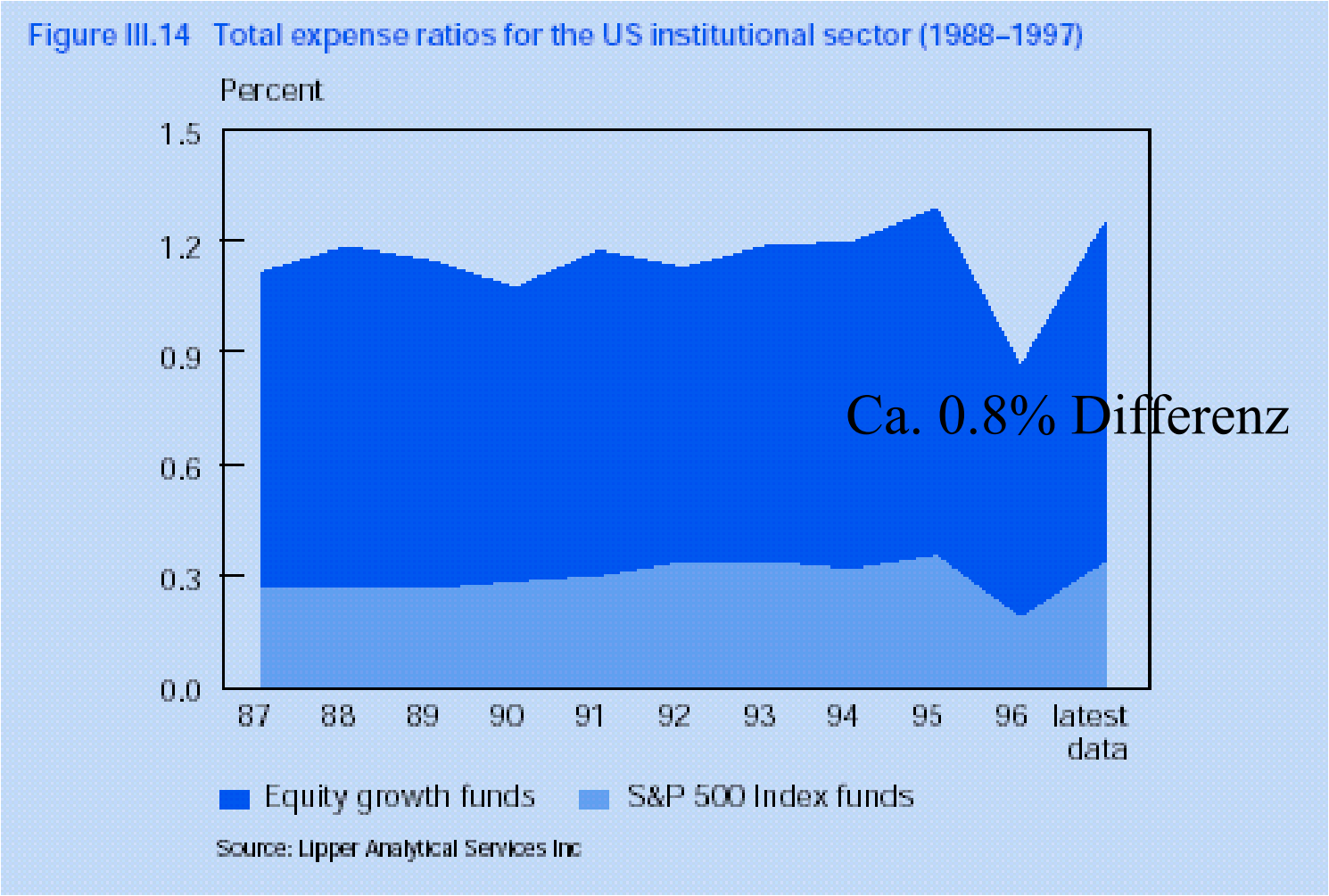


Aktive Underperformance: 1.2%

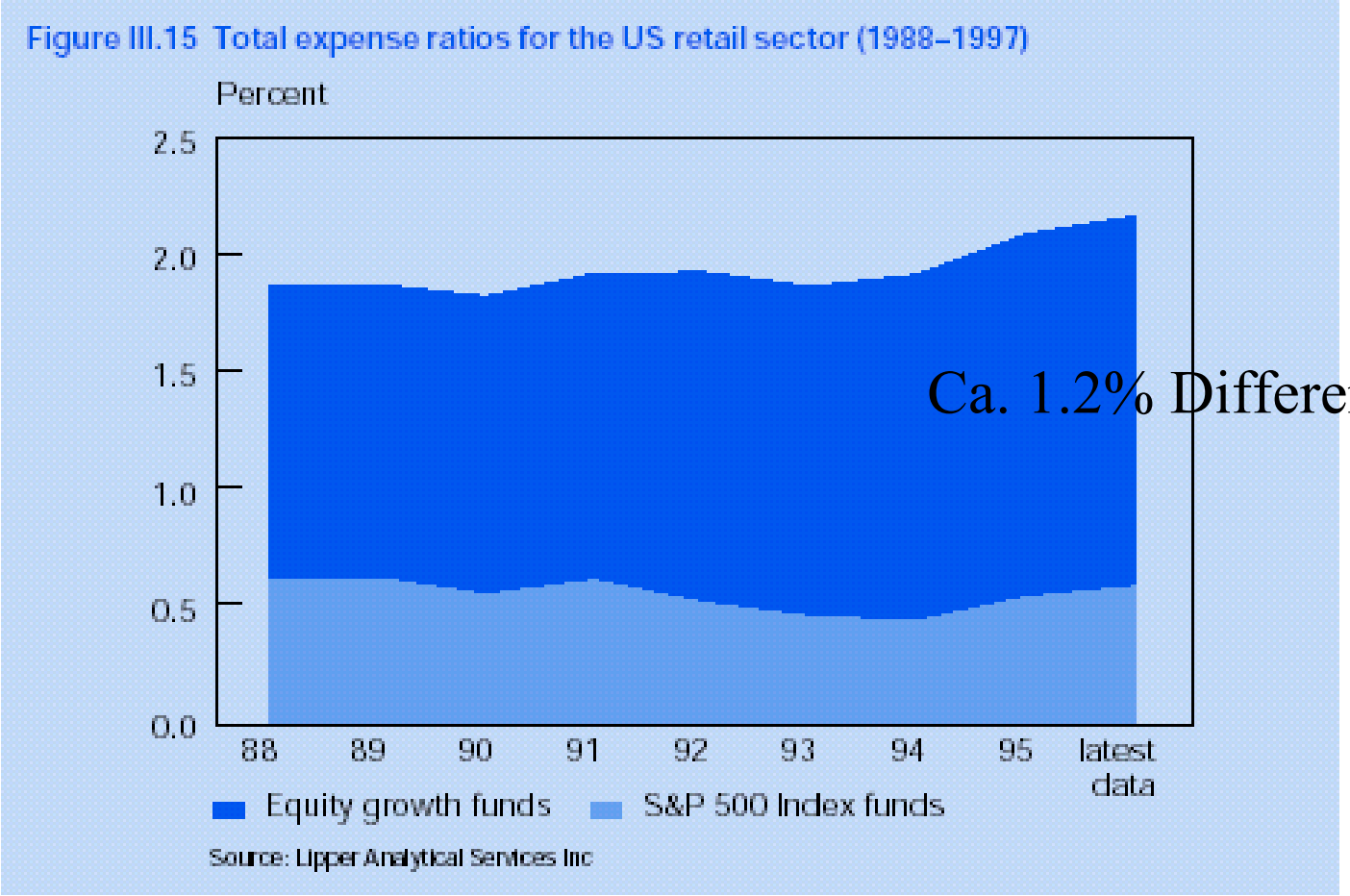
Active versus passive returns.



Expense ratios - institutional.



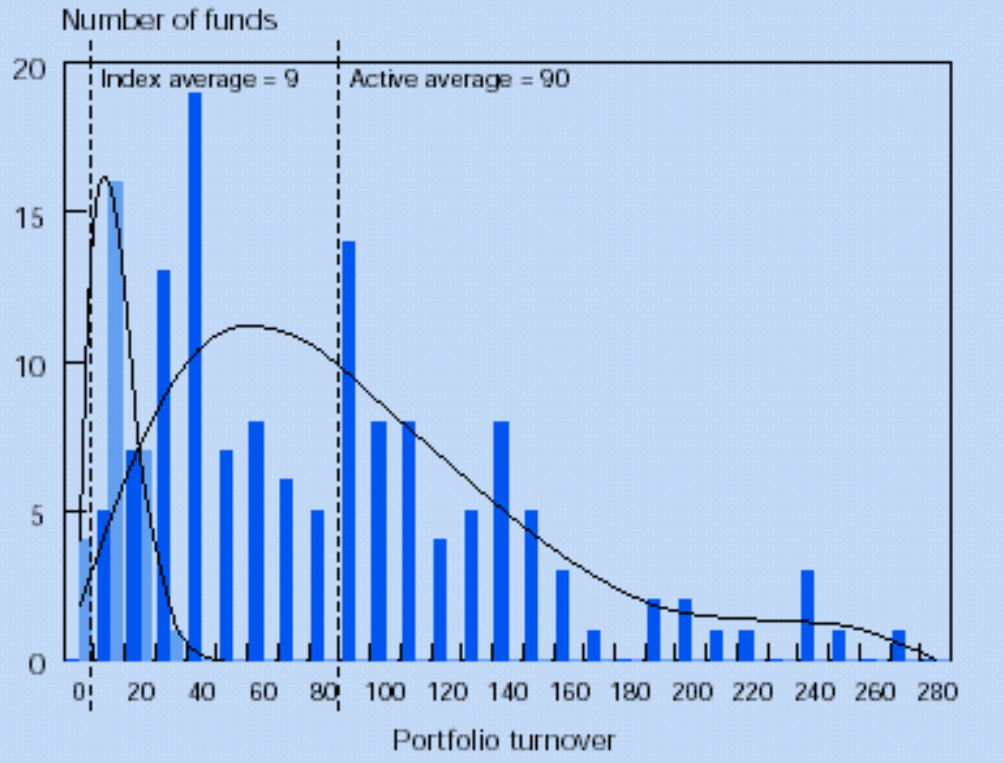
Expense ratios - private.



Ca. 1.2% Differenz

Turnover.

Figure III.17 Latest turnover levels in the US institutional sector



Note: Curves are fitted frequency distributions for active and index funds

Source: Lipper Analytical Services Inc

The impact of costs and taxes.

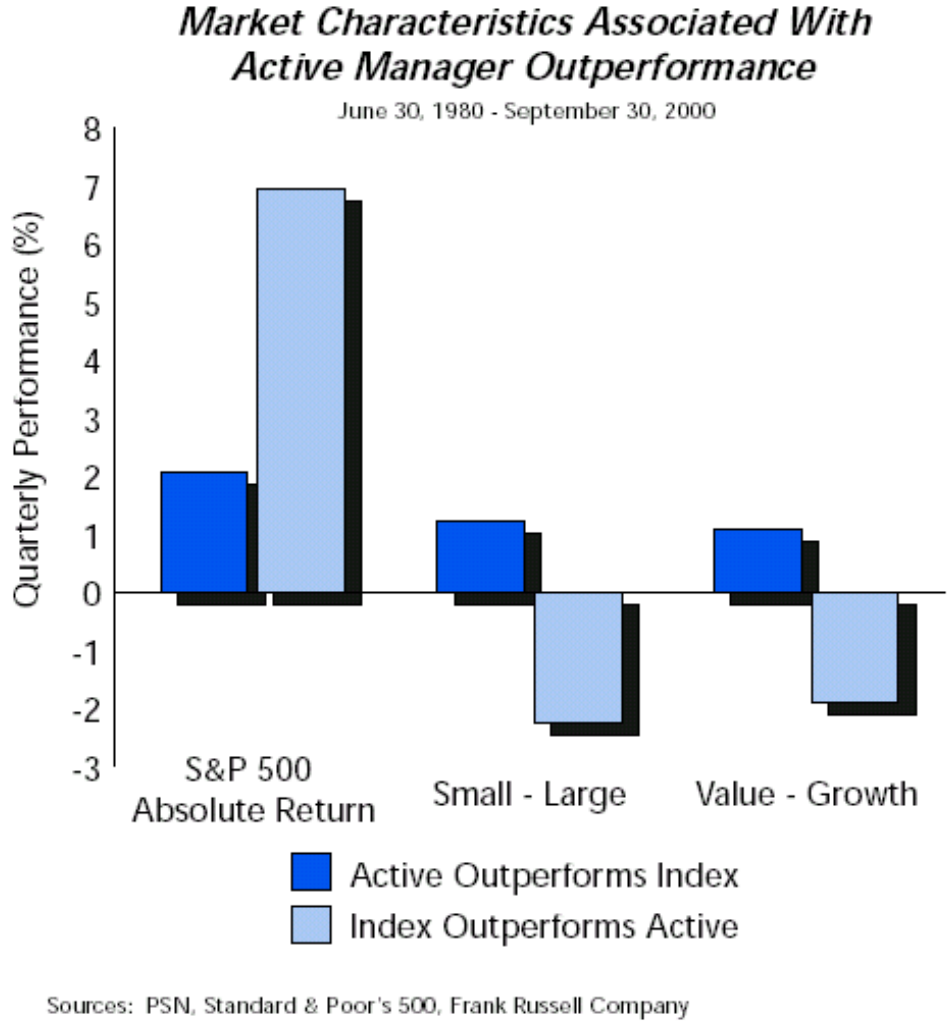
nominal	Return 1950-1999	Final Value 1999
Stock Market	13.3%	514 $
Mutual Funds incl. costs	11.1%	193 $
Mutual Funds incl. costs/taxes	8.7%	65 $
Index Funds incl. costs	13.1%	471 $
Index Funds incl. costs/tax	11.7%	276 $

Figures from various Vanguard Sources, John Bogle

Start 1950 mit 1 USD

Active vs. passive - a matter of style and timing

Zeitperiode: 1980-2000



Gute Zeiten für passives Mgmt...

German text...

- In 47% der Quartale der letzten 20 Jahre weisen die passiven Manager eine Outperformance auf.

- Die Durchschnittsrendite des Marktes betrug in diesen Quartalen 7%.
- In diesen Quartalen weisen LargeCaps eine Überperformance von deutlich über 2% auf.
- ... und Growth wies gegenüber Value eine Überperformance von rund 2% auf.

... und schlechte Zeiten.

- In 53% der Quartale der letzten 20 Jahre weisen die aktiven Manager eine Outperformance auf.

- Die Durchschnittsrendite des S&P500 betrug lediglich 2% p.Q.
- In diesen Quartalen weisen SmallCaps eine Überperformance von 1.2% auf.
- ... und Value wies gegenüber Growth eine Überperformance von 1.1% auf.

Mögliche Erklärung.

- Gibt es eine Erklärung für die zyklische Eigenschaft des Erfolgs indexierter Strategien?

- Kap.-gewichtete Indizes sind konstruktionsgemäss stark gewichtet in hochkapitalisierten Werten und Wachstumswerten, d.h. Indexierung bedeutet eine Selektivität gegen SmallCaps und Value Stocks
- ... die beide gerade in schlechten Märkten relativ gut rentieren.

Forts.

- Doch das typische aktive Portfolio vieler Investoren ist eher gleichgewichtet, d.h. besteht im Vergleich zum Index aus einer Übergewichtung in Small Caps und Value Stocks.
- Deshalb schneiden aktive Strategien in steigenden Märkten schlechter ab als passive.
- Doch dies ist eine Hypothese.... Wie sieht die internationale Evidenz dazu aus?