Term Paper

- Submitted in APA style formatting, font size 11 or 12.
  Guideline: 5-8 pages, longer if you feel like you need more space due to figures and tables.
- Attach the Excel spreadsheet in which you performed your analysis
  - **You have to create your own Excel spreadsheet!**

Due Date

Thursday, May 2, 2019, 11:59 PM

Term Paper

- **Presentation of the company:**
  business model; industry, its peers and the company's position within that group; history; leadership; etc.
- **Fundamentals of the company:**
  past performance of the stock; revenue and earnings and their development over the years; appropriate financial ratios.

Term Paper

- **Price and price expectations**: based on the previous section, run a DCF analysis to arrive at your best estimate for the intrinsic value of the company and your best estimate for the share price. Clearly explain your assumptions and provide two alternate scenarios. The report should contain the main table of the DCF for readers to observe your calculations and assumptions. For your DCF you need to find beta which you can do with a regression analysis, as well as the credit rating. Feel free to reach out to me if you need help with the credit rating and its implication for cost of debt.

Term Paper

- **Risks and headwinds**:
  your DCF is based on assumptions about the future of the company, its industry environment, and the market and business environment. How sensitive is your analysis to this? More specifically, what are the headwinds and risks that the company faces in its operations in the near and medium-term future?
- **Conclusion and recommendation for three investors**

Term Paper

Bryant is a 25-year old young professional, employed in a major city in the northeast. Since joining the workforce three years ago, he contributes as much money as possible to his retirement accounts which is invested in a diverse set of index funds. An avid fan of Benjamin Graham's "The Intelligent Investor", he has decided to consider a few individual stocks of companies with good and stable long-term prospects as well as a great management. Explain and justify your recommendation for Bryant. If you choose to not recommend your stock, propose an alternative from the same industry.

Term Paper

Nicole is 52 years old, and a few months ago, she retired from her well-paying job after aggressively saving and investing her money prudently for much of her life. While she could go back to work if necessary, she prefers her financial independence. In order to maintain a steady cash-flow, her portfolio is heavily geared towards high yielding stocks, allowing her and her family to live of dividend payments for the most part. Aware of the recent downturn of General Electric and their dividend cut, she focuses on companies from which she expects a solid and steady dividend growth. Explain and justify your recommendation for Nicole. If you choose not to recommend your stock, propose and alternative from the same industry.

Term Paper

Pete is in his mid 30s. Starting late to contribute to his retirement fund, he wants to complement his investments in ETFs in his 401k. For this purpose he sets aside $10,000 every year for the next ten years to seek out riskier, but potentially much more profitable high-growth opportunities. Similarly, he is open to shorting stock for fundamental or hedging reasons, if the opportunity presents itself. After the ten years of active portfolio management, he wishes to wind down his positions to seek more stable investments. Explain and justify your recommendation for Pete. If you choose not to recommend your stock, propose and alternative from the same industry.

AD 717:
Investment Analysis and Portfolio Management

Section A1

Options allow to trade volatility

- Implied volatility is the expectation of the market based on the option valuation.
  - If an investor believes implied volatility in an option's price is too low, a profitable trade is possible.
  - Performance depends on option price relative to the implied volatility.
- Profit must be hedged against a decline in the value of the stock.
- This is called delta-hedging or a delta-neutral position:

$$\Delta = \frac{\text{Change in Option Value}}{\text{Change in Stock Value}}$$

Options allow to trade volatility

$$\Delta = \frac{\text{Change in Option Value}}{\text{Change in Stock Value}}$$

If we only wish to trade volatility, we want to be immune against the change in stock value.

- Our option position has a non-zero delta.
  - "As how many stocks does the option move in price?"
  - Puts have negative delta and calls have positive delta.
- To be delta-neutral, we supplement the portfolio by stock.

Options allow to trade volatility

Example:

• Implied volatility	= 33%
• Investor's estimate of true volatility	= 35%
• Option maturity	= 60 days
• Put price *P*	= \$4.495
• Exercise price and stock price	= \$90
• Risk-free rate	= 4%
• Delta	= -0.453

Options allow to trade volatility

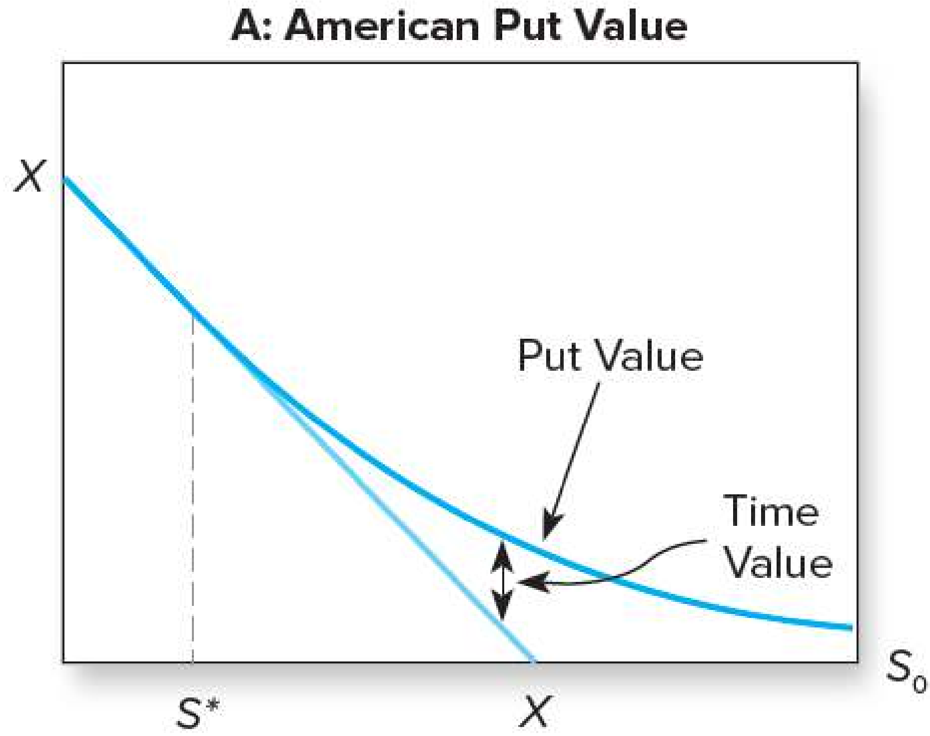
Table 21.3

Profit on hedged put portfolio

A. Cost to Establish Hedged Position			
1,000 put options @ $4.495/option	$ 4,495		
453 shares @ $90/share	40,770		
Total outlay	$45,265		
B. Value of Put Option as a Function of the Stock Price at Implied Volatility of 35%			
Stock price:	**89**	**90**	**91**
Put price	$ 5.254	$ 4.785	$ 4.347
Profit (loss) on each put	0.759	0.290	(0.148)
C. Value of and Profit on Hedged Put Portfolio			
Stock price:	**89**	**90**	**91**
Value of 1,000 put options	$ 5,254	$ 4,785	$ 4,347
Value of 453 shares	40,317	40,770	41,223
Total	$45,571	$45,555	$45,570
Profit (= Value − Cost from Panel A)	306	290	305

Options allow to trade volatility

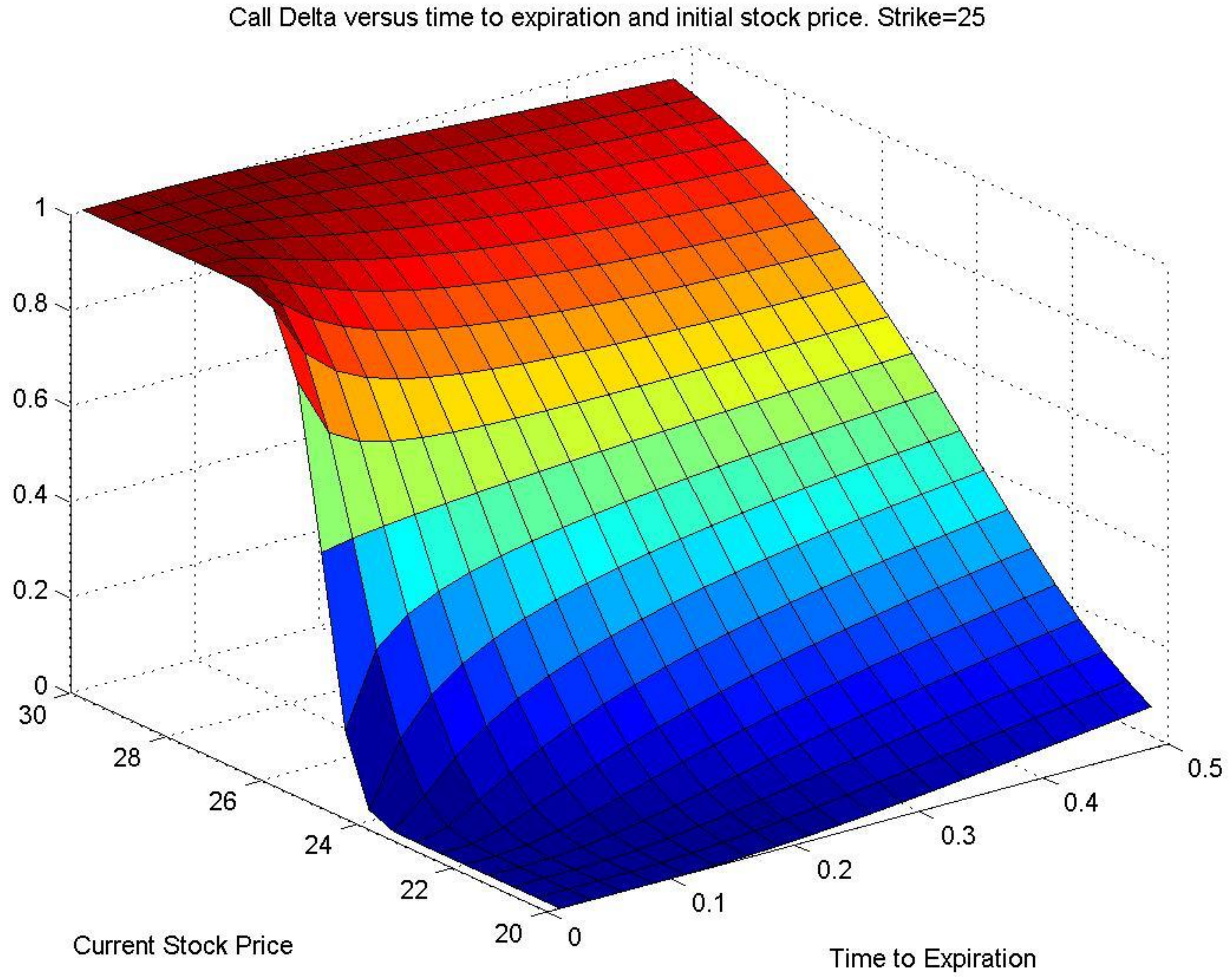
- If the stock price changes, then also the Deltas used to calculate the hedge ratio change
- We use the Greek letter Gamma (Γ) to describe the sensitivity of Delta to the stock price.
    - Gamma is similar to bond convexity
    - The hedge ratio changes with market conditions
    - Rebalancing is necessary



- In summary: Delta is the slope of the curve of the value, and Gamma is the slope that describes how Delta changes.

Time Decay

- As the time to expiration gets shorter and shorter, the likelihood of a big move in the underlying security gets less and less likely in general.
- Options *decay* in value until they only have their intrinsic value left on the day of expiration (which may be as low as 0).



Chapter 22

Futures

Futures and Forwards

- Forward —
  a deferred-delivery sale of an asset with the sales price agreed on now

- Futures —
  similar to forward but feature formalized and standardized contracts.

- Key difference in futures compared to forwards:
  - Standardized contracts create liquidity
  - Marked to market
  - Exchange mitigates credit risk

Futures and Forwards

- Profit to long = Spot price at maturity - Original futures price
- Profit to short = Original futures price - Spot price at maturity
- The futures contract is a zero-sum game, which means gains and losses net out to zero

- Profit is zero when the ultimate spot price, P_T equals the initial futures price, F_0.

- The payoff to the long position can be negative because the futures trader cannot walk away from the contract if it is not profitable

Futures and Forwards

Foreign Currencies	Agricultural	Metals and Energy	Interest Rate Futures	Equity Indexes
British pound	Corn	Copper	Eurodollar	S&P 500 index
Canadian dollar	Oats	Aluminum	Euroyen	Dow Jones Industrials
Japanese yen	Soybeans	Gold	Euro-denominated bond	S&P Midcap 400
Euro	Soybean meal	Platinum	Euroswiss	NASDAQ 100
Swiss franc	Soybean oil	Palladium	Sterling	NYSE index
Australian dollar	Wheat	Silver	British government bond	Russell 2000 index
Mexican peso	Barley	Crude oil	German government bond	Nikkei 225 (Japanese)
Brazilian real	Flaxseed	Heating oil	Italian government bond	FTSE index (British)
	Palm oil	Gas oil	Canadian government bond	CAC-40 (French)
	Rye	Natural gas	Treasury bonds	DAX-30 (German)
	Cattle	Gasoline	Treasury notes	All ordinary (Australian)
	Hogs	Propane	Treasury bills	Toronto 35 (Canadian)
	Pork bellies	Kerosene	LIBOR	Dow Jones Euro STOXX 50
	Cocoa	Fuel oil	EURIBOR	Industry indexes:
	Coffee	Iron ore	Interest rate swaps	• Banking
	Cotton	Electricity	Federal funds rate	• Telecom
	Milk	Weather	Bankers' acceptance	• Utilities
	Orange juice			• Health care
	Sugar			• Technology
	Lumber			
	Rice			

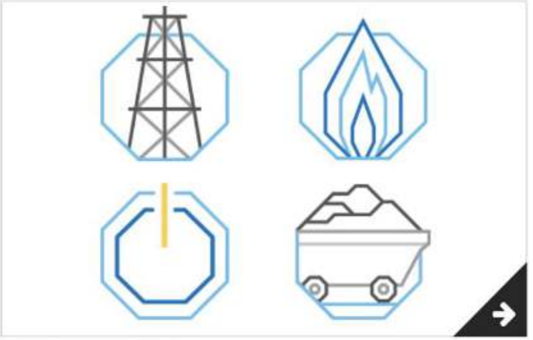
Futures Trading

- Electronic trading has mostly displaced floor trading
- CBOT and CME merged in 2007 to form CME Group
  - The exchange acts as a clearing house and counterparty to both sides of the trade
  - The net position of the clearing house is zero
- Open interest is the number of contracts outstanding
- If you are currently long, you simply instruct your broker to enter the short side of a contract to close out your position
  - Most futures contracts are closed out by reversing trades
  - Only 1-3% of contracts result in actual delivery of the underlying commodity

What Is Henry Hub?

Henry Hub refers to the central delivery location (or, hub) located near the Louisiana's Gulf Coast, connecting several intrastate and interstate pipelines. Henry Hub has been used as a pricing reference for the futures since April 1990.

Product Symbol	CME Globex/ClearPort/Clearing: NG
Contract Months	All calendar months
Price Quotation	U.S. dollars and cents per MMBtu
Contract Size	10,000m British thermal units (MMBtu)
Trading Venue	**CME Globex:** Electronically trade nearly 24 hours/6 days a week **CME ClearPort:** Clear nearly 24 hours/6 days a week
Trading Hours	5:00pm – 4:00pm (Sun–Fri) CT with a 60-minute break each day beginning at 4:00pm CT
Minimum Tick	$0.001 per MMBtu
Dollar Value of Tick	$10.00 U.S. dollars



Energy Home

NG Market Snapshot

PRODUCT	LAST	CHANGE	CHART	GLOBEX VOL
NGF9	4.583	-0.116		179,176

Futures and Forwards

- Convergence of Price — As maturity approaches the spot and futures price converge
- Marking to Market — Each day the profits or losses from the new futures price are paid over or subtracted from the account

- Margin Call: Since futures are bought on market, you have to deposit capital for loss absorption. If funds fall below maintenance level, you get a margin call.

Futures Trading

Speculators

- Seek to profit from price movement
  - Long — believe price will rise
  - Short — believe price will fall

Hedgers

- Seek protection from price movement
  - Long hedge — protecting against a rise in purchase price
  - Short hedge — protecting against a fall in selling price

Futures Pricing

- Spot-futures parity theorem — two ways to acquire an asset for some date in the future:
  1. Purchase it now and store it
  2. Take a long position in futures
- These two strategies must have the same market determined costs.
- With a perfect hedge, the futures payoff is certain — there is no risk
- A perfect hedge should earn the riskless rate of return

Futures Pricing – Spot-Futures Parity

$$\frac{(F_0 + D) - S_0}{S_0} = r_f$$

Rearranging terms

$$F_0 = S_0(1 + r_f) - D = S_0(1 + r_f - d)$$

$$d = D \big/ S_0$$

Futures Pricing – Term Spreads

$$F(T_1) = S_0 \times (1 + r_f - d)^{T_1}$$

$$F(T_2) = S_0 \times (1 + r_f - d)^{T_2}$$

$$F(T_2) = F(T_1) \times (1 + r_f - d)^{(T_2 - T_1)}$$

Futures Pricing – Term Spread

- **Expectation Hypothesis:**
  Futures price is expected spot price at futures date.
- **Backwardation:**
  Hedgers want to go short futures and offer incentive.
- **Contango:**
  Hedgers want to go long.

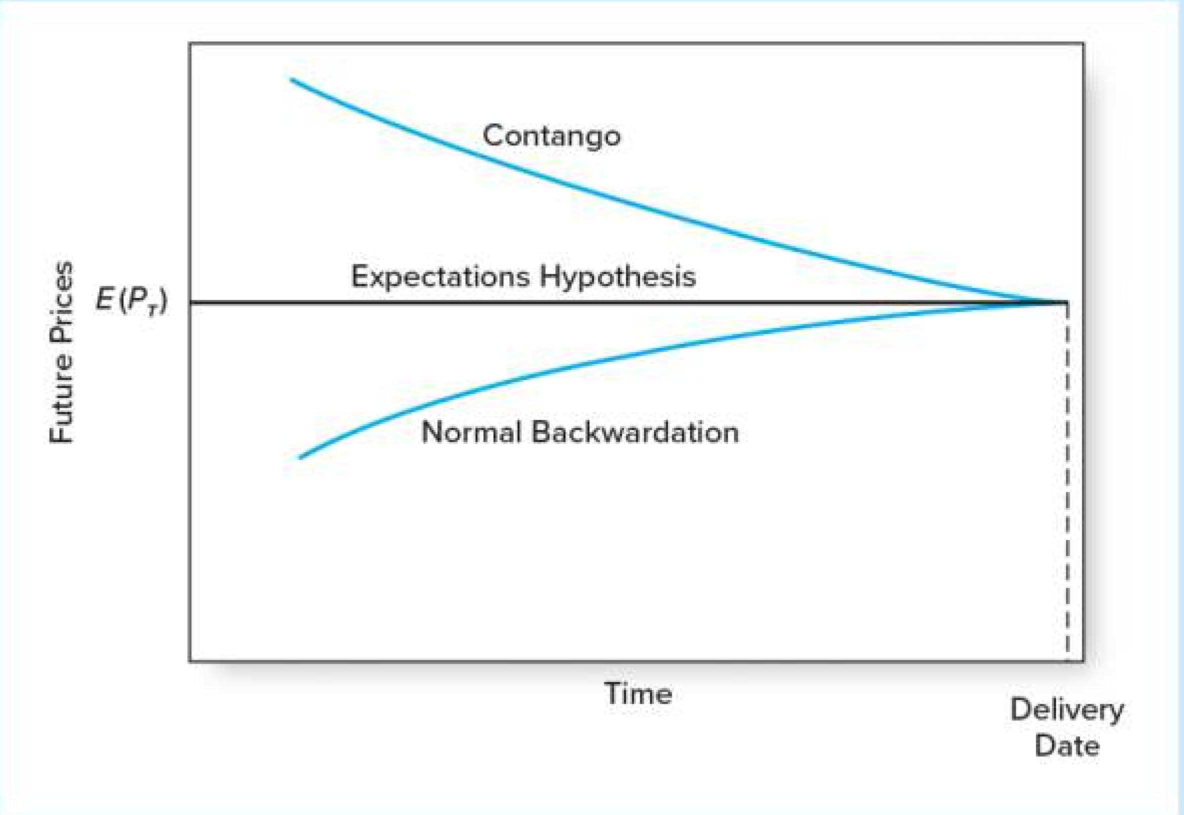


Figure 22.7 Futures price over time, in the special case that the expected spot price remains unchanged

Review: Single Factor Model

$$\mathrm{E}(r_i) = \alpha_i + \beta\,\mathrm{E}(r_M)$$

- Variance is composed of systematic risk and firm-specific risk:

$$\sigma_i^2 = \beta_i^2\sigma_M^2 + \sigma^2(e_i)$$

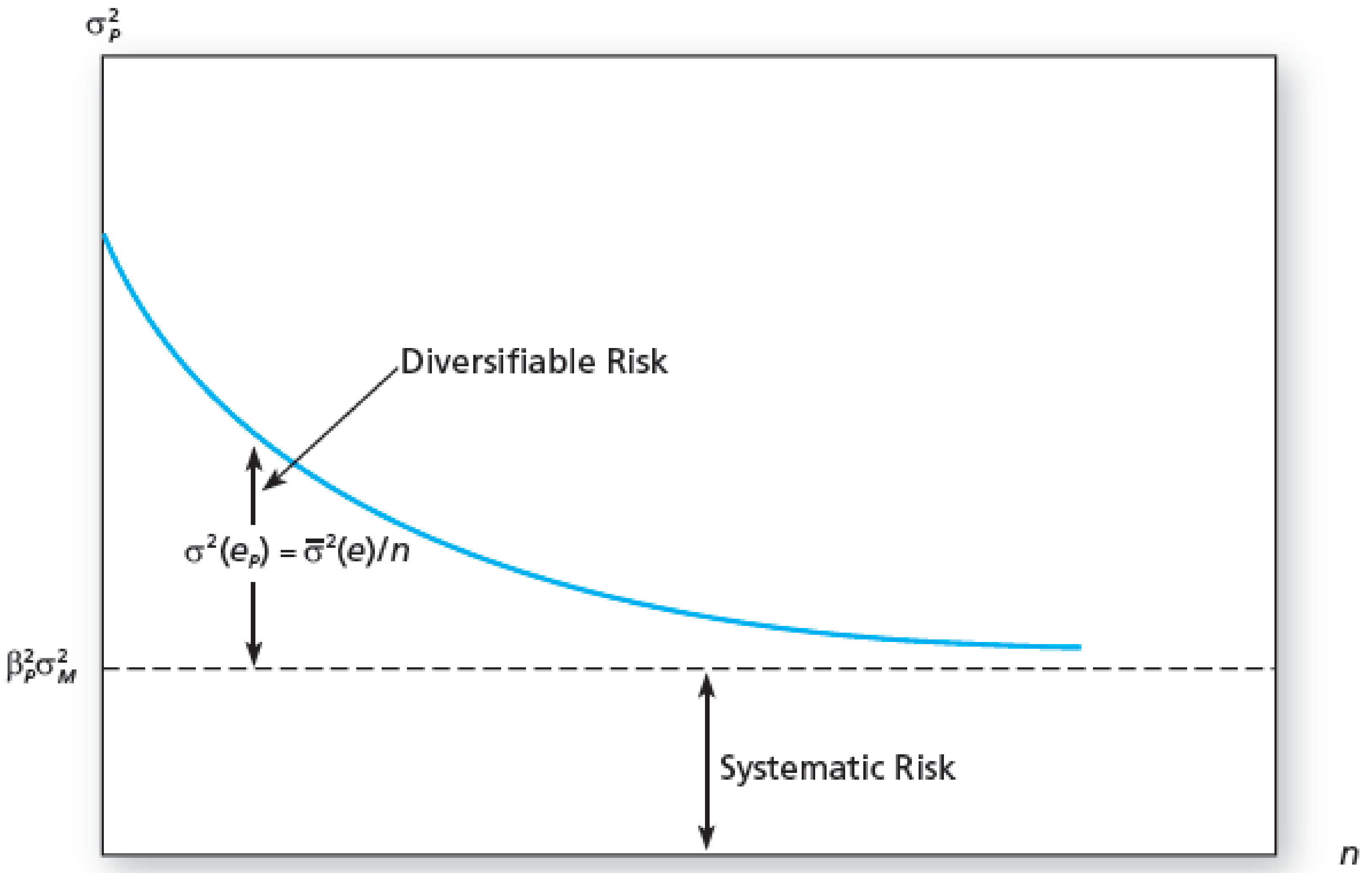
- Covariance is the product of the betas and the market risk:

$$\mathrm{Cov}(r_i, r_j) = \beta_\mathrm{i}\beta_\mathrm{j}\sigma_M^2$$

- Correlation is the product of each security's correlation w/ market:

$$\mathrm{Corr}(r_i, r_j) = \mathrm{Corr}(r_i, r_M) \times \mathrm{Corr}(r_j, r_M)$$

Diversify the firm-specific risk away!



Portfolio Construction w/ Single-Factor Model

$$E(R_P) = \alpha_P + E(R_M)\beta_P = \sum_{i=1}^{n+1} w_i\alpha_i + E(R_M)\sum_{i=1}^{n+1} w_i\beta_i$$

$$\sigma_P = [\beta_P^2\sigma_M^2 + \sigma^2(e_P)]^{1/2} = \left[\sigma_M^2\left(\sum_{i=1}^{n+1} w_i\beta_i\right)^2 + \sum_{i=1}^{n+1} w_i^2\sigma^2(e_i)\right]^{1/2}$$

$$S_P = \frac{E(R_P)}{\sigma_P}$$

Multifactor Models

Alternative: Use more than one factor:

- Examples: Market Return, GDP, Expected Inflation, Interest Rates
- Estimate a beta or factor loading for each factor using multiple regression

- Categorize investment into asset classes, like high-growth stocks, high-dividend stocks, etc.

Evaluate Portfolios

- If markets are efficient, investors must be able to measure asset management performance
- Two common ways to measure average portfolio return:
  - Time-weighted returns
  - Dollar-weighted returns
- Returns must be adjusted for risk

Time-weighted returns

- The geometric average is a time-weighted average
- Each period's return has equal weight

$$(1+r_G)^n = (1+r_1)\times(1+r_2)\times\ldots\times(1+r_n)$$

$$r_G = \left[(1+r_1)\times(1+r_2)\times\ldots\times(1+r_n)\right]^{1/n} - 1$$

Dollar-weighted returns

- Internal rate of return considering the cash flow from or to investment
- Returns are weighted by the amount invested in each period:

$$PV = \frac{C_1}{(1+r)^1} + \frac{C_2}{(1+r)^2} + \dots \frac{C_n}{(1+r)^n}$$

Dollar-weighted returns

Example of this discounted cash flow:

Outflow today:	Purchase 1 stock for \$180
Inflow 11/15/19:	Collect \$3 as dividend and sell stock for \$195.

$$\$180 = \frac{\$3 + \$195}{1 + r}$$

So what is our internal rate of return? $r = \frac{\$198}{\$180} - 1 = 10.0\%$

Dollar-weighted returns

Example of another discounted cash flow:

Outflow today:	Purchase 1 stock for \$180
Outflow 11/15/19:	Purchase 1 stock for \$195
Inflow 11/15/19:	Collect \$3 as dividend
Inflow 11/15/20:	Collect \$6 as dividend and sell stocks for \$200 each

$$\$180 + \frac{\$195}{1+r} = \frac{\$3}{1+r} + \frac{\$406}{(1+r)^2}$$

So what is our internal rate of return? $r = 6.0\%$.
Why is this lower?

Adjusting Returns for Risk

Very early, we recognized that just comparing returns is not the most appropriate way to measure performance – we must adjust for risk!

- The simplest way to adjust for risk is to compare the portfolio's return with the returns of a comparison universe
  - The comparison universe is called the benchmark
  - It is composed of a group of funds or portfolios with similar risk characteristics

Adjusting Returns for Risk

Benchmark or universe comparison over different time horizons!

- Compare to S&P 500 and the range.
- Lines indicate the median as well as the 25% and 75% quantile.
- How well is *The Markowill Group* doing?

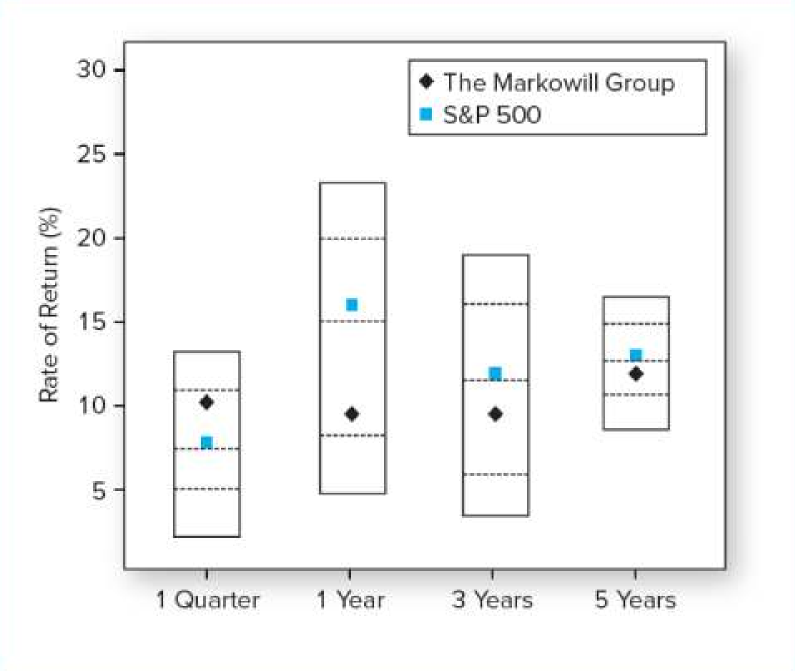


Figure 24.1 Universe comparison, periods ending December 31, 2022

Metrics for Risk-Adjusted Performance

We learned a few of these already:

- Sharpe ratio
- Modigliani-Squared
- Treynor measure
- Jensen’s alpha
- Information ratio

Metrics for Risk-Adjusted Performance

Sharpe ratio:

$$\mathrm{SR} = \frac{r_P - r_f}{\sigma_P}$$

Where we plug in:

- Average return on the portfolio
- Average risk free rate
- Standard deviation of returns for portfolio

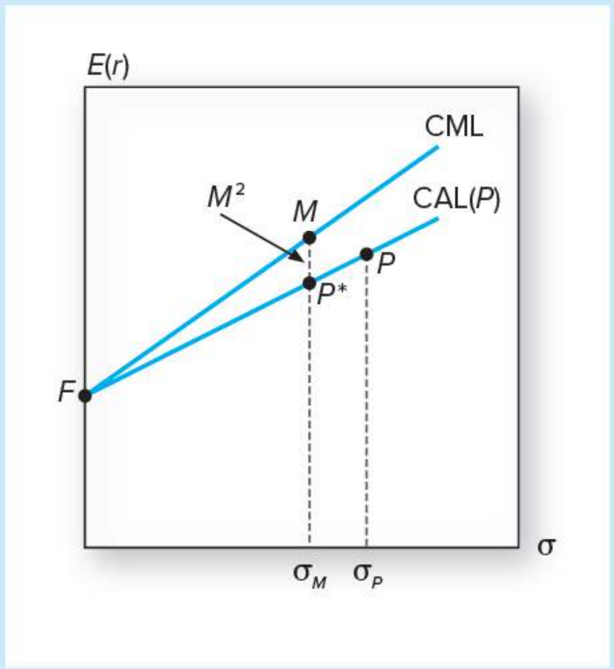
Metrics for Risk-Adjusted Performance

How do we interpret the Sharpe ratio?

- We can compare two investments or portfolio over the same time horizon and say which one was better, but the numerical value is hard to interpret…

Idea: Use Modigliani-Squared instead.

- Remember: Combination of Portfolio and risk-free Treasury bills forms CAL(P)
- We can increase or decrease position in T-bills to tune risk.
- Tune such that P and market portfolio M have the same risk. Then compare return!



Metrics for Risk-Adjusted Performance

Example:

Managed Portfolio P: $r_P = 35\%$ $\sigma_P = 42\%$

Market Portfolio: $r_M = 28\%$ $\sigma_M = 30\%$

T-bill return = 6%

Tune our synthetic portfolio:

P*: 30/42 = 0.714 in P; and 0.286 in T-bills

$r_{P*} = (.714)\times(.35) + (.286)\times(.06) = 26.7\%$

$r_{P*} < r_M$ meaning the managed portfolio underperformed

Metrics for Risk-Adjusted Performance

Treynor ratio:

$$\text{Treynor} = \frac{r_P - r_f}{\beta_P}$$

Where we plug in:

- Average return on the portfolio
- Average risk free rate
- Weighted average beta for portfolio

Metrics for Risk-Adjusted Performance

Jensen's Measure giving the alpha of the portfolio:

$$\alpha_P = r_P - [r_f + \beta_P(r_M - r_f)]$$

Where we plug in:

- Average return on the portfolio
- Average risk free rate
- Weighted average beta for portfolio
- Average return on the market index portfolio

Metrics for Risk-Adjusted Performance

Information Ratio:

$$S = \frac{\alpha_P}{\sigma(e_P)}$$

Where we plug in:

- Alpha of the portfolio
- Standard deviation of the error terms in the portfolio which is the non-systematic risk.

In theory, we could diversify this away, but in our selection for alpha it's not always possible.

Metrics for Risk-Adjusted Performance

Which one to use?

- It depends on investment assumptions
  - If P is not diversified, then use the Sharpe measure as it measures reward to risk
  - If the P is diversified, nonsystematic risk is negligible and the appropriate metric is Treynor's, measuring excess return to beta
  - If we want to to mix P with a benchmark portfolio, we can evaluate the benefit by considering the information ratio.

Metrics for Risk-Adjusted Performance

Example:

	Portfolio *P*	Portfolio *Q*	Market
Beta	0.90	1.60	1.0
Excess return ($\bar{r} - \bar{r}_f$)	11%	19%	10%
Alpha*	2%	3%	0

*Alpha = Excess return − (Beta × Market excess return)
$= (\bar{r} - r_f) - \beta(\bar{r}_M - \bar{r}_f) = \bar{r} - [\bar{r}_f + \beta(\bar{r}_M - \bar{r}_f)]$

Which portfolio is better, P, Q, or the market?

Standard Deviations: P: 6.5%, Q: 15.6%, Market: 8.8%

Sharpe Ratios?

Metrics for Risk-Adjusted Performance

Example:

	Portfolio *P*	Portfolio *Q*	Market
Beta	0.90	1.60	1.0
Excess return ($\bar{r} - \bar{r}_f$)	11%	19%	10%
Alpha*	2%	3%	0

*Alpha = Excess return − (Beta × Market excess return)
$= (\bar{r} - r_f) - \beta(\bar{r}_M - \bar{r}_f) = \bar{r} - [\bar{r}_f + \beta(\bar{r}_M - \bar{r}_f)]$

Standard Deviations: P: 9.5%, Q: 15.6%, Market: 8.8%

$$\mathrm{SR}_P = \frac{11\%}{9.5\%} = 1.16 \qquad \mathrm{SR}_Q = \frac{19\%}{15.6\%} = 1.23 \qquad \mathrm{SR}_M = \frac{10\%}{8.8\%} = 1.14$$

Metrics for Risk-Adjusted Performance

For Treynor, we can plot the return as a function of beta which is what we determined for the portfolio as the weighted average!

- Market portfolio has slope of Excess return divided by 1. (Why?)

	Portfolio *P*	Portfolio *Q*	Market
Beta	0.90	1.60	1.0
Excess return ($\bar{r} - \bar{r}_f$)	11%	19%	10%
Alpha*	2%	3%	0

*Alpha = Excess return − (Beta × Market excess return)

$= (\bar{r} - r_f) - \beta(\bar{r}_M - \bar{r}_f) = \bar{r} - [\bar{r}_f + \beta(\bar{r}_M - \bar{r}_f)]$

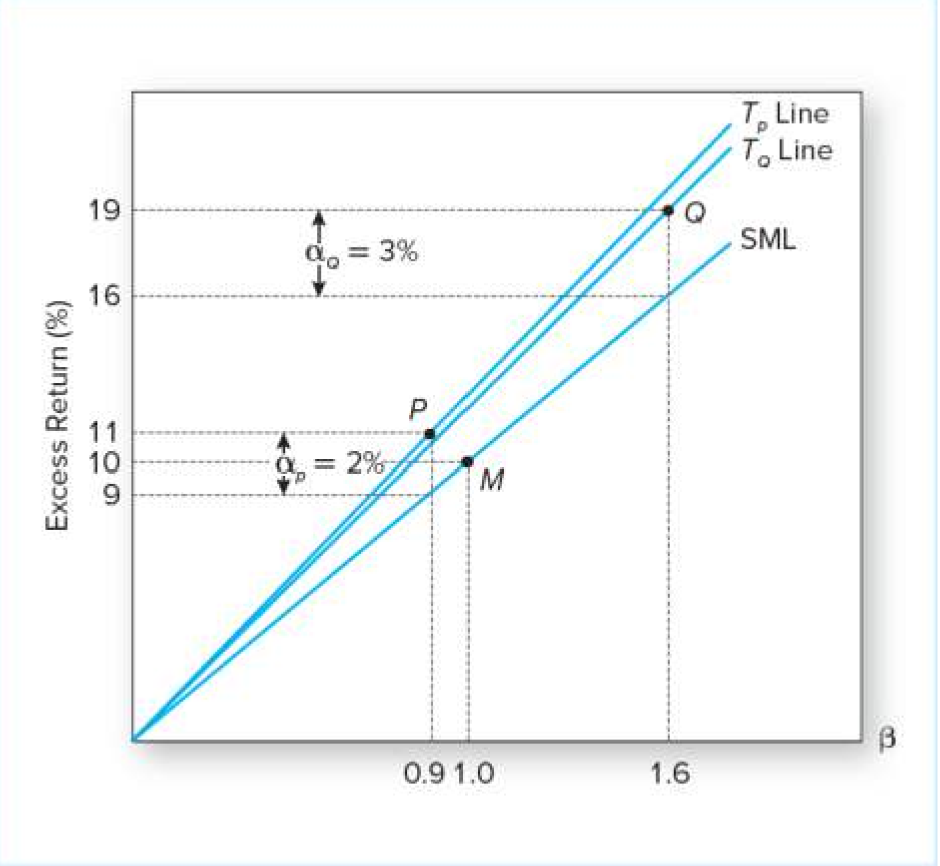


Figure 24.3 Treynor's measure

Metrics for Risk-Adjusted Performance

- If P or Q represents the entire investment, the one with the higher Sharpe ratio is better -- in this case Q.
- If P and Q are competing for a role as one of a number of subportfolios, Q also dominates because its Treynor measure is higher

Performance Measure over Time

- We need a very long observation period to measure performance with any precision, even if the return distribution is stable with a constant mean and variance.
  - Think about statistical analysis and t-statistics and confidence intervals..
- What if the mean and variance are not constant? We need to keep track of portfolio changes

Style Analysis

Question:
How much of the performance stems from asset selection and home much comes from portfolio composition by groups of assets?

Style analysis introduced by William Sharpe

- Regress fund returns on indexes representing a range of asset classes
- The regression coefficient on each index measures the fund’s implicit allocation to that “style”
- R-square measures return variability due to style or asset allocation
- The remainder is due either to security selection or to market timing

Style Analysis

Table 24.4

Style analysis for Fidelity's Magellan Fund

Style Portfolio	Regression Coefficient
T-bill	0
Small cap	0
Medium cap	35
Large cap	61
High P/E (growth)	5
Medium P/E	0
Low P/E (value)	0
Total	100
R-square	97.5

Source: Authors' calculations. Return data for Magellan obtained from **finance.yahoo.com/funds** and return data for style portfolios obtained from the Web page of Professor Kenneth French: **mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html.**

Can you “game the system”?

Assumption:
Rates of return are independent and drawn from same distribution

- Managers may employ strategies to improve performance at the loss of investors
- Ingersoll, Spiegel, Goetzmann, and Welch study leads to MPPM
- Using leverage to increase potential returns

$$MRAR(\gamma) = \left[\frac{1}{T} \times \sum_{t=1}^{T} \left(\frac{1+r_t}{1+r_{ft}} \right)^{-\gamma} \right]^{\frac{12}{\gamma}} - 1$$

where

$\gamma =$ Investor Risk Aversion

$t = 1, 2, \ldots, T =$ Monthly Observations

Back to Building of Portfolios

Last time we talked about how to build an optimal risky portfolio from the single-factor model.

- We considered the main parameters:
  - Alpha of stocks
  - Beta of stocks
  - Individual surprises as the residual variances
- Assumption: residuals were uncorrelated.
- Goal: Improve the passive portfolio by adding an active part in which we do security selection.

How to build your portfolio

Numerous steps to be followed, but it's a straightforward procedure!

- Compute the initial position of each security. If you have high alpha, you'd like more, but only relative to the risk involved:

$$w_i^0 = \alpha_i / \sigma^2(e_i)$$

- Scale the positions such that the sum of your weights is one:

$$w_i = \frac{w_i^0}{\sum_i w_i^0}$$

- Compute the alpha of your active portfolio: $\alpha_A = \sum_i w_i \alpha_i$

How to build your portfolio

We found the weights in our active portfolio which consists of hand-selected securities where we expect abnormal returns.

- Compute residual variance of your active portfolio which comes from the individual securities:

$$\sigma^2(e_A) = \sum_i w_i^2 \sigma^2(e_i)$$

- Compute how much you want to have in A given the risk and return (like for the individual securities before):

$$w_A^0 = \frac{\alpha_A}{\sigma^2(e_A)} \bigg/ \frac{\mathrm{E(r_M)}}{\sigma_M^2}$$

How to build your portfolio

- Find the beta of this active portfolio, which is the weighted sum of all the individual securities' beta:

$$\beta_A = \sum_i w_i \beta_i$$

- Depending on the securities and the weights we assigned, beta might be quite different. If our beta is very high, then the passive portfolio becomes less and less beneficial for diversification.

$$w_A^* = \frac{w_A^0}{1 + (1 - \beta) w_A^0}$$

- Finally, calculate how much should go in A and how much in M.

Treynor-Black Model

- The optimization uses analysts' forecasts of superior performance.
- The model is adjusted for tracking error and for analyst forecast error.

- Problems:
  - The optimal portfolio calls for extreme long/short positions that may not be feasible for a real-world portfolio manager
  - The portfolio is too risky and most of the risk is nonsystematic risk.
  - Restricting extreme positions however reduces diversification..

Treynor-Black Model

	S&P 500	*Active Portfolio A*		HP	DELL	WMT	TGT	BP	SHELL
			α	0.1471	0.1753	0.1932	0.2814	0.1797	0.0357
			$\sigma^2(e)$	0.0705	0.0572	0.0309	0.0392	0.0297	0.0317
		25.7562	$\alpha/\sigma^2(e)$	2.0855	3.0641	6.2544	7.1701	6.0566	1.1255
		1.0000	$w_0(i)$	0.0810	0.1190	0.2428	0.2784	0.2352	0.0437
			$[w_0(i)]^2$	0.0066	0.0142	0.0590	0.0775	0.0553	0.0019
α_A		0.2018							
$\sigma^2(e_A)$		0.0078							
w_0		7.9116							
w^*	−4.7937	5.7937		0.4691163	0.6892459	1.4069035	1.6128803	1.3624061	0.2531855
			Overall Portfolio						
Beta	1	0.9538	0.7323	0.4691	0.6892	1.4069	1.6129	1.3624	0.2532
Risk premium	0.06	0.2590	1.2132	0.2692	0.2492	0.2304	0.3574	0.2077	0.0761
SD	0.1358	0.1568	0.5224	0.3817	0.2901	0.1935	0.2611	0.1822	0.1988
Sharpe ratio	0.44	1.65	2.3223						
M-square	0	0.1642	0.2553						
Benchmark risk			0.5146						

Treynor-Black Model with Constraints

	S&P 500	*Active Portfolio A*		HP	DELL	WMT	TGT	BP	SHELL
			α	0.1471	0.1753	0.1932	0.2814	0.1797	0.0357
			$\sigma^2(e)$	0.0705	0.0572	0.0309	0.0392	0.0297	0.0317
		25.7562	$\alpha/\sigma^2(e)$	2.0855	3.0641	6.2544	7.1701	6.0566	1.1255
		1.0000	$w_0(i)$	0.0810	0.1190	0.2428	0.2784	0.2352	0.0437
			$[w_0(i)]^2$	0.0066	0.0142	0.0590	0.0775	0.0553	0.0019
α_A		0.2018							
$\sigma^2(e_A)$		0.0078							
w_0		7.9116							
w^*	0.0000	1.0000		0.0810	0.1190	0.2428	0.2784	0.2352	0.0437
			Overall Portfolio						
Beta	1	0.9538	0.9538	0.0810	0.1190	0.2428	0.2784	0.2352	0.0437
Risk premium	0.06	0.2590	0.2590	0.2692	0.2492	0.2304	0.3574	0.2077	0.0761
SD	0.1358	0.1568	0.1568	0.3817	0.2901	0.1935	0.2611	0.1822	0.1988
Sharpe ratio	0.44	1.65	1.6515						
M-square	0	0.1642	0.1642						
Benchmark risk			0.0887						

Treynor-Black Model with Constraints

- We still have fairly large weights in individual positions because we believed in their superior or inferior performance.
- Positions came based on our forecast of their alphas.
- Before committing, we should ask:
  - How sure are we of our forecast, or
  - How big is our precision of the forecast alpha?
- Study tracking error, meaning the past performance of our forecasts, then adjust the position with an *adjusted alpha*.

Treynor-Black Model and Tracking Error

Tracking Error:

$$\text{Tracking Error } = T_E = R_P - R_M$$

where

$$R_P = w_A^* \alpha_A + [1 - w_A^* \times (1 - \beta_A)] \times R_M + w_A^* e_A$$

$$T_E = w_A^* \alpha_A - w_A^* \times (1 - \beta_A) \times R_M + w_A^* e_A$$

$$Var(T_E) = [w_A^*(1 - \beta_A)]^2 Var(R_M) + Var(w_A^* e_A) = [w_A^*(1 - \beta_A)]^2 \sigma_M^2 + [w_A^* \sigma(e_A)]^2$$

$$\text{Benchmark risk} = \sigma(T_E) = w_A^* \sqrt{(1 - \beta_A)^2 \sigma_M^2 + [\sigma(e_A)^2]}$$

Black-Litterman Model

Steps:

1. Estimate the covariance matrix from recent historical data
2. Determine a baseline forecast
3. Integrate the manager's private views including a degree of confidence in these views.
   The model is sensitive to this!
4. Develop revised (posterior) expectations
5. Apply portfolio optimization

This sounds familiar – and indeed, it's a generalization of the TB model.