



CMSC 5718

INTRODUCTION TO COMPUTATIONAL FINANCE

Lecture 5

Outline

- Equity portfolio management
 - Construction of indices
 - Passive and Active management styles
- References:
 - Bodie, Kane and Marcus, Investments, 9th edition (or earlier editions), McGraw Hill (2011)
 - Frank Reilly and Keith Brown, Investment Analysis and Portfolio Management, 10th edition (or earlier editions), South-Western Cengage Learning (2012)

Portfolio management and market indices

- Passive equity portfolio management attempts to replicate the performance of a specific market index
 - Hence it is important to understand how the index is calculated
- According to many financial research results, a broad-based market index (e.g. S&P 500) can outperform a majority of active portfolio managers annually
 - One explanation is that the market is efficient, and it is difficult for active strategies to achieve outperformance after taking into account of fees
- Passive management funds are popular in recent years, especially in the form of Exchange Traded Funds (ETF)

Index calculation example

source: Reilly and Brown (2003), p.154

STOCK	SHARE PRICE	NUMBER OF SHARES	MARKET VALUE
December 31, 2002			
A	\$10.00	1,000,000	\$ 10,000,000
B	15.00	6,000,000	90,000,000
C	20.00	5,000,000	<u>100,000,000</u>
Total			\$200,000,000
Base Value Equal to an Index of 100			
December 31, 2003			
A	\$12.00	1,000,000	\$ 12,000,000
B	10.00	12,000,000 ^a	120,000,000
C	20.00	5,500,000 ^b	<u>110,000,000</u>
Total			\$242,000,000

$$\begin{aligned}
 \text{New Index Value} &= \frac{\text{Current Market Value}}{\text{Base Value}} \times \text{Beginning Index Value} \\
 &= \frac{\$242,000,000}{\$200,000,000} \times 100 \\
 &= 1.21 \times 100 \\
 &= 121
 \end{aligned}$$

^aStock split two-for-one during the year.

^bCompany paid a 10 percent stock dividend during the year.

Dollar weighting and basket weights

- In the above example, stock *B*'s dollar weighting was:
 - Dec 31, 2002: $900000000 / 2000000000 = 45\%$
 - Dec 31, 2003: $1200000000 / 2420000000 = 49.59\%$
- Dollar weighting is not a constant; it changes everyday, depending on share prices
- Basket weight to replicate the index (in number of shares) remains unchanged, unless there is a change in the number of shares outstanding due to technical adjustments
 - In this example, the number of shares changed because of the stock split, which is one of the events leading to an adjustment in the number of shares

HSI calculation methodology

$$I_t = I_{t-1} \times \frac{\sum w_{i,t} \times S_{i,t} \times FAF_i \times CF_i}{\sum w_{i,t} \times S_{i,t-1} \times FAF_i \times CF_i}$$

- I_{t-1} is the index level at time $t-1$, $S_{i,t}$ is the price of stock i at time t
- $w_{i,t}$ is the number of shares outstanding for company i
 - Note that $w_{i,t-1}$ is not used
- FAF_i is a free float adjustment factor
- CF_i is a capitalization adjustment factor, so as to limit the weight of a stock to a maximum of 10% (since September 5, 2015; revised every quarter)

FAF and CF for selected stocks

Code 股份代號	Stock 股份		FAF	CF
0001.HK	CKH Holdings	長和	70.00%	100.00%
0002.HK	CLP Hldgs	中電控股	75.00%	100.00%
0003.HK	HK & China Gas	香港中華煤氣	60.00%	100.00%
0004.HK	Wharf (Hldgs)	九龍倉集團	45.00%	100.00%
0005.HK	HSBC Hldgs	滙豐控股	100.00%	61.06%
0006.HK	Power Assets	電能實業	65.00%	100.00%
0011.HK	Hang Seng Bank	恒生銀行	40.00%	100.00%
0012.HK	Henderson Land	恒基地產	30.00%	100.00%
0016.HK	SHK Prop	新鴻基地產	45.00%	100.00%
0017.HK	New World Dev	新世界發展	60.00%	100.00%
0019.HK	Swire Pacific 'A'	太古股份有限公司'A'	55.00%	100.00%
0023.HK	Bank of E Asia	東亞銀行	50.00%	100.00%
0027.HK	Galaxy Ent	銀河娛樂	55.00%	100.00%
0066.HK	MTR Corporation	港鐵公司	25.00%	100.00%

- Effective from Dec 5, 2016; from www.hsi.com.hk

HSI basket weights example

stock code	name	shares outstanding (millions)	3-Jan close	board lot	shares required for 25 futures	rounded
5	HSBC	12,250	63	400	46,904	46,800
700	Tencent	3,844	189.4	100	14,718	14,700
939	China Construction Bank	108,188	5.86	1,000	414,244	414,000
1299	AIA	12,056	43.75	200	46,163	46,200
941	China Mobile	6,143	82	500	23,520	23,500
1398	ICBC	73,775	4.68	1,000	282,479	282,000
3988	Bank of China	79,441	3.48	1,000	304,175	304,000
1	CK Hutchison	2,702	90.8	500	10,345	10,500
388	Hong Kong Exchanges	1,163	184.3	100	4,453	4,500
2318	Ping An Insurance	5,213	39.35	500	19,961	20,000
883	CNOOC	17,859	9.79	1,000	68,381	68,000
2628	China Life Insurance	7,441	20.8	1,000	28,492	28,000
386	Sinopec	25,513	5.57	2,000	97,689	98,000
2	CLP Holdings	1,895	72.55	500	7,255	7,500
16	Sun Hung Kai Prop	1,303	100.7	1,000	4,989	5,000
1113	Cheung Kong Prop	2,692	48.25	500	10,307	10,500
857	PetroChina	21,099	5.8	2,000	80,786	80,000
823	Link REIT	2,231	50.9	500	8,544	8,500
11	Hang Seng Bank	765	146.8	100	2,928	2,900
3	Hong Kong & China Gas	7,630	13.76	1,000	29,216	29,000

- The above shows a partial list of stocks required for 25 HSI futures as of Jan 3, 2017

Equity portfolio indexing techniques

- If an index contains a comparatively small number of stocks and they are liquid, the index fund will usually attempt to engage a full replication of the index
 - i.e. every stock will be held according to its proportion
 - However, if some stocks are illiquid, this could easily lead to underperformance
- Alternatively, a sampling technique can be used, whereas the stocks with most weights will be held in full and those with less weights are sampled
- It is also possible to use a quadratic optimization programme to match the characteristics of the index performance

Calculation of tracking error

PERIOD	MANAGER	INDEX	DIFFERENCE (Δ)
1	2.3%	2.7%	-0.4%
2	-3.6	-4.6	1.0
3	11.2	10.1	1.1
4	1.2	2.2	-1.0
5	1.5	0.4	1.1
6	3.2	2.8	0.5
7	8.9	8.1	0.8
8	-0.8	0.6	-1.6

- This example gives the returns of the portfolio and the index for eight consecutive quarters
- Average tracking error is 0.2%, standard deviation is 1.0%
 - Annualized tracking error = $1.0\% \times \sqrt{4} = 2.0\%$
- Source: Reilly and Brown (2003), p.657

Active equity portfolio management strategies

- Aim to earn a return that exceeds the return of a passive benchmark portfolio
 - Net of transaction costs
 - On a risk-adjusted basis (c.f. lecture 6)
- There are two group of strategies:
 - Fundamental – based on stock valuation, identify stocks which are undervalued or overvalued
 - Technical – prediction of future price trends based on historical prices

Stock valuation approaches

- Accounting approach
 - Book value – net worth of the company as shown in the balance sheet and annual report
 - Liquidation value – amount of money that could be realized by selling all the assets and repaying all the debts
 - Replacement cost – cost of replacing all the assets and liabilities of the company
 - However, these methods tend to concentrate on “historical” performance
- Corporate finance approach
 - Forward looking
 - calculate the present value of projected future cash flows

Dividend discount model (DDM)

- The price of a stock today V_0 should equal the present value of all future dividends to be paid by the share

$$V_0 = \frac{D_1}{1+k} + \frac{D_2}{(1+k)^2} + \frac{D_3}{(1+k)^3} + \dots$$

- D_i is the dividend to be received at the end of year i
- k is the required rate of return (i.e. the risky discount rate)
- Sometimes we don't estimate all the future dividends; we may estimate an ultimate share price P at year H :

$$V_0 = \frac{D_1}{1+k} + \frac{D_2}{(1+k)^2} + \dots + \frac{D_H + P_H}{(1+k)^H}$$

Constant growth DDM

- Even for a mature company, hopefully the dividends paid each year would not stay constant
- Let's say it is growing at constant rate g , such that

$$D_{i+1} = D_i(1 + g)$$

- We could then show that

$$V_0 = \frac{D_1}{k - g}, \text{ if } g < k$$

Example of DDM

Growth rate g	Rate of return k						
	8%	10%	12%	14%	16%	18%	20%
0%	12.50	10.00	8.33	7.14	6.25	5.56	5.00
1%	14.29	11.11	9.09	7.69	6.67	5.88	5.26
2%	16.67	12.50	10.00	8.33	7.14	6.25	5.56
4%	25.00	16.67	12.50	10.00	8.33	7.14	6.25
6%	50.00	25.00	16.67	12.50	10.00	8.33	7.14
8%	-	50.00	25.00	16.67	12.50	10.00	8.33
10%	-	-	50.00	25.00	16.67	12.50	10.00

Price of stock (V_0) assuming initial dividend is \$1

- We could see that the stock price is very sensitive to the assumptions for k and g
 - *almost any theoretical price could be achieved!*

Gordon equation

$$V_0 = \frac{D_1}{k - g} \Rightarrow k = \frac{D_1}{V_0} + g$$

- Expected return = dividend yield
+ dividend growth rate
- Also known as the discounted cash flow formula
- If we know the dividend yield and dividend growth rate, we could estimate the expected return
- If stock price equals intrinsic value of the stock, then the expected return is also the expected return of the stock
- Sometimes used in rate hearings for regulated utilities companies
 - A method to estimate what is a competitive expected return that would be demanded by stock investors

Multi-stage DDM

- Assume that the risky discount rate k is 15% and we have estimated the following dividend streams:
 - year 1 = \$1.40, year 2 = \$1.95, year 3 = \$2.55
and 10% growth from year 4 onwards
- Ultimate price at year 3

$$P_3 = \frac{D_4}{k - g} = \frac{D_3(1 + g)}{k - g} = \frac{2.55 \times (1 + 0.1)}{0.15 - 0.1} = \$56.1$$

- Price today

$$P_0 = \frac{1.40}{1 + 0.15} + \frac{1.95}{(1 + 0.15)^2} + \frac{2.55 + 56.10}{(1 + 0.15)^3} = \$41.26$$

Using earnings in the DDM formula

- Define b as the *plowback ratio*, which is the fraction of earnings E re-invested in the firm
- Dividend for the coming year

$$D_1 = E(1 - b)$$

- Price of stock today is thus

$$V_0 = \frac{E(1 - b)}{k - g} \Rightarrow \frac{V_0}{E} = \frac{1 - b}{k - g}$$

- The ratio V_0/E is called the Price-earning multiple or *Price-earning (P/E) ratio*

Price/Earning (P/E) ratio

- The most commonly used equity multiple (first introduced in the 1930s)
- P/E ratio is defined as:
 - $\text{P/E ratio} = \text{Price per share} / \text{Earnings per share}$
- In a typical analysis, three numbers are usually provided
 - The P/E of the past year
 - An estimate of the current year's P/E
 - A forecast of next year's P/E

Combining P/E analysis with DDM

- Assume that the risky discount rate k is 15% and we have estimated the following dividend streams:
 - year 1 = \$1.40, year 2 = \$1.95, year 3 = \$2.55
 - at the end of year 3, P/E ratio is forecast to be 13 and earnings per share (EPS) is forecast to be \$5.20
- Ultimate price at year 3

$$P_3 = \text{P/E ratio} \times \text{EPS} = 13 \times 5.20 = \$67.60$$

- Price today

$$P_0 = \frac{1.40}{1 + 0.15} + \frac{1.95}{(1 + 0.15)^2} + \frac{2.55 + 67.60}{(1 + 0.15)^3} = \$48.82$$

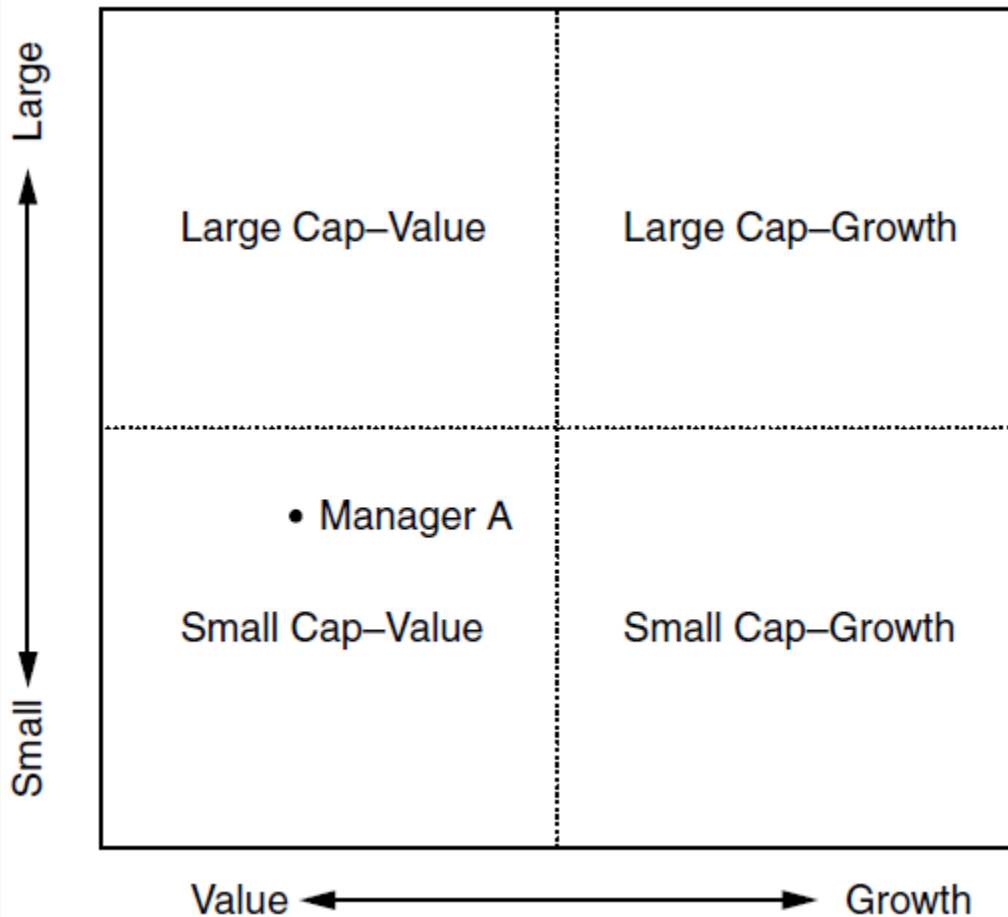
Using the DDM in forecasting

- The DDM is often used in two different ways
 - Assuming a particular P/E multiple, an analyst can try to estimate the futures earnings and hence derive the fair price
 - Assuming that the dividend, its growth rate and the risky discount rate can be estimated, the stock's fair price can be derived
- However, note that in each case, strong assumptions are made and there is no guarantee that the fair price can be reachable

Equity style analysis

- Value style
 - Look for stocks that are cheap in terms of earnings or assets
 - low price/book ratio, low P/E, contrarian, high yield, regulated industries
 - May have higher risk, therefore it can have higher return
- Growth style
 - Companies that deliver future earnings growth
 - earnings momentum, higher valuation multiples

A style analysis grid

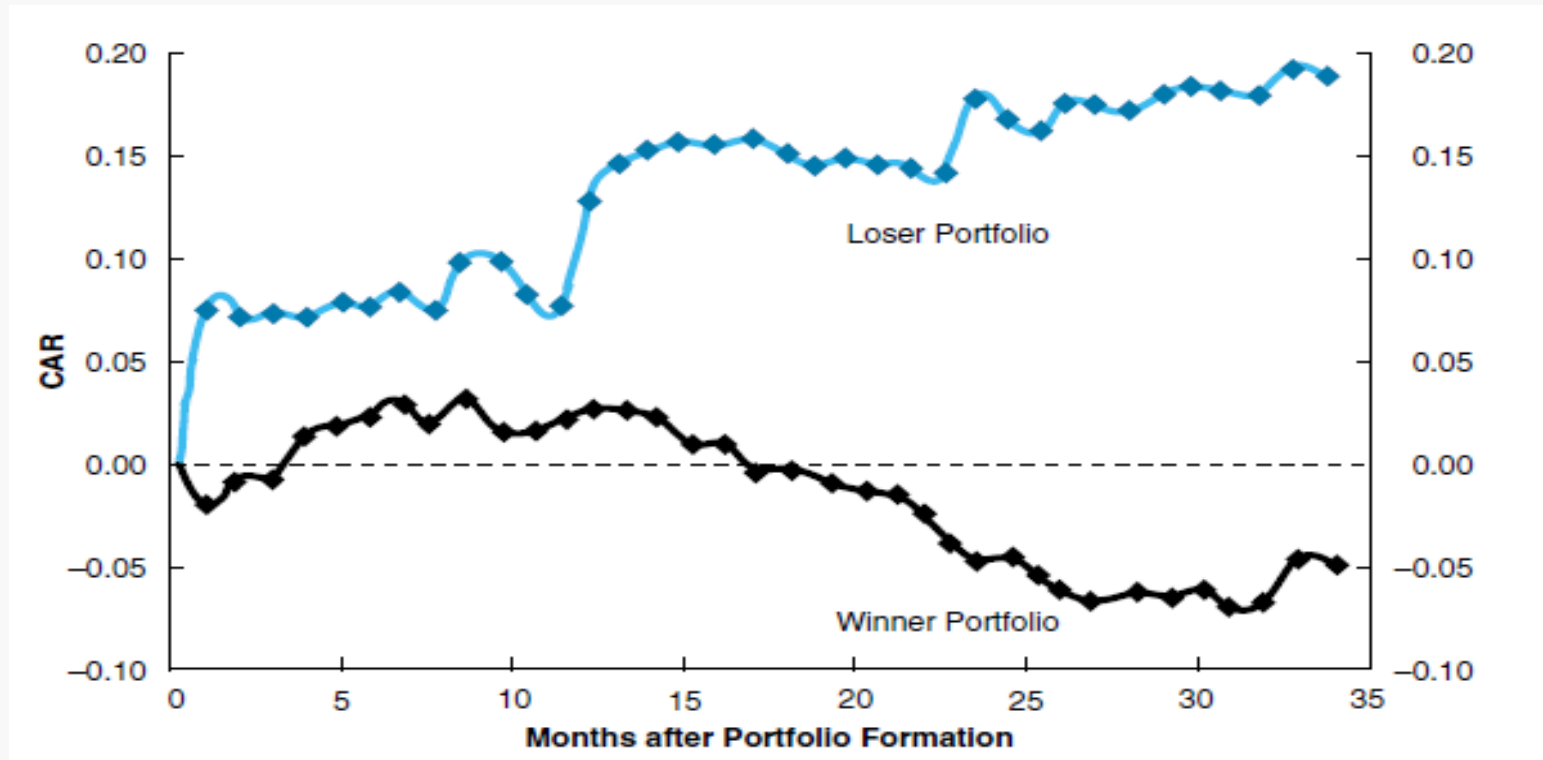


- Source: Reilly and Brown (2003), p.675

Technical trading strategies

- Technical strategies: use historical data to predict future price trends
- Two main types:
 - Price momentum – assume that recent price trend will continue
 - Contrarian – assume that recent price trend will reverse
- These strategies tend to contradict each other in its underlying assumptions, but there have been studies that support both theses, e.g. DeBondt and Thaler (1985), Chan, Jegadeesh and Lakonishok (1999)

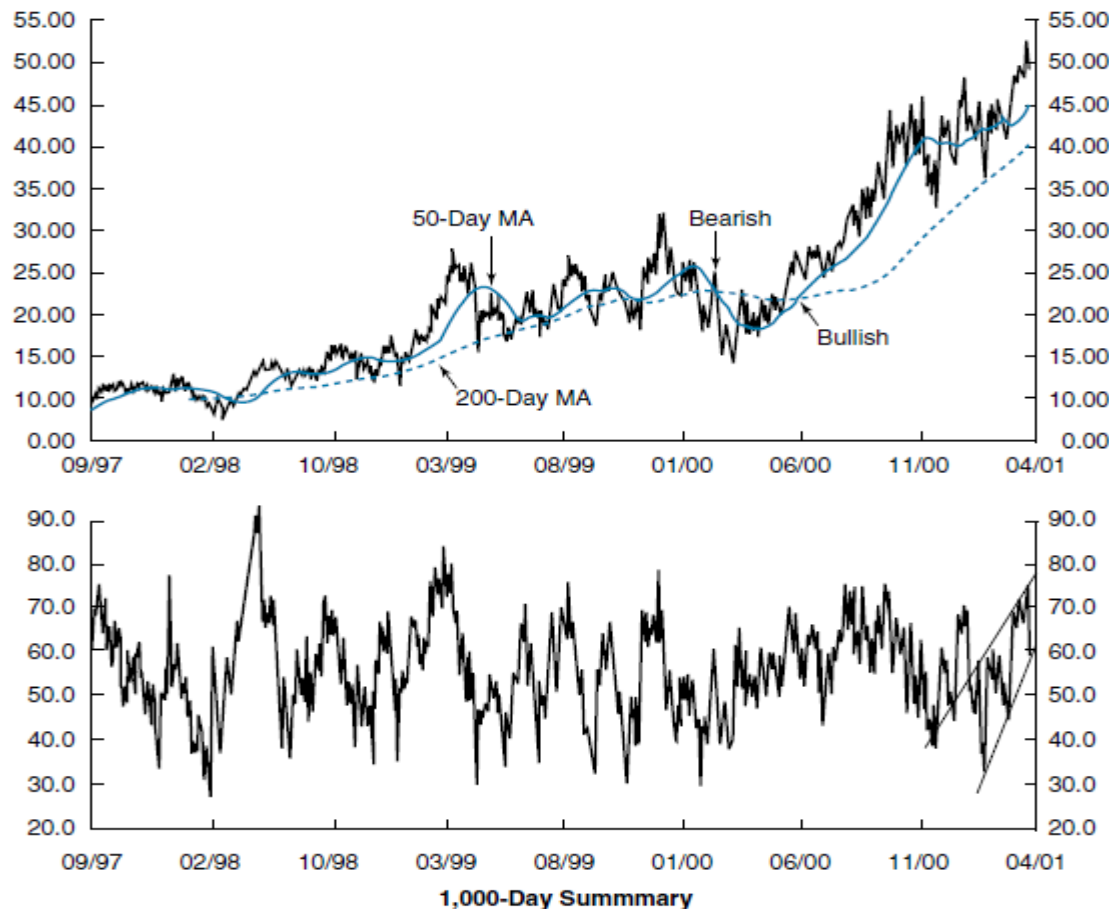
A Contrarian Strategy



- Compare the performance of a portfolio of stocks that had the worst performance over the last 3 years (loser) and a portfolio with best past performance (winner)
- CAR is the Cumulative Abnormal Return
- Source: Reilly and Brown (2003), p.665

Technical analysis example

DAILY STOCK PRICES FOR CONCORD EFS WITH 50-DAY AND 200-DAY MOVING AVERAGE LINES AND A 14-DAY RELATIVE STRENGTH INDEX COMPARED TO THE S&P 500 INDEX

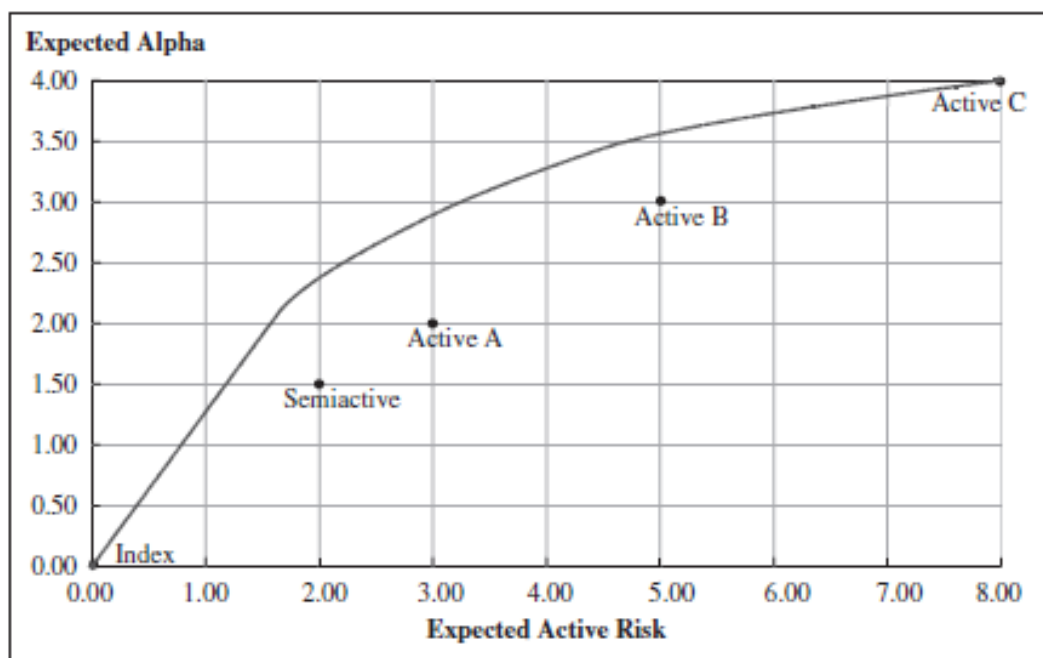


- These graphs make use of moving averages (MA) and the Relative Strength Index (RSI)
- Source: Reilly and Brown (2003), p.640

Challenges to technical trading rules

- Past patterns or relationships may not repeat in the future
- Many people may be using the same rules, causing the price to behave as a self-fulfilling prophecy
 - But it will revert to its true equilibrium value after a short period of time
- If the strategy becomes too successful, it will lead to many imitators, which will then make the rule obsolete
- While the rule is supposed to be quantitative, a great deal of subjective judgment is still required

Managing a portfolio of managers



	Return	Risk
Index	0.0%	0%
Semi-Active	1.5%	2%
Active A	2.0%	3%
Active B	3.0%	5%
Active C	4.0%	8%

- Assume the managers have 0 correlation with each other

- A fund manager may allocate its assets into different funds, using MPT to work out the efficient frontier
- If most of the assets are allocated to an index portfolio or an enhanced index portfolio, the arrangement is known as a core-satellite strategy
- Source: Magnin et al. (2007), p.459

Bond portfolio management

- Modern portfolio theory has made less impact on bond portfolio management than in equity portfolio management
- Major source of risk is the change in the interest rate yield curve
 - Need to quantify this risk through some sensitivity measure
- Some portfolios require the risk management of a combination of assets and liabilities