Summary

-Investment Management-

Chapter 5: Introduction to Risk, Return, and the Historical Record.

5.1 Determinants of the level of interest

- Fundamental factors that determine the level of interest rates
  - The supply of funds from savers, primarily households
  - The demand for funds from businesses to be used to finance investments in plant, equipment and inventories
  - The government's net supply of or demands for funds
- An interest rate is a promised rate of return denominated in some unit of account over some time period.
- If an interest rate is risk-free for one unit of account and time period, it will not be risk-free for other units or periods. E.g. returns depends on inflation / consumer price index
- *Nominal interest rate*: the growth rate of your money
- *Real interest rate*: the growth of your purchasing power
- $r = \frac{R - i}{1 + i}$ with R = nominal rate, *r* = real rate and *i* = inflation rate.
- The future real rate is unknown → thus future inflation is risky, the real rate of return is risky even when the nominal rate is risk-free
- Four basic factors determine the real rate
  - Supply
  - Demand
  - Government actions
  - Inflation
- <u>Nominal interest rate = real rate + expected inflation rate</u>
- *Real returns*: the increase in their purchasing power
- Fisher equation: $R = r + E(i)$ with *E(i)* = expected inflation rate
- Tax liabilities are based on nominal income.

5.2 Comparing rates of return for different holding periods

- *Zero-coupon bonds* = bonds that are sold at discount from par value and provide their entire return from the difference between the purchase price and the ultimate repayment of par value.
- Formula → $rf(T) = \frac{100}{P(T)} - 1$ with P(T) price of the treasury bond.
- To compare returns with differing horizons → *Effective annual rate (EAR)* = the percentage increase in funds invested of a 1-year horizon.
- Formula → $[1 + rf(T)]^{1/T}$ with period *T in years.*
- Continuous compounding → $e^{(T*rcc)}$ with *rcc* = rate of annual percentage in continuous compounding.

5.3 Bills and inflation

- Even a moderate rate of inflation can offset most of the nominal gains provided by low-risk investments
- Nominal rates have tended to respond less than one-for-one to changes in expected inflation.

5.4 Risk and Risk premiums

- The realized rate of return on your investments depends on
  - the price per share at year's end
  - the cash dividends you will collect over the year
- *Holding-period return (HPR)* = the realized return
  - $HPR \ = \frac{ending\ price\ of\ a\ share - beginning\ price + cash\ dividend}{Beginning\ price}$

    $$\text{Return} = \frac{D_{it} + P_{it} - P_{it-1}}{P_{it-1}} = R_{it} = HPR^2$$

    With D = dividend and P = price of the share
- *Dividend yield* = the percent return from dividends
  - → dividend yield + capital gains = HPR
- Expected return → $E(r) \ = \Sigma\, p(s) r(s)$ with *E(r)* = expected return, *p(s)* = probability of each scenario and *r(s)* = HPR in each scenario
- The standard deviation of the rate of return (σ) is a measure of risk
- In a bell-shaped curve (normality curve) *E(r)* and (σ) are adequate to characterize the distribution
- How much should you invest in your index fund?
  - How much of an expected reward is offered for the risk involved?
  - Reward = difference between the expected HPR on the index stock fund and the *risk-free rate*
  - *Risk-free rate* = the rate you can earn in risk-free assets (T-bills, bank account)
  - *Risk premium* = reward on common stocks $Risk\ Premium = \ E[R] - Rf$ with E[R] is expected return and Rf is risk-free rate
  - *Excess return* = difference between *actual* rate of return and the actual risk-free rate $Excess\ Return = R - Rf$
  - *Risk aversion* = the degree to which investors are willing to commit funds to stocks. (this risk premium must be positive in order for investors willing to invest)

5.5 Time series analysis of past rates of return

- Arithmetic average of rates of return
  - $E(r) \ = \frac{1}{n}\sum_{s=1}^{n}\frac{a_1+a_2+\cdots+a_n}{n} r(s)$
  - Arithmetic average provides an unbiased estimate of the *expected* rate of returns.
- Geometric (time-weighted) average return
  - tells something about the *actual* performance over the *past* sample period.

$$E[R] = \sqrt{1 + R_1 * (1 + R2) \ldots * (1 + R_t)}^{\frac{1}{n}}$$

- Variance and Standard Deviation
    - Variance = expected value of squared deviations
    - Variance $\rightarrow \sigma_i^2 = E[(R_{it} - \mu_i)^2]$
    - Used to determine the likelihood of deviations from the *expected* return
    - Standard deviation $\rightarrow \sigma_i = \sqrt{\sigma_i^2}$
    - The standard deviation is a measure of the amount of variation or dispersion of a set of values

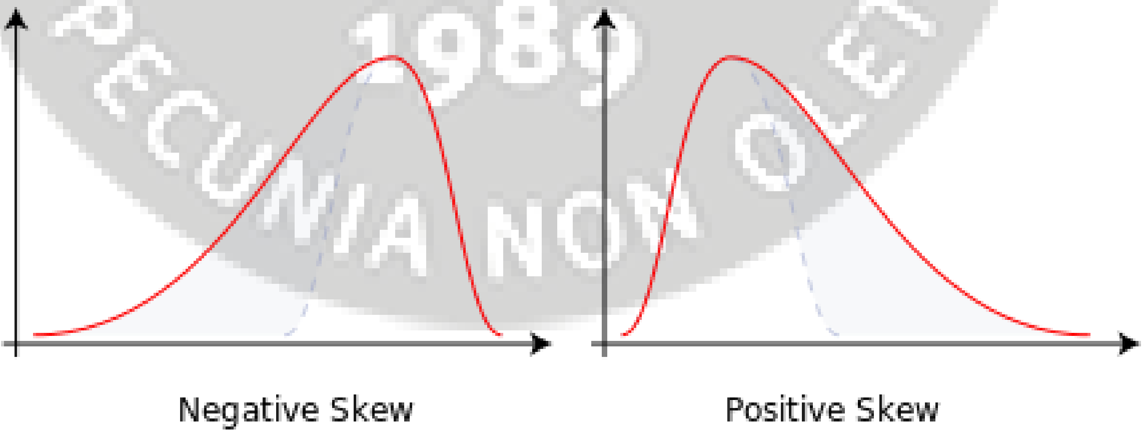
- Reward to volatility (Sharpe) Ratio
    - Tradeoff between reward (the risk premium) and the risk (measured as SD)
    - Sharpe ratio = $\frac{Risk\ premium}{SD\ of\ excess\ return} = \frac{E(r_p) - r_f}{\sigma_p}$ with r_p = rate of portfolio.
    - Sharpe ratio is used to evaluate the performance of investment managers.
    - A higher Sharpe ratio, the better risk-adjusted performance, a negative Sharpe indicates that a risk-less asset would perform better.

5.6 The Normal Distribution

- If return expectations implicit in asset prices are rational, actual rates of return realized should be normally distributed around these expectations.
- *n* options can produce *n* + 1 possible outcomes

5.7 Deviations from Normality and Risk Measures

- *Skew* = a measure of asymmetry
- If positively skewed → (skew > 0) the standard deviation overestimates risk
- If negatively skewed → (skew < 0) the standard deviation underestimates risk



- *Kurtosis* = measure of the degree of fat tails

$$\text{Kurtosis} = \left\{ \frac{1}{n} \sum_{s=1}^{n} \left[\frac{x_s - \bar{x}}{\sigma} \right]^4 \right\} - 3$$

- Value at risk (VaR)

- VaR = measure of loss most frequently associated with extreme negative returns
- VaR seen as the 5% worst-case future scenarios
- = mean + (-1.65) SD

- Expected Shortfall (ES)
  - A more realistic downside exposure → the *expected* loss given that we find ourselves in one of the worst-case scenarios.
- Lower partial standard deviation and the Sortino ratio
  - *Lower partial standard deviation (LPSD)* → ''left-tail standard deviation''
  - When this LPSD is used in the Sharpe ratio → Sortino Ratio.

5.8 Historic returns on risky portfolios: Equities and long-term government bonds

- Five important risky portfolios
  - *World large stocks*: all available country index portfolios
  - *US large stocks*: index of corporations accounting for 75% of total market value
  - *US small stocks*: index of corporations accounting for 25% of total market value
  - *US long-term government bonds*: Government bonds of 10 years +
  - *Diversified portfolios*: mixture of all other portfolios
- Performance
  - Sharpe ratio is used
  - Diversified portfolio gives highest Sharpe ratio

Chapter 6: Risk Aversion and Capital Allocation to Risky Assets

6.1 Risk and Risk Aversion

- *Risk premium* = the *expected* excess return
- *Speculation* = the assumption of considerable investment risk to obtain commensurate gain
- *Considerable risk* = the risk is sufficient to affect the decision.
- *Commensurate gain* = positive risk premium
- *Gamble* = to bet or wager on an uncertain outcome (thus actually speculation but without commensurate gain)
- Heterogeneous expectations → case of differing beliefs between people
- *Risk averse* = penalize the expected return of a risky portfolio due to the risk.
- How to quantify the rate investors are doing the trade-off between return and risk?
  - Utility score for each competing investment portfolios
  - Utility = U = $E(r) - \frac{1}{2} A\,\sigma^2$ with A is risk aversion and σ^2 is variance
  - The more risk averse, the higher A

- Utility scores of risky portfolios = *certain equivalent rate of return* → the rate that risk-free investments would need to offer to provide the same utility score as the risky portfolio.
- *Risk averse investors* → A > 0
- *Risk neutral investors* → A = 0 (judge solely on expected rates of return)
- *Risk lover investors* → A < 0 (adjusts expected returns upwards due to the 'fun' of taking risks)

- Portfolio A dominates portfolio B if
  - $E(r_a) \geq E(r_b)$ and $\sigma_a \leq \sigma_b$
- *Indifference curve* = curve which connects all portfolios points with the same utility

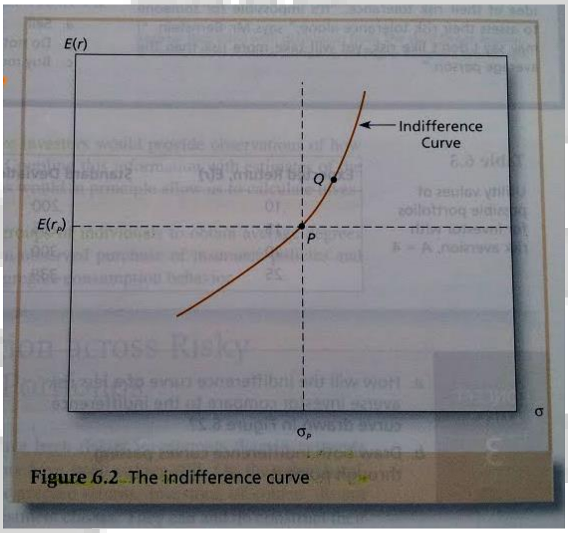


Figure 6.2 The indifference curve

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  - Quadrant I (upper left) → contains all dominant portfolios
  - Quadrant IV (lower right) → contains all inferior portfolios
  - Quadrant II and III (lower left and upper right) → depends on the indifference curve if portfolio is preferred / indifferent / or not
- How to determine risk aversity:
  - Questionnaires
  - Look at portfolio compositions of active investors
  - Track behaviour of group of individuals

6.2 Capital Allocation across Risky and Risk-free Portfolios

- straightforward way to control risk → invest partially in T-bills, partially in risky assets.
- → Capital allocation
- Ratio between risky assets and risk-free assets.

6.3 The risk-free Asset

- Only the government can issue default-free bonds
- Not completely risk-free, it depends on changes in the *real* interest rate.
- Treasury bills → *risk free asset*
- Money market funds holds for the most part three type of securities
    - Treasury bills
    - Bank certificates of deposits (CD's)
    - Commercial paper (CP)
- Money market is the most easily accessible risk-free asset for most investors

6.4 Portfolios of One Risky asset and a Risk-Free Asset

- Rate of return on the *complete* portfolio (denoted C) is *rc* when
    - $r_C = yr_P + (1 - y)\, r_f$ with expectation $E(r_C) = yE(r_P) + (1 - y)\, r_f$
    - where r_P = risky rate of return of P
    - y = proportion investments in risky assets
    - r_f = rate of return on risk-free asset
- when combining risky assets with risk-free assets, the SD of the complete portfolio is the SD of the risky asset multiplied by the weight of the risky asset in that portfolio.
    - $\sigma_C = y\sigma_P$
    - σ_C= risk complete portfolio
    - σ_P= risk risky asset
- The expected return of the complete portfolio as a function of its standard deviation is a straight line, with intercept r_f and slope S (Sharpe) = $\frac{E(r_P) - r_f}{\sigma_P}$

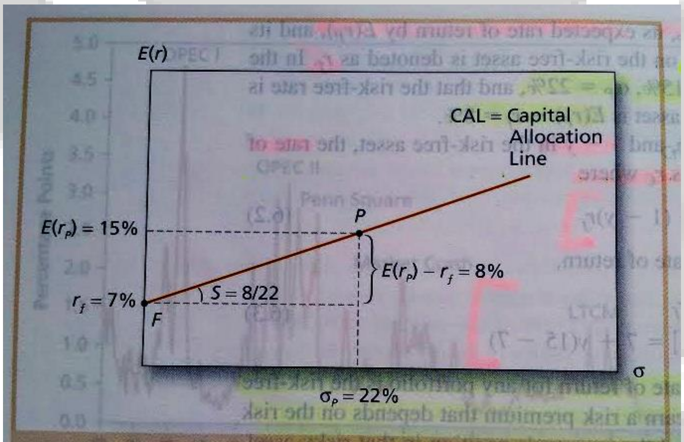

Figure 6.4 The investment opportunity set with a risky asset and a risk-free asset in the expected return–standard deviation plane

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    - The straight line is called the *capital allocation line*
    - *Capital allocation line (CAL)* = all the risk-return combination available to investors
    - The slope is called *Reward-to-volatility ratio* → incremental return per incremental risk (and also thus the Sharpe ratio)
    - Points on the right of P at the CAL → borrow money and invest

- If an investor borrows money and uses this to invest → called a *leveraged position*
- A leveraged portfolio has a higher standard deviation than does an unleveraged position in the risky asset.

6.5 Risk Tolerance and Asset Allocation

- The investor confronting with the CAL must choose one optimal portfolio, C
  - This depends on the risk aversion
- Utility increases as *y* increases, but eventually it declines
- Optimal position for risk-averse investors in the risky asset y*
  - $y^* = \frac{E(r_P) - r_f}{A\,\sigma^2{}_P}$
- To obtain indifference curve for required E(r) with the same utility but with different levels of σ $\rightarrow required\ E(r) = U + 1/2 * A * \sigma^2$

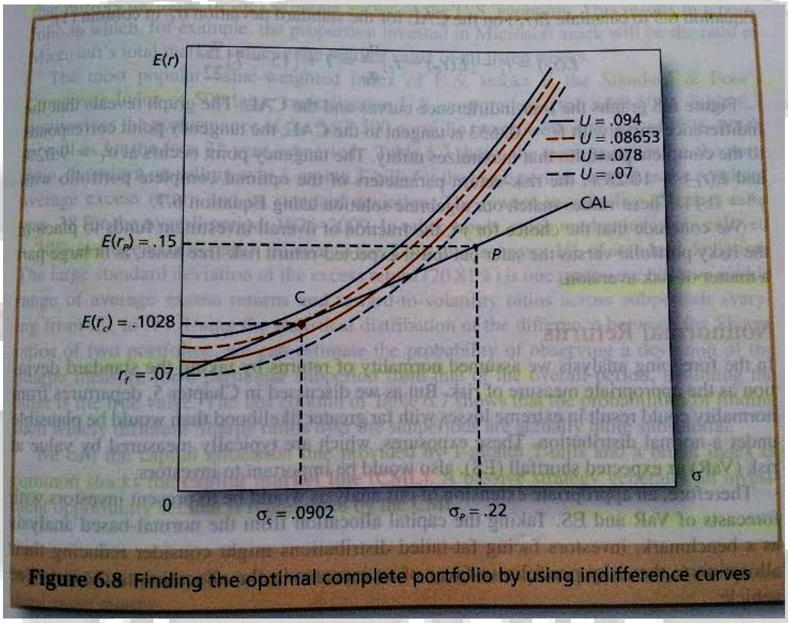

Figure 6.8 Finding the optimal complete portfolio by using indifference curves

6.6 Passive strategies: The capital market line

- CAL is derived from the risk-free and ''the'' risky portfolio P.
- *Passive strategy*: portfolio decision that avoids *any* direct or indirect security analysis. → Thus no spending on gathering information on stocks or group of stocks
  - Good candidate for passively held risky assets = well diversified portfolio of common stocks.
  - Must follow a ''neutral'' diversification strategy
- *Capital market line (CML)*: the capital allocation line provided by 1-month T-bills and a broad index of common stocks. A passive strategy generates an investment opportunity set that is represented by CML.
- How reasonable is it for an investor to pursue a passive strategy?
  - The alternative active strategy is not for free (acquiring information)

        - Free-rider benefit (due to active investors, assets are fairly priced)
- Passive strategy involves investment in two passive portfolios
    - Virtually risk-free short-term T-bills (or alternatively, money market fund)
    - Fund of common stocks that mimics a broad market index
    - The capital allocation line representing such a strategy is called Capital Market Line.

Chapter 7: Efficient diversification

7.1 Diversification and portfolio risk

- Two kinds of risk
    - Market risk (business cycle) → cannot be predicted
        - *Systematic risk* or *nondiversifiable risk*
    - Firm specific risk (success of business and factors related to the sector)
        - *Nonsystematic risk* or *diversifiable risk*
- Diversification can reduce firm-specific risk at arbitrarily low levels.
- *Insurance principle* = reduction of risk to very low levels in case of independent risk sources

7.2 Portfolios of two risky assets

- *Efficient diversification*: construct risky portfolios to provide the lowest possible risk for any given level of expected return
- The rate of return will be
    - $r_P = W_D r_D + W_E r_E$
    - W_D= proportion invested in bond fund
    - W_E= proportion invested in stock fund
- The expected rate of return
    - $E(r_P) = W_D E(r_D) + W_E E(r_E)$
- The covariance of a variable with itself is the variance of that variable
- Thus $\sigma_p^2 = W_D W_D Cov(r_D r_D) + W_E W_E Cov(r_E r_E) + 2W_D W_E Cov(r_D r_E)$
- The variance of the portfolio is a weighted sum of covariances, and each weight is the product of the portfolio proportions of the pair of assets in the covariance term.
- $Cov(r_D r_E) = \rho_{DE}\sigma_D\sigma_E$
- thus $\sigma_p^2 = W_D W_D Cov(r_D r_D) + W_E W_E Cov(r_E r_E) + 2W_D W_E \rho_{DE}\sigma_D\sigma_E$
- W_D >1 and $W_E < 0$ → sell the equity fund and invest the proceeds of the share sale in the debt/bond fund.
- W_D <0 and W_E >1 → selling the bond fund short and using the proceeds to finance additional purchases of the equity fund.

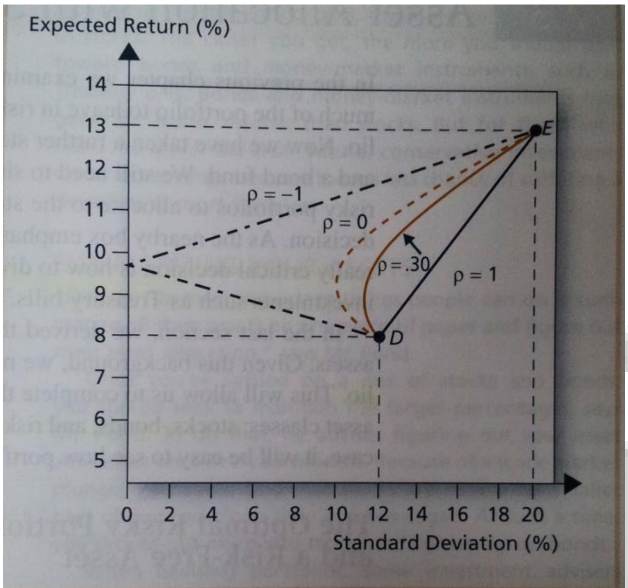

Figure 7.5 Portfolio expected return as a function of standard deviation

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    - Solid colored curve → *Portfolio opportunity set (with ρ=0.3)*
    - → it shows all combination of portfolio expected return and standard deviation that can be constructed from two available assets
    - Solid black line → no benefit from diversification when correlation is perfect *ρ=1*
    - for *ρ= -1* → perfect hedging opportunity and the maximum advantage from diversification.
- <u>The lower the correlation between the two available assets, the greater the potential benefit from diversification</u>

7.3 Asset allocation with stocks, bonds and bills

- Capital allocation decision → The choice of how much of the portfolio to leave in risk-free money market securities versus in a risky portfolio.
- Asset allocation across three key asset classes:
    - Stocks
    - Bonds
    - Risk-free money market securities

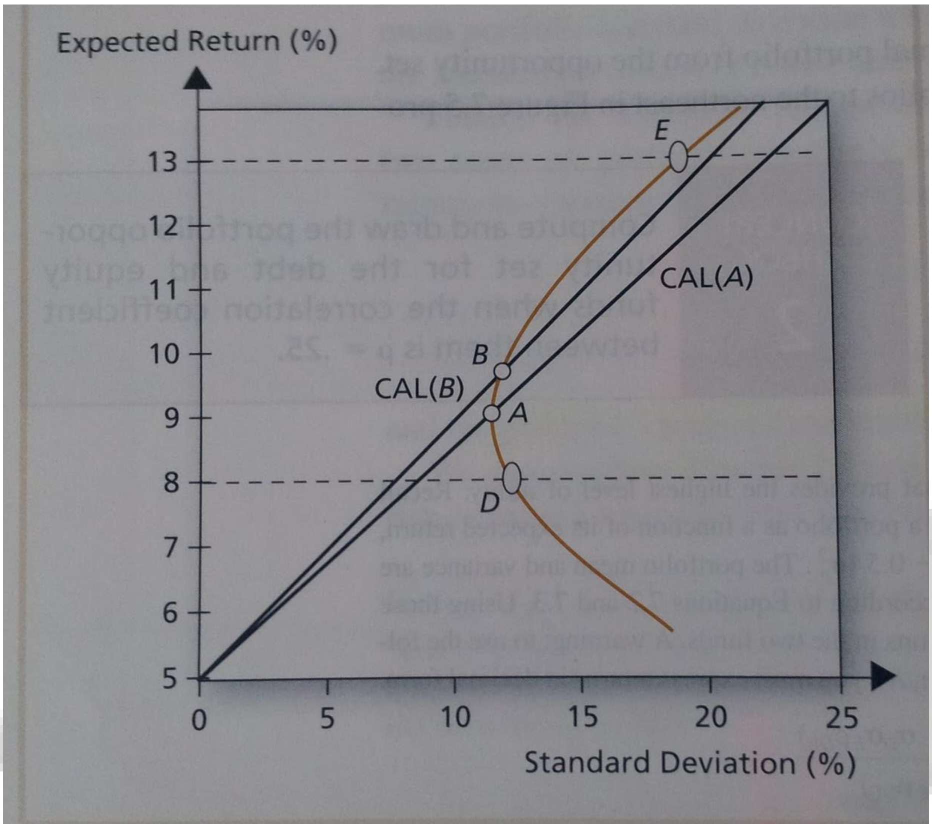

Figure 7.6 The opportunity set of the debt and equity funds and two feasible CALs

- *Reward-to-volatility (Sharpe) ratio* → slope of the CAL combining T-bills and the minimum variance portfolio
- Portfolio B dominates Portfolio A because the CAL P_B > CAL P_A
- The objective is to find the weights W_D and W_E that result in the highest slope of the CAL.
- *Optimal risky portfolio P*
  - $W_D = \frac{E(R_D)\sigma_E^2 - E(R_E)Cov(R_D,R_E)}{E(R_D)\sigma_E^2 + E(R_E)\sigma_E^2 - [E(R_D) + E(R_E)]\,Cov(R_D,R_E)}$
  - $W_D = 1 - W_E$
- Steps to arrive at the complete portfolio
  1. Specify the return characteristics of all securities (expected returns, variances, covariances)
  2. Establish the risky portfolio
     a. Calculate the optimal risky portfolio, P
     b. Calculate the properties of portfolio P using the weights determined in step (a) using $E(r_P) = W_D E(r_D) + W_E E(r_E)$ and $\sigma_p^2 = W_D W_D Cov(r_D r_D) + W_E W_E Cov(r_E r_E) + 2 W_D W_E\, \rho_{DE}\sigma_D\sigma_E$
  3. Allocate funds between the risky portfolio and the risk-free asset
     a. Calculate the fraction of the complete portfolio allocated to portfolio P (the risky portfolio) and to T-bills (the risk-free asset).

using $y = \frac{E(r_p) - r_f}{A\sigma^2{}_p}$ with y invested into the portfolio and 1-y in t-bills.

b. Calculate the share of the complete portfolio invested in each asset and in T-bills.

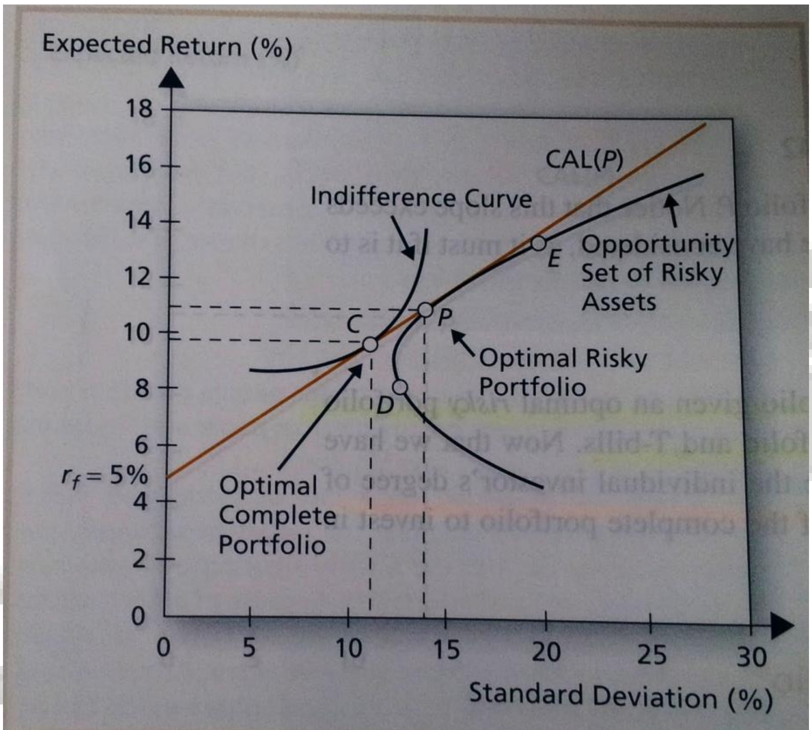

Figure 7.8 Determination of the optimal complete portfolio

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7.4 The Markowitz portfolio selection model

- Portfolio construction
    - Identify the risk-return combinations available from the set of risky assets
    - Identify the optimal portfolio of risky assets by finding the portfolio weights that results in the steepest CAL.
    - Choose an appropriate complete portfolio by mixing the risk-free asset with the optimal risky portfolio.

- Overview

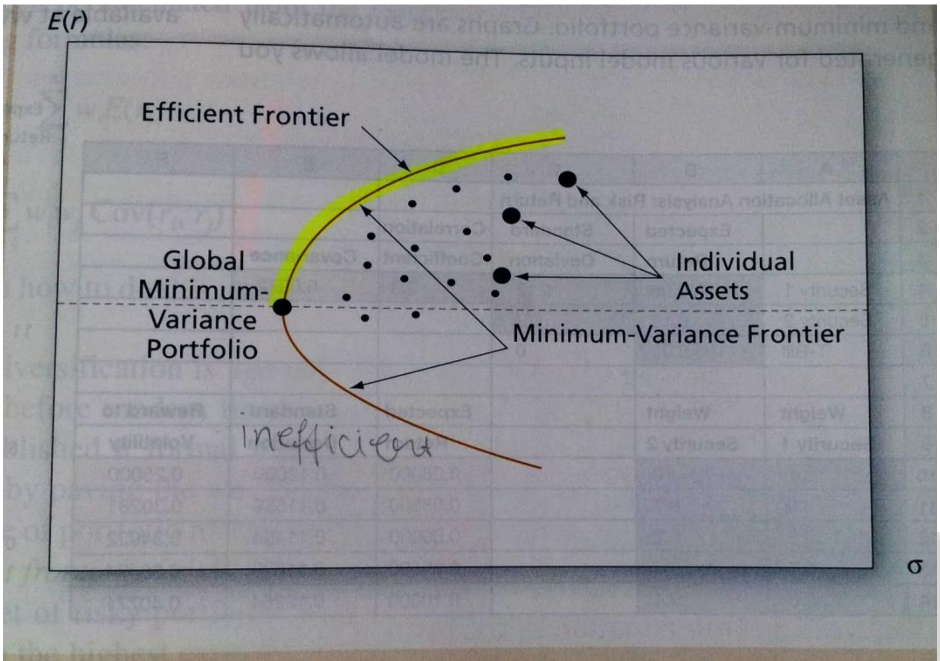

Figure 7.10 The minimum-variance frontier of risky assets

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    - The first step is to determine the risk-return opportunities available to the investor → *minimum-variance frontier* of risky assets.
    - *Minimum-variance frontier*: a graph of the lowest variance that can be attained for a given portfolio expected return.
    - All portfolios that lie on the minimum-variance frontier from the global minimum-variance portfolio and upward provide the best risk-return combinations.
    - *Efficient frontier of risky assets*: The part of the frontier that lies above the global minimum-variance frontier
    - Second step involves risk-free asset → we search for the CAL with the highest reward-to-volatility (Sharpe ratio)
    - The CAL that is supported by the optimal portfolio, P, is tangent to the efficient frontier.
    - Last part is the individual investor chooses the appropriate mix between the optimal risky portfolio P and T-bills
- Principle Markowitz: For any risk level, we are interested only in that portfolio with the highest expected return. Alternatively, the frontier is the set of portfolios that minimizes the variance for any target expected return.
- The degree of risk aversion of the client comes into play only in the selection of the desired point along the CAL.

Chapter 8: Index models

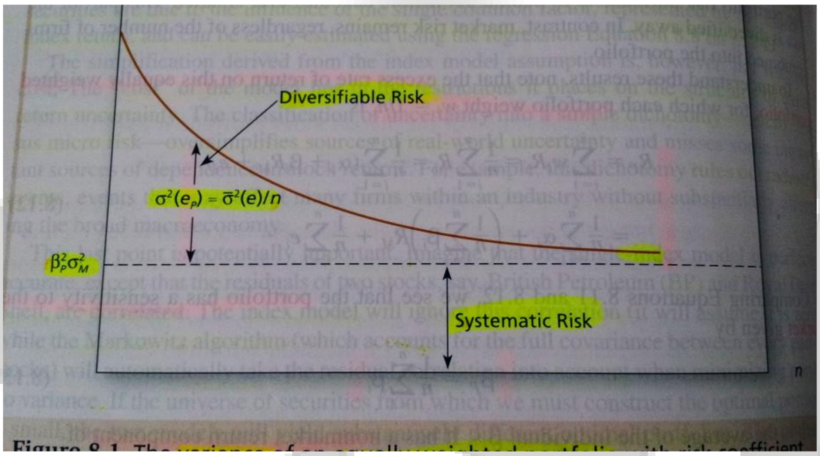
8.1 A Single-Factor Security Market

- Common factors (e.g. business cycles, interest rates and costs of natural resources) generates correlation across securities
- Single factor model
    - $r_i = E(r_i) + \beta_i m + e_i$
    - With *m* = macroeconomic factors
    - β_i = sensitivity coefficient for firm i to the macroeconomic conditions

8.2 Single-index model

- Single-index model → it uses the market index to proxy for the common factor.
- $R_i(t) = \alpha_i + \beta_i R_M(t) + e_i(t)$
- Excess return $R_M = r_M - r_f$
- Excess return $R_i = r_i - r_f$
- α_i = the security's expected excess return when the market excess return is zero
- β_i = the security's sensitivity to the index.
- $Total\ Risk = Systematic\ Risk + Firmspecific\ Risk$
- Systematic risk = non-diversifiable risk / market risk
- Firm-specific risk = opposite of systematic risk, the risk specific for a company, thus diversifiable risk
- The set of estimates needed for the single-index model
    1. The stock's expected return if the market is neutral, that is, if the market's excess return, $r_M - r_f$ is zero → α_i
    2. The component of return due to movements in the overall market; $\beta_i$is the security's responsiveness to market movements → $\beta_i(r_M - r_f)$
    3. The unexpected component of return due to unexpected events that are relevant only to this security (firm-specific) → e_i
    4. The variance attributable to the uncertainty of the common macroeconomic factor → $\beta_i^2\sigma_M^2$
    5. The variance attributable to firm-specific uncertainty → $\sigma^2(e_i)$
    6. Variance of the equally weighted portfolio of firm specific components $\sigma^2(e_p) = \frac{1}{n}\overline{\sigma^2(e)}$ → when n gets large $\sigma^2(e_p)$ becomes negligible
       Or use $\sigma^2(e_p) = W_1^2 * \sigma_1^2 + W_2^2 * \sigma_2^2 + W_3^2 * \sigma_3^2$ with W_i = weight company *i*
- These calculations show that if we have
    - *n* estimates of the extra-market expected excess returns, α_i
    - *n* estimates of the sensitivity coefficients, β_i
    - *n* estimates of the firm-specific variances, $\sigma^2(e_i)$
    - 1 estimate for the market risk premium $E(R_M)$
    - 1 estimate for the variance of the (common) macroeconomic factor σ_M^2

    - Then these (3n +2) estimates enable us to prepare the entire input list for this single index-security universe.
- However, this model may oversimplify the real-world uncertainties and misses some important sources of dependence in stock returns. e.g. industry events and correlations
- The optimal portfolio derived from the single-index model therefore can be significantly inferior to that of the full-covariance (Markowitz) model when stocks with correlated residuals have large alpha values and account for a large fraction of the portfolio



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- As diversification increases, the total variance of a portfolio approaches the systematic variances, defined as the variance of the market factor multiplied by the square of the portfolio sensitivity coefficient β_P^2
- Excess returns → $R_i = r_i - r_f$
- Regression equation → $R_i(t) = \alpha_i + \beta_i R_M(t) + e_i(t)$
- Expected return-beta relationship → $R_i(t) = \alpha_i + \beta_i E(R_M)$

8.3 Estimating the Single-index model

- *Security characteristic line (SCL)*: describes the (linear) dependence of excess return on changes in the state of the economy represented by the excess returns of the index portfolio.
- If swings in excess return > market swings, then ß is often greater than 1.
- Intercept of regression → 0.0086 means 0.86% per month → is the estimate of the alpha for the sample period
- Beta of regression → 2.03 means more than 2 times that of the index → thus it high sensitive for the market.
- Highest sensitivity for market = technology (IT)
- Medium sensitivity for market = retail and lowest
- Lowest sensitivity for market = energy market (oil)

Chapter 9: The Capital Asset Pricing Model

9.1 The Capital Asset Pricing Model

- *Capital asset pricing model (CAPM)* = set of prediction concerning equilibrium expected returns on risky assets. → A model that describes the relationship between risk and expected return on the market portfolio and that is used in the pricing of risky securities.
- The general idea behind CAPM is that investors need to be compensated in two ways: time value of money and risk. The time value of money is represented by the risk-free (rf) rate in the formula and compensates the investors for placing money in any investment over a period of time. The other half of the formula represents risk and calculates the amount of compensation the investor needs for taking on additional risk. This is calculated by taking a risk measure (beta) that compares the returns of the asset to the market over a period of time and to the market premium (Rm-rf).
- First simplifying assumptions:
  - There are many investors, each with a small wealth
  - Investors are price takers, securities are unaffected by their own trades
  - All investors plan for one identical holding period (short sighted)
  - Investments are limited to stocks/bonds/risk-free borrowing
  - Investors pay no taxes on returns and no transaction costs
  - All investors use Markowitz portfolio selection model
  - All investors analyse securities the same way and share same economic view → result: identical estimates of probability distribution for future cash flow → named the *homogeneous expectations*
- With this we can summarize the equilibrium that will occur in this hypothetical world
  - All investors will hold a portfolio of risky assets in proportions duplicating the assets in the market portfolio. → proportion of each stock in the market portfolio equals the market value of the stock divided by the total market value of all stocks
  - Risky asset will be called *stocks*
  - Market portfolio will be on efficient frontier and on tangent with the CAL. → therefore the CML will also be the best attainable line.
  - Risk premium will be proportional to its risk and degree of risk aversion
  - Risk premium on individual assets will be proportional to the risk premium on the market portfolio M
  - Beta coefficient measures the extent to which returns on the stock and the market move together
- *Market portfolio* = an aggregated risky portfolio of all individual investors, which is equal to the wealth of the economy

    - Proportion of each stock in this portfolio equals the market value of the stock divided by the sum of the market values of all stocks
- The optimal risky portfolio of all investors is simply a share of the market portfolio.
- *CML* = the capital allocation line constructed from the money market account (or T-bills)
- Risk premium on the market portfolio is related to its variance times the average degree of risk aversion of all individuals
- CAPM is built on the insight that the appropriate risk premium on an asset will be determined by its contribution to the risk of investor's overall portfolios. Portfolio risk is what matters to investors and is what governs the risk premiums they demand
- The stock's contribution to the risk of the market portfolio depends on its covariance with that portfolio
- The reward-to-risk ratio can be expressed as $\frac{Asset's\ contribution\ to\ risk\ premium}{Asset's\ contribution\ to\ variance}$
- The reward-to-risk ratio for investment in the market portfolio = $\frac{Market\ risk\ premium}{Market\ variance}$
    - → also called the *Market price of risk*, it quantifies the extra return that investors demand to bear portfolio risk.
    - *Market risk premium*: the risk premium on the market portfolio will be proportional to its risk and the degree of risk aversion of the investor
        - if *y* = 1 then:
        - $E(r_M) - r_f = \underline{A}\,\sigma_M^2$ with $\underline{A}$ = average degree of of risk aversion
- Equilibrium → all investments should offer the same reward-to-risk ratio
    - Thus reward-to-risk ratios and market portfolio should be equal.
- CAPM relation = $E(r_i) = r_f + \beta_i[E(r_M) - r_f]$ → altered expected return-beta relationship with E(Ri) = expected return on the risky portfolio, E(Rm) = expected return on the market, and Rf = risk-free rate
- $\beta_i = \frac{cov\{R_i, R_M\}}{\sigma_M^2}$ → Cov = Covariance
- The beta is used to correct the risk of a security or portfolio that is not the efficient portfolio. It measures the non-diversifiable risk of the stock.
- When we talk about an efficient portfolio, we use σ (sigma), the variance instead of the beta
- If everyone holds an identical risky portfolio, then everyone will find that the beta of each asset with the market portfolio equals the asset's beta with his or her own risky portfolio
- A well-diversified portfolio will be so highly correlated with the market, that the stock's beta relative will still be a useful risk measure.
- The CAPM predicts returns on investments in the securities of the firm
- *Security market line (SML)* is the representation of the capital asset pricing model. It displays the expected rate of return of an individual security as a function of systematic, non-diversifiable risk → the expected return-beta relationship (is a reward-risk equation)
    - the beta of a security is the appropriate measure of its risk.

- CML graphs the risk premiums of *efficient* portfolios (i.e. portfolios composed of the market and risk-free asset)
- SML graphs *individual asset* risk premiums as a function of asset risk.
    - SML is valid of both efficient portfolios and individual assets
    - SML provides a benchmark for the evaluation of investment performance.
    - SML is the required rate of return of an asset according to its riskiness

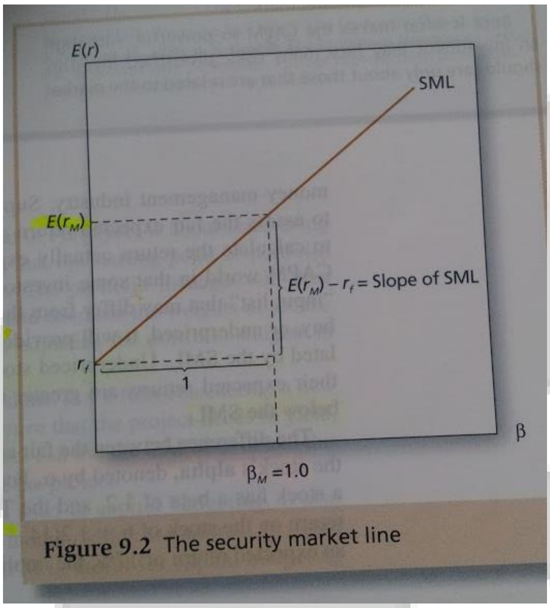

Figure 9.2 The security market line

    - SML provides required rate of return to compensate investors for risk
    - Underpriced stocks are plot above the SML
    - Overpriced stocks are plot below the SML
- Use of CAPM
    - Useful in capital budgeting decisions (what required rate or return will a project need)
    - Utility rate-making cases

9.3 Is the CAPM practical?

- The difference between the fair and actually expected rates of return on a stock is called the stock's *alpha*, denoted by *α*
- A security is mispriced if and only if its alpha is nonzero
    - Underpriced if alpha is positive
    - Overpriced if alpha is negative.
- Is the CAPM testable?
    - Normative tests (examine assumptions), positive tests (examine predictions)
    - Model is robust with respect to an assumption if its predictions are not highly sensitive to violation of the assumption
- The CAPM fails empirical tests
    - the market portfolio cannot be observed, tests of CAPM can only use proxies
    - The CAPM fails these tests → data reject the hypothesis that alpha values are uniformly zero at acceptable levels of significance

- The economy and the validity of the CAPM
    - CAPM is an accepted norm in US and developed countries, despite empirical shortcomings
        - However, it is the best model available
        - It may not be all that far from being valid
- The investments industry and the validity of the CAPM
    - CAPM provides discount rates that help security analysts assess the intrinsic value of a firm
- So yes, practitioners do use CAPM → If they use a single-index model and derive optimal portfolios from ratios of alpha forecasts to residual variance, they behave as if the CAPM is valid.

9.4 Econometrics and the expected return-beta relationship

- Econometric problems could lead one to reject the CAPM even if it were perfectly valid
- Problems with estimation of beta-coefficient
    - residuals can be correlated (e.g. firms in same industry) → standard beta estimates are not efficient
    - alpha and beta coefficients are likely time varying

Chapter 10: Arbitrage Pricing Theory and multifactor Models of risk and return

10.1 Multifactor models: an overview

- Arbitrage: The exploitation of security mispricing in such a way that risk-free profits can be earned
- multifactor models can provide better descriptions of security returns.
- Multifactor security market line → risk premium is determined by the exposure to *each* systematic risk factor, and by a risk premium associated with each of those factors
- Difference between single- and multiple-factor economy is that a factor risk premium can be negative.

10.2 Arbitrage pricing theory

- *Arbitrage pricing theory (APT)* = predicts a security market line linking expected returns to risk. Depends on three key propositions:
    - Security returns can be described by a factor model
    - There are sufficient securities to diversify away idiosyncratic risk
    - Well-functioning security markets do not allow for the persistence of arbitrage opportunities

- *Arbitrage* = opportunity when an investor can earn riskless profits without making an investment
- *Law of one price* = if two assets are equivalent in all economically relevant aspects, then they should have the same market price.
- *Arbitrage activity* → buying asset where it is cheap and selling where it is expensive
    - Thus, bid up the price where it is low and forcing price down where it is high, until the arbitrage opportunity is eliminated.
- The idea that market prices will move to rule out arbitrage opportunities is perhaps the most fundamental concept in capital market theory → violation would indicate the grossest form of market irrationality.
- Pressure on equilibrium prices result from many investors shifting their portfolios
- *Arbitrageur* → a professional searching for mispriced securities, rather than look for arbitrage opportunities.
- If portfolio is well-diversified, its firm-specific or nonfactor risk becomes negligible, and only systematic risk remain.
- Well-diversified portfolios with equal betas must have equal expected returns in market equilibrium, or arbitrage opportunities exist.
- To avoid arbitrage opportunities, the expected return on all well-diversified portfolios must lie on the straight line from the risk-free asset.

10.3 Individual Assets and the APT (Arbitrage Pricing Theory)

- If arbitrage opportunities are to be ruled out, each well-diversified portfolio's expected excess return must be proportional to its beta
- Imposing the no-arbitrage condition on a single-factor security market implies maintenance of the expected return-beta relationship for all well-diversified portfolios and for all but possibly a small number of individual securities.
- APT highlights the crucial distinction between non diversifiable risk that reward in the form of a risk premium and diversifiable risk that does not
- APT depends on assumption that rational equilibrium in capital markets precludes arbitrage opportunities

10.4 A multifactor APT (Arbitrage Pricing Theory)

- *Factor portfolio* → a well-diversified portfolio constructed to have a beta of 1 on one of the factors and a beta of zero on any other factor
    - will serve as the benchmark portfolios for a multifactor security market line
- multifactor SML is used for an economy with multiple sources of risk

10.5 Where should we look for factors

- A possible set of factors could be
    - IP = % change in industrial production

- EI = % change in expected inflation
- UI = % change in unanticipated inflation
- CG = excess return of long-term corporate bonds over long-term government bonds
- GB = excess return of long-term government bonds over T-bills

- This results into:
- $r_{it} = \alpha_i + \beta_{iIP} IP_t + \beta_{iEI} EI_t + \beta_{iUI} UI_t + \beta_{iCG} CG_t + \beta_{iGB} GB_t + e_{it}$
    - A multidimensional security characteristic line (SCL)
    - Thus a multiple regression
- **Fama-French (FF) Three Factor Model**
    - = A factor model that expands on the capital asset pricing model (CAPM) by adding size and value factors in addition to the market risk factor in CAPM. This model considers the fact that value and small cap stocks outperform markets on a regular basis. By including these two additional factors, the model adjusts for the outperformance tendency, which is thought to make it a better tool for evaluating manager performance.
    - $r_{it} = \alpha_i + \beta_{iM} R_{Mt} + \beta_{iSMB} SMB_t + \beta_{iHML} HML_t + e_{it}$
    - SMB = Small Minus Big i.e. return of a portfolio of small stocks in excess of the return on a portfolio of large stocks
    - HML = High Minus Low i.e. return of a portfolio of stocks with a high book-to-market ratio in excess of the return on a portfolio of stocks with a low book-to-market ratio.
    - SMB and HML are a proxy for yet-unknown more-fundamental variables
    - Reason → firms with high ratios of book-to-market value are more likely to be in financial distress and that small stocks may be more sensitive to changes in business conditions.
    - Thus, in the FF model, the expected return on each stock depends on its exposure to:
        - The market portfolio less the risk-free rate
        - The difference between the return on small/large firm stocks
        - The difference between the return on stocks with high and low book-to-market ratios

10.6 The multifactor CAPM and the APT

- Distinguish multifactor APT from multi-index CAPM
- Multi-index CAPM
    - Factors are derived from a multiperiod consideration of a stream of consumption and random evolving investment opportunities
    - Index derived from utility of consumption, nontraded assets and change in investment opportunities

- The index will inherit its risk factors from sources of risk that a broad group of investors deem important enough to hedge
- APT
  - largely silent on where to look for priced sources of risk
  - a less structured search for relevant risk factors
  - Thus, may reflect a broader set of investors, including institutions (e.g. pension funds)

Chapter 16 Managing bond portfolios

16.1 Interest Rate Risk

- There can be an inverse relationship between bonds and yield
- interest rates can fluctuate substantially
- Bond prices decrease when yields rise, and the price curve is convex, meaning that decreases in yields have bigger impacts on price than increases in yields of equal magnitude
  1. Bond prices and yields are inversely related: as yields increase, bond prices fall; as yields fall bond prices rise
  2. An increase in a bond's yield to maturity results in a smaller price change than a decrease in yield of equal magnitude
  3. Prices of long-term bonds tend to be more sensitive to interest rate changes than prices of short-term bonds
  4. The sensitivity of bond prices to changes in yields increases at a decreasing rate as maturity increases. In other words, interest rate risk is less than proportional to bond maturity
  5. Interest rate risk is inversely related to the bond's coupon rate. Prices of low-coupon bonds are more sensitive to changes in interest rates than prices of high-coupon bonds
  6. The sensitivity of a bond's price to a change in its field is inversely related to the yield to maturity at which the bond currently is selling.
- Higher-coupon-rate bonds have a higher fraction of value tied to coupons rather than final payment of the par value → thus the earlier short-maturity payments are weighted more heavily than the final payment. (corresponds with number 5 above)
- *Macaulay's duration*: the weighted average of the times to each coupon or principal payment → present value of the payment divided by the bond price
- *Price of a bond:* $$P = \sum_{t=1}^{T-1} \frac{C_t}{(1+y)^t} + \frac{C_t + \text{Face Value}}{(1+y)^T}$$ with C(t) = cash flows at time t, t = time and y = yield to maturity
- *Macaulay's duration* $$D_{Mac} = \sum_{t=1}^{T} \left[\frac{\text{CF}_t}{P(1+y)^t} \right] \times t$$

- $w_t = \frac{CF_t \,/\, (1+y)^t}{Bond\ price}$
- w_t = weight, associated with the cash flow made at time *t* (denoted as CF_t)
- *y* = bond's yield to maturity
- Duration is a key concept in fixed-income portfolio management for three reasons
    - it is simple summary statistics of effective average maturity of the portfolio
    - It is essential tool in immunizing portfolios from interest risk
    - it is a measure of the interest rate sensitivity of a portfolio

- *Modified duration*
    - D* = D/(1 + y), with $\Delta(1 + y) = \Delta y$ and D = Macaulay's duration
    - $\frac{\Delta P}{P} = -D * \Delta y$

- We conclude that bonds with equal durations do in fact have equal interest rate sensitivity and that (at least for small changes in yields) the percentage price change is the modified duration times the change in yield
- What determines duration?
    - We can use durations for quantification of interest rate sensitivity
    1. The duration of a zero-coupon bond equals its time to maturity
    2. Holding a maturity constant, a bond's duration is lower when the coupon rate is higher
    3. Holding the coupon rate constant, a bond's duration generally increases with its time to maturity. Duration always increases with maturity for bonds selling at par or at a premium to par.
    4. Holding other factors constant, the duration of a coupon bond is higher when the bond's yield to maturity is lower.
        a. lower yield bonds have longer duration → at lower yield the more distant payments made by the bond have relatively greater present values and account for a greater share of the bond's total value.
    5. Duration of a level perpetuity is
        a. Duration of perpetuity = $\frac{1+y}{y}$

16.2 Convexity

- The relationship between the modified duration of the bond and the curve of the actual price change becomes worse at relatively larger changes in yield to maturity

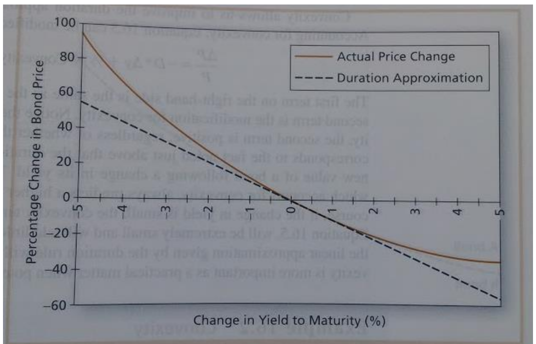

Figure 16.3 Bond price convexity: 30-year maturity, 8% coupon bond; initial yield to maturity = 8%

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- When yields fall the duration approximation always underestimate the increase in bond prices
- When yields rise the duration approximation always overestimate the decline in prices.
- This because the shape of the actual curve is convex
    - The curvature of the price-yield curve is called the *convexity* of the bond
- Convexity can improve our formula →
    - $\frac{\Delta P}{P} = -D * \Delta y + ½ * convexity * (\Delta y)^2$
    - Convexity: $\frac{1}{P(1+y)^2}\sum_{t=1}^{T}\left[\frac{CF_t}{(1+y)^t}(t^2+t)\right]$
    - Convexity is more important when potential interest rates changes are large
- Convexity is generally considered a desirable trait.
    - Bonds with a greater curvature gain more in price when yields fall than they lose when yields rise.
    - Taylor's expansion series: $\frac{\Delta P}{P} = \frac{\delta P}{\delta(1+y)}\Delta(1+y) + \frac{1}{2!}\frac{\delta^2 P}{\delta(1+y)^2}\Delta(1+y)^2$
    - → It enjoys greater price increases and smaller price decreases when interest rates fluctuate by larger amounts

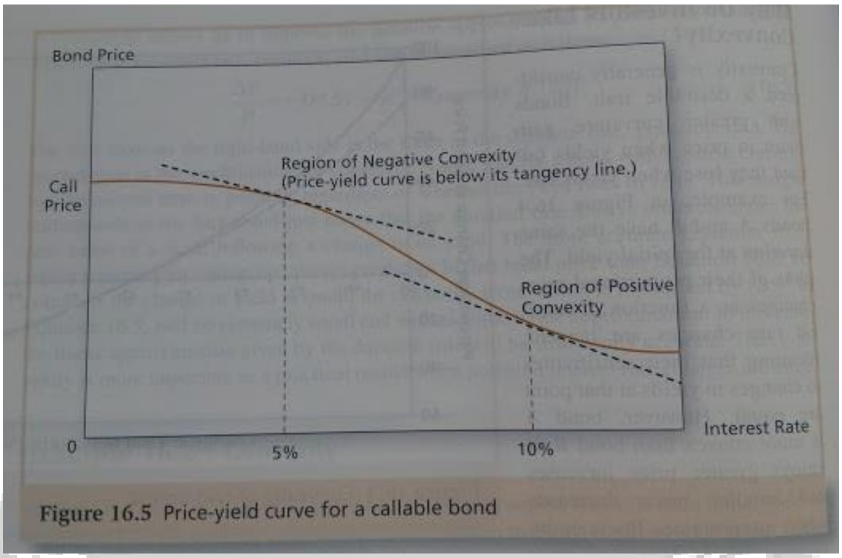


Figure 16.5 Price-yield curve for a callable bond

   - Investors will have to pay higher prices and accept lower yields to maturity on bonds with greater convexity.
- Callable bonds have a different convexity. If the interest rate falls, there is a ceiling on the possible price.
   - This because if the rates fall, the bondholder has a choice to call back all bonds and thus the investor loses
   - Investors are compensated for this unattractive situation with a higher yield → callable bonds sell at lower initial prices, than comparable straight bonds
   - Callable bonds cannot be analysed with Macaulay's duration
- Therefore → *Effective Duration*: the proportional change in the bond price per unit change in market interest rates.
   - Effective duration = $-\frac{\Delta P \ / \ P}{\Delta r}$
   - Δr= assumed increase in rates - assumed decrease in rates
   - ΔP= price at the increase in rates - price at the decrease in rates
   - it calculates price change relative to a shift in the level of the term structure of interest rates.
- Differences between Macaulay duration, modified duration, and effective duration
   - *Macaulay's duration*: the weighted average of the time until receipt of each bond payment
   - *Modified duration*: is Macaulay's duration divided by 1 + y (where y is yield per payment period). For a straight bond, modified duration approximately equals the percentage change in bond price per change in yield
   - *Effective duration:* Captures this last property of modified duration. It is defined as percentage change in bond price per change in market interest rates. Effective duration for a bond with embedded options require a valuation method that allows for such options in computing price changes. Effective duration cannot be related to a weighted average of times until payments, because those payments are themselves uncertain.

- Mortgage-backed loans are subject to the same negative convexity as other callable bonds. → if interest rates fall, homeowners will take new loans at lower interest rates and repay the older loans. Thus, it reflect callable bonds

16.3 Passive Bond Management

- Passive managers take bond prices as fairly set and seek to control only the risk of their fixed-income portfolio. There are two passive managements:
    - Indexing strategy that attempts to replicate the performance of a given bond index
    - Immunization techniques: designed to shield the overall financial status of the institution from exposure to interest rate fluctuations.
- Bond index funds
    - Idea is to create a portfolio that mirrors the composition of an index that measures the broad market
    - First problem: these indexes contain thousands of securities, making it hard to purchase each security
    - The security compositio of the index changes all the time. Thus an index manager must update and rebalance the bond portfolio continuously
    - In practice it is unfeasible to precisely replicate the broad bond indexes
        - Cellular approach is used → the bond market is stratified (e.g in maturity and issuer), bonds falling in the same cell are regarded as homogeneous. Then it is determined how much each cell is represented in the index. Then the portfolio manager establishes a bond portfolio which represents those cells. → hereby the characteristics of the portfolio will match that of the index.
- Immunization
    - Many banks and institutions have a mismatch between assets and liability
        - assets: largely mortgages and outstanding commercial loans
        - liabilities: the deposits owed to customers, often very short termed.
    - Pension funds are also affected by interest rates, due to future fixed obligations.
    - fixed income investors face two offsetting types of interest rate risk (see picture):
        - *Price risk*:
        - *Reinvestment rate risk*

Payment Number	Years Remaining until Obligation	Accumulated Value of Invested Payment		
A. Rates remain at 8%				
1	4	$800 \times (1.08)^4$	=	1,088.39
2	3	$800 \times (1.08)^3$	=	1,007.77
3	2	$800 \times (1.08)^2$	=	933.12
4	1	$800 \times (1.08)^1$	=	864.00
5	0	$800 \times (1.08)^0$	=	800.00
Sale of bond	0	10,800/1.08	=	10,000.00
				14,693.28
B. Rates fall to 7%				
1	4	$800 \times (1.07)^4$	=	1,048.64
2	3	$800 \times (1.07)^3$	=	980.03
3	2	$800 \times (1.07)^2$	=	915.92
4	1	$800 \times (1.07)^1$	=	856.00
5	0	$800 \times (1.07)^0$	=	800.00
Sale of bond	0	10,800/1.07	=	10,093.46
				14,694.05
C. Rates increase to 9%				
1	4	$800 \times (1.09)^4$	=	1,129.27
2	3	$800 \times (1.09)^3$	=	1,036.02
3	2	$800 \times (1.09)^2$	=	950.48
4	1	$800 \times (1.09)^1$	=	872.00
5	0	$800 \times (1.09)^0$	=	800.00
Sale of bond	0	10,800/1.09	=	9,908.26
				14,696.02

Table 16.4

Terminal value of a bond portfolio after 5 years (all proceeds reinvested)

- For a horizon equal to the portfolio's duration, price risk and reinvestment risk exactly cancel out.
- Duration matching balances the difference between the accumulated value of the coupon payments (reinvestment rate risk) and the sale value of the bond (price risk).
- It is important to rebalance immunized portfolios → as interest rates and asset durations change, a manager must rebalance the portfolio of fixed-income assets continually to realign its duration with the duration of the obligation.
- Immunization is a passive strategy only in the sense that it does not involve attempts to identify undervalued securities.
- Construction an immunized portfolio (pg. 561)
    1. calculate the duration of the liability
    2. calculate the duration of the asset portfolio
    3. find the asset mix that sets the duration of assets equal to the duration of the liabilities
    4. fully fund the obligation

Chapter 20: Options markets: Introduction

20.1 The option contract

- Call option

- *Call option*: gives its holder the right to purchase an asset for a specified price, called the *exercise or strike price,* on or before some specified expiration date.
    - Net profit is the value of the option minus the price originally paid to purchase it.
- *Premium*: the purchase price of the option → represents the compensation the purchases of the call must pay for the right to exercise the option if exercise becomes profitable.
- *Writer:* the seller of the call options, receive premium income
    - Net profit for writer (if option is exercised): premium income – (difference between value of the stock and the exercise value)
- Value at expiration = stock price - exercise price
- Profit = final value - original investment

- Put option
    - *Put option*: gives its holder the right to *sell* an asset for a specified exercise or strike price on or before some expiration date.
        - profits on put options increase when the stock price decreases.
    - Value at expiration date = exercise price - stock price
- An option is described as
    - In the money: when its exercise would produce profit for its holder
    - Out of the money: when exercise would be unprofitable
    - At the money: when the exercise price and asset price are equal
- Options traded on over-the-counter market can be individualized, options exchanged at the exchange market are standardized.
- Call options are more worth if the value of the call (strike price) is lower
- Put options are more worth if the value of the put is higher
- *American options:* allows its holder to exercise the right to purchase (if a call) or sell (if a put) the underlying asset on *or before* the expiration date.
- *European options*: allows for exercise of the option only at the expiration date.
- Options will adjust themselves when a split of the stocks occurs (e.g. for a 2-for-1 split the option will be reduced by a factor 2 -thus halved-)
- Options Clearing Corporation (OCC): Acts as an intermediary institute, ensuring the contract performance
    - writers have to put money in a margin account with the OCC to guarantee that they can fulfill their contracts.
- *Index options*: a put or call based on a stock market index such as the S&P500.
- *Futures options*: gives their holders the right to buy or sell a specified futures contract, using as a futures price the exercise price of the option.
- *Foreign currency options:* Offers the right to buy or sell a quantity of foreign currency for a specified amount of domestic currency
- *Interest rate options:* Options are traded on Treasury notes and bonds

20.2 Values of options at Expiration

- The value of the call option at expiration equals

- Payoff to call holder: (S_T = stock price, X = exercise price)
    - $S_T - X$ if $S_T > X$
    - 0 if $S_T \leq X$
    - Break-even point = when the net profit is equal to the call options initial price

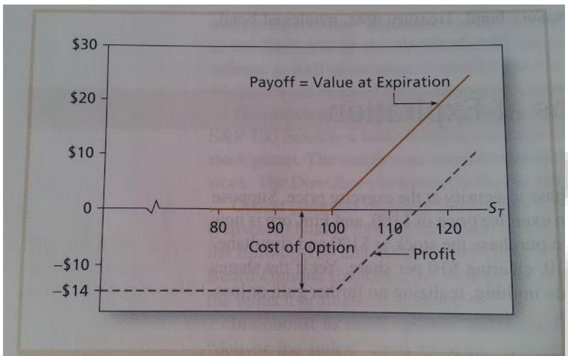


Figure 17.2 Payoff and profit to call option at expiration

-
- Payoff to call writer: (S_T = stock price, X = exercise price)
    - $-(S_T - X)$ if $S_T > X$
    - 0 if $S_T \leq X$

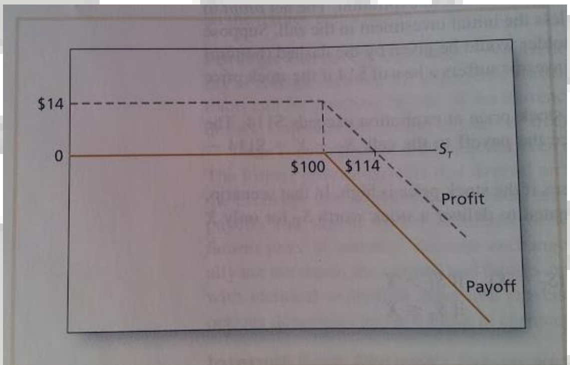


Figure 17.3 Payoff and profit to call writers at expiration

-
- The value of a put option
    - Payoff to put holder: (S_T = stock price, X = exercise price)
        - 0 if $S_T \geq X$
        - $X - S_T$ if $S_T < X$

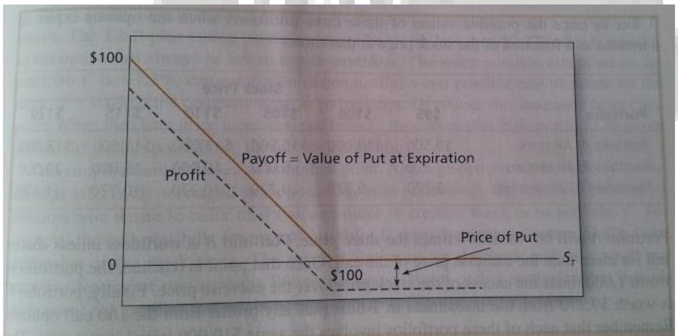


Figure 17.4 Payoff and profit to put option at expiration

-
- Writing puts *naked*: writing a put without an offset shorting position in the stock for hedging purposes)

- Purchasing call options is a bullish strategy: the calls provide profits when the stock prices increase
- Purchasing puts (or writing calls) is a bearish strategy: it provides profits when the stock prices decrease
- Options can be used by speculators as effectively leveraged stock positions
- Options can also be used as to tailor risk exposures

20.3 Option strategies

- *Protective put:* invest in a stock and purchase a corresponding put option, so that an eventual loss will be limited.

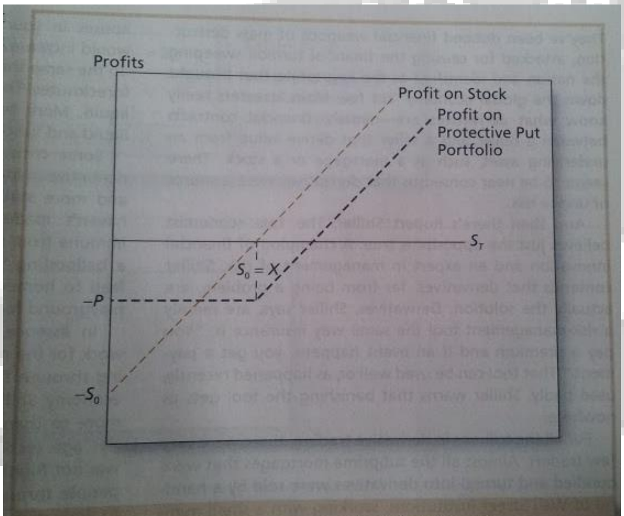


Figure 17.7 Protective put versus stock investment (at-the-money option)

-

Table 17.1

Value of a protective put portfolio at option expiration

	$S_T \le X$	$S_T > X$
Stock	S_T	S_T
+ Put	$X - S_T$	0
= *TOTAL*	X	S_T

-
- Protective put provides some portfolio insurance
- *Covered call*: purchase of a share of stock with a simultaneous sale of a call on that stock. This is covered, because the potential obligation to deliver stock is covered by the stock held in the portfolio.

Table 17.2

Value of a covered call position at option expiration

	$S_T \le X$	$S_T > X$
Payoff of stock	S_T	S_T
+ Payoff of written call	-0	$-(S_T - X)$
= *TOTAL*	S_T	X

-
- *Straddle*: buying both a put and a call option each with the same exercise price.
  - Investors believe the price of the stock will move a lot, but don't know in which direction. → bets on volatility
  - Writers of *straddles*: believe the stock will remain stable

Table 17.3 Value of a straddle position at option expiration

	$S_T < X$	$S_T \geq X$
Payoff of call	0	$S_T - X$
+ Payoff of put	$X - S_T$	0
= TOTAL	$X - S_T$	$S_T - X$

- *Spread*: a combination of two or more call options (or two or more puts) on the same stock with differing prices or times to maturity.
    - *Money spread*: the purchase of one option and the simultaneous sale of another with a different exercising price.
    - *Time spread*: refers to the sale and purchase of options with differing expiration dates.

Table 17.4 Value of a bullish spread position at expiration

	$S_T \leq X_1$	$X_1 < S_T \leq X_2$	$S_T \geq X_2$
Payoff of purchased call, exercise price = X_1	0	$S_T - X_1$	$S_T - X_1$
+ Payoff of written call, exercise price = X_2	−0	−0	$-(S_T - X_2)$
= TOTAL	0	$S_T - X_1$	$X_2 - X_1$

-
- *Collars*: an option strategy that brackets the value of a portfolio between two bounds
    - You own stock, write a call and purchase a put
    - Payoff diagram looks a bit similar to bullish spread.

20.4 The Put-Call parity relationship

- strategy of buying a call option and treasury bills with face value equal to the exercise price of the call, and with maturity date equal to the expiration date of the option.

	$S_T \leq X$	$S_T > X$
Value of call option	0	$S_T - X$
Value of riskless bond	X	X
TOTAL	X	S_T

-
- Will be the value of this position which is equal to that of the protective put
- If two portfolios always provide equal values, then they must cost the same amount to establish.
- Therefore, we conclude that the call-plus-bond portfolio must cost the same as the stock-plus-put portfolio → thus its holds that
    - $C + \frac{X}{(1+r_f)^T} = S_0 + P$
    - C = call costs
    - $\frac{X}{(1+r_f)^T}$ = riskless zero-coupon bond costs
    - S_0 = stock costs
    - P = put costs
    - This is called the *Put-Call Parity Theorem* → it represents the relationship between put and call prices.
    - If the Put-Call parity theorem is not present, there is room for arbitrage!

- If there is arbitrage → Buy cheap, sell expensive and borrow money to do so
- This relationship only applies on stocks that do not pay dividends before expiration
- Therefore modified → $P = C - S_0 + PV(X) + PV(dividends)$
    - PV(dividends) = present value of the dividends that will be paid by the stock during the life of the option. Modified put-call = $C + D + \frac{X}{(1+r_f)^T} = P + S_0$

20.5 Option-like securities

- *Callable bond*: a sale of a *straight bond* to the investor with a call option by the investor to the bond-issuing firm.
    - A callable bond's potential for capital gains is limited by the firm's option to repurchase at the call price.
    - Usually it may only be exercised after some initial period of call protection.
- *Convertible securities:* Gives the holder the option to exchange each bond or share of preferred stock for a fixed number of shares of common stock, regardless of the market price of the securities at the time.
    - conversion value: the value it would have if you converted it into stock immediately.

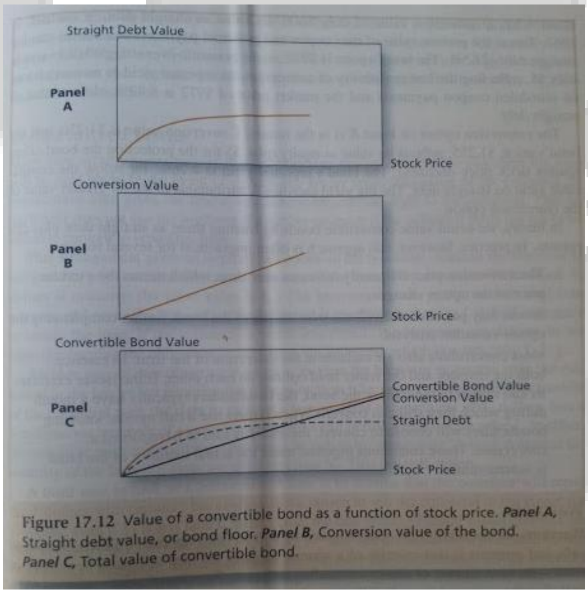
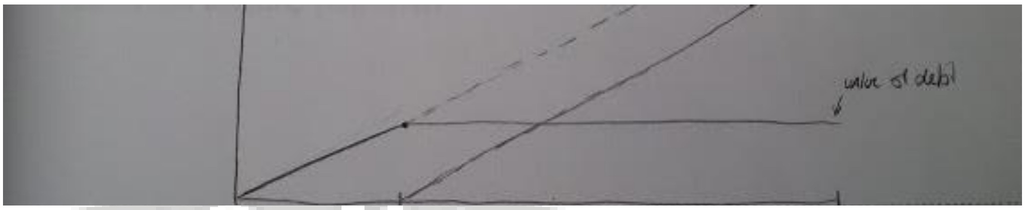


Figure 17.12 Value of a convertible bond as a function of stock price. *Panel A,* Straight debt value, or bond floor. *Panel B,* Conversion value of the bond. *Panel C,* Total value of convertible bond.

-
- *Warrants*: are call options issued by a firm. One important difference between calls and warrants is that exercise of a warrant requires the firm to issue a new share of stock - the total number of shares outstanding increases.
    - are also protected against stock splits

- Collateralized loans

- Turning over the collateral to the lender but retaining the right to reclaim it by paying of the loan.
- If the loan is more worth than the collateral, the borrower might decide to default on the loan and let the issuer hold the collateral.

- Equity can be viewed as a call option on the firm
- 

Chapter 21: Option Valuation

21.1 Option valuation: Introduction

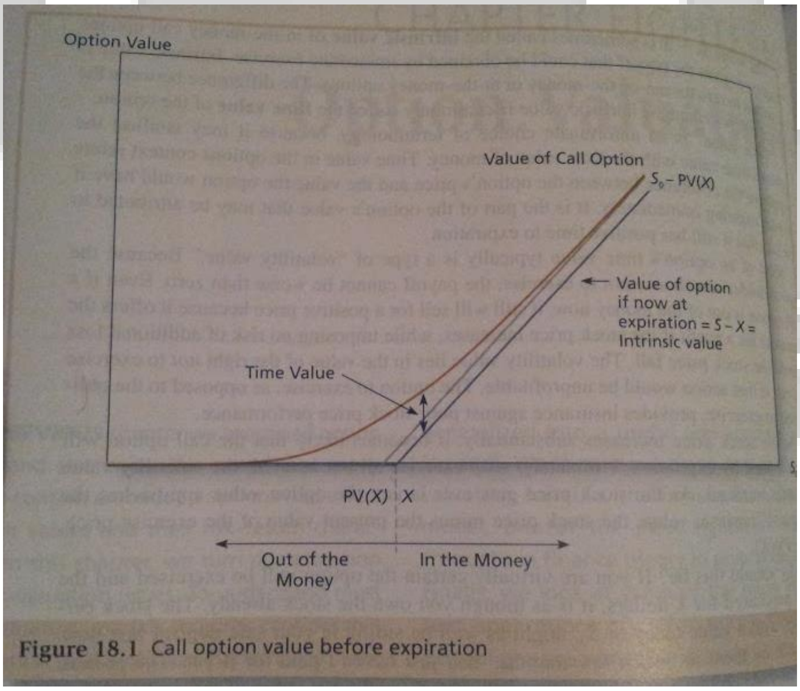
- *Intrinsic value:*
  - is S_0 - X for in the money call options because it gives the payoff that could be obtained by immediate exercise.
  - is equal to zero for out of the money or at the money call options
- *Time value:* the difference between the option's price and the value the option would have if it were expiring immediately.
- Even if an option is currently out of the money, it will sell for a positive price for a potential increase in stock price
- 

Figure 18.1 Call option value before expiration
  - If stock price is low, option is worthless
  - If stock price is high, option is valuable
  - If stock price is mid-range, option is at the money.
- Determinants of Option values

Table 18.1 Determinants of call option values

If This Variable Increases . . .	The Value of a Call Option
Stock price, S	Increases
Exercise price, X	Decreases
Volatility, σ	Increases
Time to expiration, T	Increases
Interest rate, r_f	Increases
Dividend payouts	Decreases

21.2 Restrictions on Option Values

- value of a call option cannot be negative

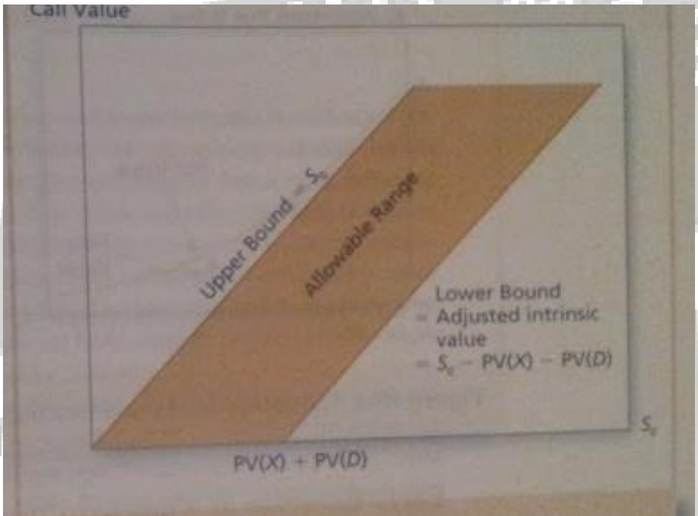


Figure 18.2 Range of possible call option values

-
    - the option can be sold for at least S_t - PV(X) - PV(D)
        - S_t = stock price at expiration date
        - PV(X) = present value of the exercise price
        - PV(D) = present value of the dividends the stock will pay
- It never pays to exercise a call option before expiration
- For put options it pays to exercise before expiration, only if the stock is nearly worthless. Therefore because of the ability to be exercised before expiration date, American put options are more worth than European put options.
- The hedge ratio for a two-state problem → is the ratio of the swings in the possible end-of-period values of the option and the stock
    - $H = \frac{C_u - C_d}{uS_0 - dS_0}$
    - C_u = call options value when the stock goes up
    - C_d = call options value when the stock goes down
    - uS_0 = stock price when the stock goes up
    - dS_0 = stock price when the stock goes down
- Hedge ratio: How many shares do you need, to hedge an option (⅓ = per share, 3 calls)

21.4 Black-Scholes option evaluation

- Takes additional two assumptions:

- Risk-free interest rate is constant over the life of the option
- Stock price volatility is constant over the life of the option
- The stock will pay no dividends until after the expiration date
- Stock price are continuous, meaning that sudden extreme jumps such as those in the aftermath of an announcement of takeover attempt are ruled out.
- *Black-Scholes pricing formula (for call option)*
  - $C_0 = S_0 N(d_1) - Xe^{-rT} N(d_2)$
  - with $d_1 = \frac{ln(S_0 / X) + (r + \sigma^2 / 2)T}{\sigma\sqrt{T}}$
  - with $d_2 = d_1 - \sigma\sqrt{T}$
  - C_0 = Current call option value
  - S_0 = Current stock price
  - *N(d)* = the probability that a random draw from a standard normal distribution will be less than d.
  - *X* = Exercise price
  - *e* = the base of the natural logarithm
  - *r* = risk-free rate (annual continuously compounded, with same maturity as the expiration date of the option)
  - *T* = Time to expiration of options, in years
  - *ln* = Natural logarithm function.
  - *σ* = standard deviation of the annualized continuously compounded rate of return of the stock.
- *N(d)* can be loosely seen as the risk-adjusted probability that the call option will expire in the money.
- *Implied volatility:* the volatility level for the stock implied by the option price.
  - Investors can judge whether they think the actual stock standard deviation exceeds the implied volatility → if it does option is considered good buy, if actual volatility seems greater than the implied volatility, its fair price would exceed the observed price.
- *Black-Scholes pricing formula (for put option)*
  - $P = Xe^{-rT}[1 - N(d_2)] - S_0[1 - N(d_1)]$
  - $P = C + PV(X) - S_0$ thus $P = C + Xe^{-rT} - S_0$

21.5 Using the Black-Scholes formula

- *Hedge ratio*: is the change in the price of an option for a $1 increase in the stock price
  - $Delta = \frac{Change\ in\ the\ value\ of\ the\ option}{Change\ in\ the\ value\ of\ the\ stock}$
  - Call option therefore has a *positive* hedge ratio
  - Put option therefore has a *negative* hedge ratio
- Hedge ratio is also commonly known as the *delta* Δ of an option
- Hedge ratio for a call is $N(d_1)$
- Hedge ratio for a put is $N(d_1)$ - 1

- *Option elasticity*: percentage change in the option's value given a 1% change in the value of the underlying stock
- *Dynamic hedging (delta hedging)*: because delta's constantly change, constant updating of the hedge ratios is necessary.
- The delta can be used to determine how many options/stocks you need to buy to offset your position. e.g. if hedge ratio is -0.6. We need 0.6 share of stock to hedge each put.
- *Vega*: the sensitivity of an option price to change in volatility.
- For using Black-Scholes with dividends, replace S_0 with S_0 - PV(dividends)
- Hedging on mispriced options:
    - Option value is positively related to volatility:
        - If an investor believes that the volatility that is implied in an option's price is too low, a profitable trade is possible
        - Implied volatility: volatility implied by all other variables
        - Profit must be hedged against a decline in the value of the stock → hence: hedge ratio important → put option makes you negatively correlated to the market
        - Performance depends on option price relative to the implied volatility

Chapter 22: Futures markets

22.1 The futures contract

- *Forward contract:* a delivery contract for a specific price and amount at a certain date, regardless of the market price at that time.
    - Protects each party from future price fluctuations
    - Set in the contract: contract size, acceptable grade of commodity, contract delivery dates, and more
- *Futures contract*: a standardized forward contract, often used in futures markets
    - Delivery of a commodity at a specific delivery or maturity date, for an agreed-upon price (futures price), to be paid at contract maturity.
    - Is not as flexible as forward contract
    - Has more liquidity than forward contract, since many traders will concentrate on the same small set of contracts
- *Long position*: commits to purchasing the commodity on the delivery date (buy a contract)
- *Short position*: commits to delivering the commodity at contract maturity (sell a contract)
- Profit:
    - to long position = spot price at maturity - original futures price
    - to short position = original futures price - spot price at maturity
    - The shorts position's loss equals the long position's gain.
- Every long position is offset by a short position

- The aggregate profits to futures trading summing over all investors must be equal to zero
- → the net exposure to changes in commodity price is also zero
- → Thus, the establishment of a futures market in a commodity should not have a major impact on price in the spot market for that commodity
- Profit can be negative in a futures position.
    - If the futures price is higher than the current price
    - A futures trader cannot walk away from the contract, it is bounding

- Futures and forward contracts are possible in four broad categories
    - Agricultural commodities
    - Metals and minerals
    - Foreign currencies
    - Financial futures (fixed-income securities and stock market indexes)

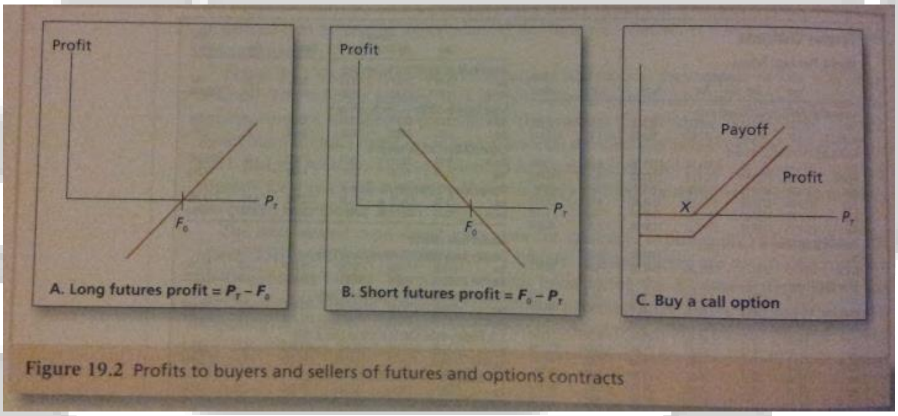


Figure 19.2 Profits to buyers and sellers of futures and options contracts

-
- F_0 = initial futures price
- P_T = ultimate spot price

22.2 Trading mechanics

- Once a trade is agreed to, the *clearinghouse* enters the picture.

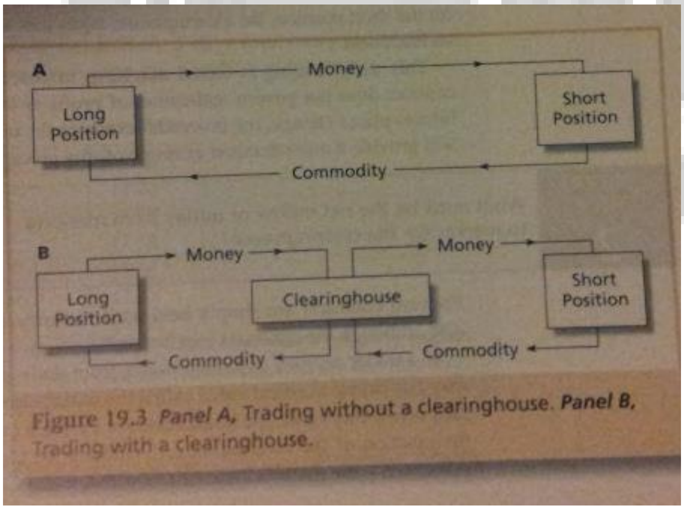


Figure 19.3 *Panel A,* Trading without a clearinghouse. *Panel B,* Trading with a clearinghouse.

-
- The clearinghouse makes it possible for traders to liquidate positions easily
    - Also protects both parties against defaulting on one of the two parties

- *Open interest*: is the number of contracts outstanding
- The total profit or loss realized by the long trader who buys a contract at time 0 and closes, or reverses, it at time *t* is just the change in the futures price over the period, F_t - F_0. Symmetrically, the short trader earns F_0 - F_t.
    - F_0 = initial futures price
    - F_t = future price at time *t*
- At initial execution of a trade, each trader establishes a margin account. → ensures the trader is able to satisfy the obligations of the futures contract.
- Both buyer and seller must set up a margin account, as both can lose money
- *Marking to market*: daily settling of the futures price to the current price.
    - futures contract uses marking to market
    - forward contractsare held until maturity, no funds are transferred before that date
    - On a daily basis profits and losses are distributed
    - This to prevent sudden large charges on the margin account
- *Maintenance margin*: if the margin account falls below this value, the trader receives a margin call and he has to fill the margin account with money.
- Futures and spot price must converge at maturity → *Convergence property* (otherwise an arbitrage is possible!)
- *Cash settlement*: the cash value of the asset rather than the asset itself is delivered by the short position in exchange for the futures price.
- There are regulations on the futures markets
    - The limit on the amount by which futures prices may change from one day to the next → this will limit violent price fluctuations. However, it does not provide a real protection, it will adjust to the price fluctuations… just at a slower pace.
- Multiplier: Adding leverage effect (e.g. silver: 5000 ounces per contract, S&P500: $250 per point)

22.3 Futures markets strategies

- Speculator: uses a futures contract to profit from movements in futures prices
    - If they believe prices will increase, they will take long position for expected profits
    - If they expect price drops, they will take short position
- Hedger: uses a futures contract to protect against price movements.
    - protects himself against price fluctuations
    - *short hedge*: taking a short futures position to offset risk in the sales price of an asset
    - *long hedge*: eliminating risk of an uncertain purchase price
    - *cross-hedging*: hedging a position using futures on another position
    - Profit short: $(F_0 - P_T) * contract\ size$
    - Profit long: $(P_T - F_0) * contract\ size$

- Why buy a futures contract and not asset?
    - → futures contract lower transaction costs
    - → futures contracts gives *leverage*, since margin accounts involves less money than buying the assets
- *basis*: is the difference between the futures price and the spot price
    - at maturity date of contract, basis = 0
    - before maturity date, it can differ substantially
    - at t = T: $F_T - P_T = 0$→ convergence property
- *Basis risk*: The variability in the basis that will affect profits and/or hedging performance. Risk attributable to uncertain movements in the spread between a futures price and spot price.
- *Calendar spread*: investor takes a long position in a futures contract of one maturity and a short position in a contract on the same commodity but with a different maturity
    - Profits: the difference in futures prices between the two contracts changes in the hoped-for direction → if the futures price on the contract held increases by more (or decreases by less) than the futures price on the contract held short.

22.4 Futures prices

- If the hedge is perfect (the asset-plus-futures portfolio has no risk), then the hedged position must provide a rate of return equal to the rate on other risk-free investments → otherwise arbitrage is possible!
- Rate of return on perfectly hedged stock portfolio = $\frac{(F_0 + D) - S_0}{S_0}$
    - *D* = the dividend pay-out on the portfolio
    - S_0 = a total investment
    - F_0 = futures contract
- Therefore, since this has to be equal to the rate on other risk-free investments →
    - $\frac{(F_0 + D) - S_0}{S_0} = r_f$
    - This leads to $F_0 = S_0(1 + r_f) - D = S_0(1 + r_f - d)$
    - *d* = the dividend yield on the stock portfolio, defined as D/S_0
    - This is called the *spot-futures parity theorem*
- The parity relationship is also called the *cost-of-carry* relationship
    - It asserts that the future price is determined by the relative costs of buying a stock with deferred delivery in the futures market versus buying it in the spot market with immediate delivery and ''carrying'' it in inventory.
    - For contract maturity of T periods, the parity relationship is
        - $F_0 = S_0(1 + r_f - d)^T$
- Spreads

- We can determine the proper relationships among futures price for contracts of different maturity dates → futures price is partly determined by time to maturity
- If the risk-free rate is greater than the dividend yield ($r_f > d$), then the futures price will be higher on longer-maturity contracts and if ($r_f < d$) longer-maturity futures prices will be lower.
- Spread pricing:
  - $F(T_1)$ current futures price for delivery at date T_1
  - $F(T_2)$ current futures price for delivery at date T_2
  - d = the dividend yield of the stock
  - $F(T_2) = F(T_1)(1 + r_f - d)^{(T_2 - T_1)}$ = basic parity relationship for spreads
- Forward versus Futures pricing
  - Futures prices will deviate from parity values when marking-to-market gives a systematic advantage to either the long or short position.
    - If it favours the long position → future prices > forward price, because the long position will be willing to pay a premium for the advantage of marking-to-market
  - A trader will be benefit if daily settlements are received when the interest rate is high, and when daily settlements are paid when the interest rate is low.
  - Because long positions will benefit if futures prices tend to rise when interest rates are high, those investors will be willing to accept a higher futures price.

22.5 Futures prices versus expected spot prices

- How well does the futures price forecast the ultimate spot price?
  - *Expectations hypothesis:* the futures prices equals the expected value of the future spot price of the asset $F_0 = E(P_T)$
  - *Normal backwardation*: the futures price will be bid down to a level below the expected spot price and will rise over the life of the contract until the maturity date at which point $F_T = P_T$ → Producers are the natural hedgers (they settle for less)
  - *Contango*: Long hedgers will agree to pay high futures prices to shed risk, and because speculators must be paid a premium to enter into the short position, the contango theory holds that $F_0 > E(P_T)$. Demand side are the natural hedgers (willing to pay more for security)
  - *Modern Portfolio Theory*: If commodity prices pose positive systematic risk, futures prices must be lower than expected spot prices. $F_0 = E(P_T)\left(\frac{1 + r_f}{1 + k}\right)^T$
    - k = required rate of return on the stock

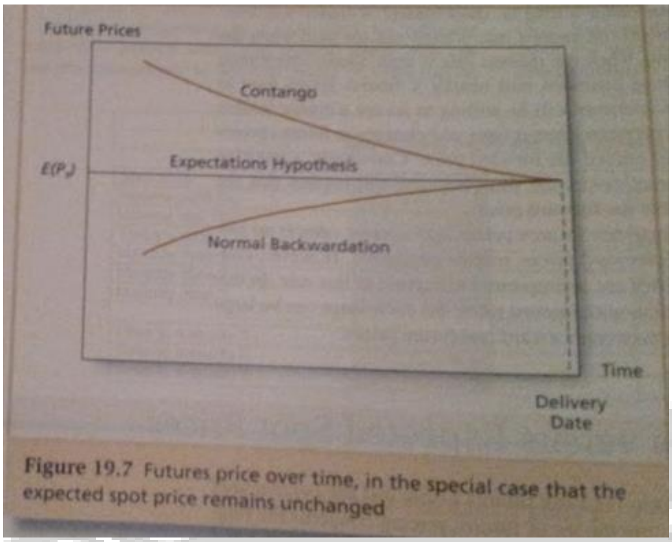
- 

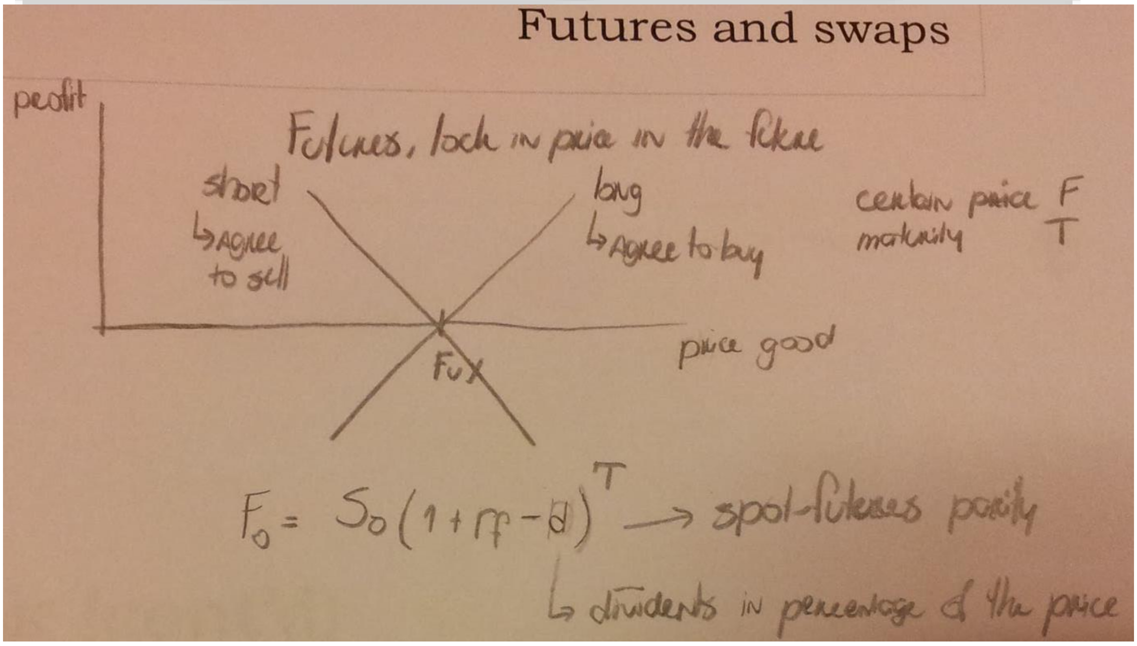
Figure 19.7 Futures price over time, in the special case that the expected spot price remains unchanged

Chapter 23: Futures, Swaps, and Risk Management.

23.1 Foreign Exchange Futures

- International companies are exposed to currency exchange risks.
- This risk can be hedged through currency futures or forward markets.
- Forward market in foreign exchange is informal
  - Contracts are not standardized, but individually established
  - There is no marking-to-market
  - There is *counterparty risk* (the possibility that a trading partner may not be able to make good on its obligations under the contract if prices move against it)
- Futures markets
  - Contracts are standardized
  - Margin positions are used to ensure contract performance
- *Interest rate parity relationship (covered interest arbitrage relationship)*:
  - $F_0 = E_0\left(\frac{1+r_{US}}{1+r_{UK}}\right)^T$
  - F_0 = forward price is the number of dollars that is agreed to today for purchase of one pound at time *T* in the future.
  - E_0 = Dollars required to purchase one pound
  - r_{US} = risk-free rates in the United States
  - r_{UK} = risk-free rates in the United Kingdom
  - when $r_{US} < r_{UK}$ then $F_0 < E_0$
  - when $r_{US} > r_{UK}$ then $F_0 > E_0$
- Direct vs indirect quotes
  - Direct quote: Foreign currency expressed in domestic currency → 1£ = 2.01$

- Indirect quote: domestic currency expressed in foreign currency → 92¥ = 1$
- When the exchange rate is quoted as foreign currency per dollar, the domestic and foreign exchange rates must be switched
    - F_0 (foreign currency/\$) = $\left(\frac{1+r_{foreign}}{1+r_{US}}\right) * E_0$(foreign currency/\$)
- Hedge ratio is the number of futures positions necessary to hedge the risk of the unprotected portfolio, in this case the firm's export business. → *hedge risk*: the number of hedging vehicles (e.g futures contracts) one would establish to offset the risk of a particular unprotected position
    - H = $\frac{Change\ in\ value\ of\ unprotected\ position\ for\ a\ given\ change\ in\ exchange\ rate}{Profit\ derived\ from\ one\ futures\ position\ for\ the\ same\ change\ in\ exchange\ rate}$
- Other interpretation of hedge ratio → ratio of sensitivities to the underlying source of uncertainty. → e.g. \$200.000 per \$0.10 swing in exchange rate → Hedge ratio is 200.000/0.10 = 2.000.000
- Profits are generally lower when the exchange rate is lower (when the foreign exchange rate depreciates)
- Hedging systematic risk
    - To protect against a decline in level of stock prices, short the appropriate number of futures index contracts
        - Less costly and quicker to use the index contracts
        - Use the beta for the portfolio to determine the hedge ratio
    - What to do if you think markets decline
        - sell stocks now and buy back later (huge transaction costs + impacts on stock price)



        - Trade in futures markets → e.g. taking short positions

-

23.2 Stock-index futures

- The contracts
  - In contrast to commodities, stock-index contracts return cash equal to the value of the stock-index times the size of the contract
    - Profit long position = $S_T - F_0$
    - Profit short position = $F_0 - S_T$
- Stock-indexes futures are popular since they can substitute for holdings in the underlying stocks themselves. → broad representation
- It is cheaper to trade in future contracts than in the actual stocks themselves
- Index arbitrage
  - *Index arbitrage* is an investment strategy that exploits divergences between the actual futures price and its theoretically correct parity value.
  - In theory simple: if futures price is too high, short the futures contract and buy the stocks in the index
  - In theory simple: if futures price is too low, short the index stocks and buy the futures contracts.
  - However, in practice impossible to sell/buy all the stocks in an index simultaneously. Therefore →
  - *Program trading*: purchase or sale of entire portfolios of stocks.
- Using index futures to hedge market risk
  - You can use index to offset market risk.

Example 20.4 Hedging Market Risk

Suppose that the S&P 500 index currently is at 1,000. A decrease in the index to 975 would represent a drop of 2.5%. With a portfolio beta of .8, you would expect a loss of .8 × 2.5% = 2%, or in dollar terms, .02 × $30 million = $600,000. Therefore, the sensitivity of your portfolio value to market movements is $600,000 per 25-point movement in the S&P 500 index.

To hedge this risk, you could sell stock index futures. When your portfolio falls in value along with declines in the broad market, the futures contract will provide an offsetting profit.

The sensitivity of a futures contract to market movements is easy to determine. With its contract multiplier of $250, the profit on the S&P 500 futures contract varies by $6,250 for every 25-point swing in the index. Therefore, to hedge your market exposure for 2 months, you could calculate the hedge ratio as follows:

$$H = \frac{\text{Change in portfolio value}}{\text{Profit on one futures contract}} = \frac{\$600{,}000}{\$6{,}250} = 96 \text{ contracts (short)}$$

You would enter the short side of the contracts, because you want profits from the contract to offset the exposure of your portfolio to the market. Because your portfolio does poorly when the market falls, you need a position that will do well when the market falls.

... problem in Example 20.4 using a similar regres-

-
  - *Market-neutral bet*: a position on a stock is taken to capture its alpha (its abnormal risk-adjusted expected return), but that market exposure is fully hedged, resulting in a position beta of zero.

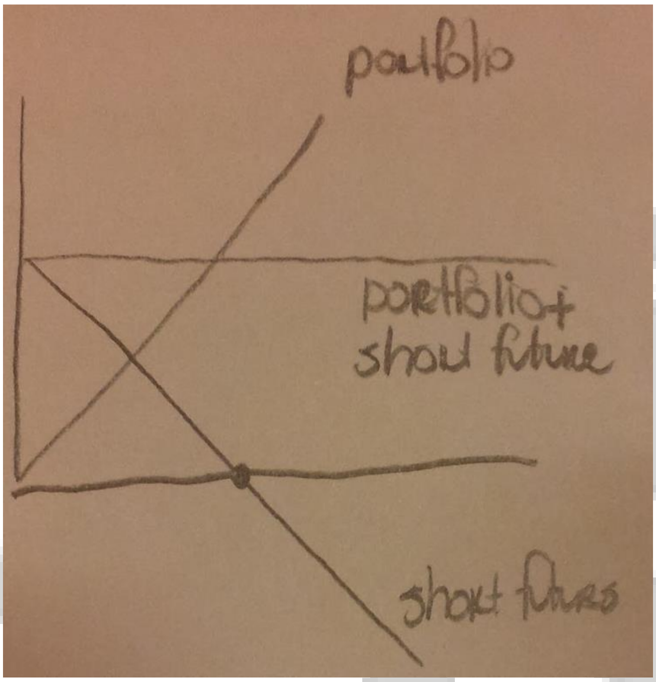
23.3 Interest rate futures

- Investor hedging against a decline in rates for a planned future investment
- Corporations planning to issue debt securities protecting against a rise in rates
- Owners of fixed-income portfolios protecting against a rise in rates
  - Exposure for a fixed income portfolio is proportional to modified duration
  - What happens if interest rates go up by 1 base point (0.01%), use modified duration

Basis Points	Percentage Terms
1	0.01%
10	0.1%
50	0.5%
100	1%
1000	10%
10000	100%

- Fixed-income managers also desire to hedge market risk.
  - Therefore, investment managers wish to hedge interest rate uncertainty
- The capital loss in percentage = modified duration * the change in the portfolio yield
  - $D^* * \Delta y$
- *Price value of a basis point* (PVBP):
  - PVBP = $\frac{Change\ in\ portfolio\ value}{Predicted\ change\ in\ yield}$
  - Equals the sensitivity of the value of the unprotected portfolio to changes in market yield per 1 basis point change in the yield
  - → represents the sensitivity of the dollar value of the portfolio to changes in interest rates
- One way to hedge this risk is an offsetting position in an interest rate futures contract (e.g. treasury bonds)
- Hedge ratio using PVBP = $\frac{PVBP\ of\ portfolio}{PVBP\ of\ hedge\ vehicle}$
- *Example interest rate sensitivity of bond portfolio:*
  - Portfolio value = $10 mln
  - Modified duration = 9 years
  - If rates rises by 10 basis points (0.10%), then
  - $\frac{\Delta P}{P} = -D * \Delta y$ = -9 * 0.001 = -0.9%
  - -0.9% * 10mln = -$90000
  - Price value of a basis point (PVBP) = $\frac{90000}{10} = \$9000$
- How to hedge this example?
  - Look for a hedge vehicle and calculate its PVBP
  - E.g. Bond-future
    - Par value 100; current price 90; D*10 years
    - Impact of a 1 basis points rise in interest rate
    - $\frac{\Delta P}{P} = -D * \Delta y = -10 * 0.0001 = -0.1\%$
    - $-0.1\% * 90 = -\$0.09$
    - Multiplier on bond-future is 1000: total price change $90
    - Hedge ratio thus becomes: $\frac{9000}{90} = 100$

- meaning that one has to hedge using 100 contracts
- Hedge ratio can be used to hedge against
    - Systematic (market / non-diversifiable) risk
    - Interest rate changes

- 

23.4 Swaps

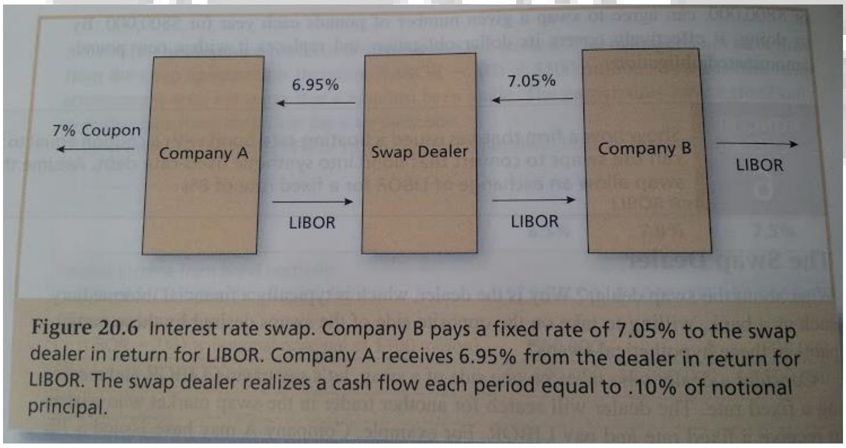
- Swaps are multiperiod extensions of forward contracts
    - *Foreign exchange swap:* call for an exchange in each of the next 5 years
    - *Interest rate swap*: call for exchange of a series of cash flows proportional to a given interest rate for a corresponding series of cash flows proportional to a floating interest rate.
- Can be used to restructure the balance sheets.
    - Switch your fixed interest rates for floating ones, and vice versa
    - Switch between currencies
- 

Figure 20.6 Interest rate swap. Company B pays a fixed rate of 7.05% to the swap dealer in return for LIBOR. Company A receives 6.95% from the dealer in return for LIBOR. The swap dealer realizes a cash flow each period equal to .10% of notional principal.

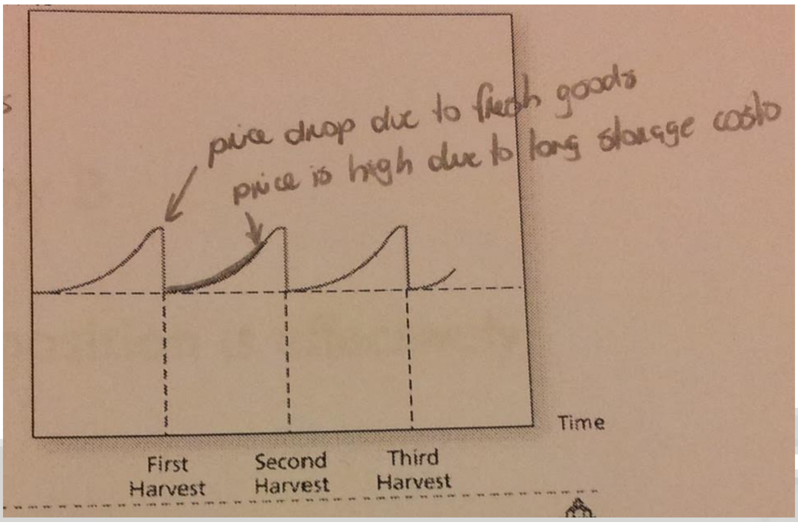
- Swap pricing
    - What is a fair price for a swap?
    - A swap can be seen as multiple foreign currency forward contracts

- it is a portfolio of forward transactions, but instead of each transaction being priced independently, one forward price is applied to all of the transactions.
- therefore $\frac{F_1}{1+y_1} + \frac{F_2}{(1+y_2)^2} = \frac{F1^*}{1+y_1} + \frac{F1^*}{(1+y_2)^2}$
  - F_1 and $F_2 = E_0(1+ r_{US})/(1+ r_{UK})$
  - y_1 and y_2 are the appropriate yields from the yield curve for discounting dollar cash flows of 1- and 2-year maturities
- Credit risk
  - There is only a loss is after the initial agreement the interest rate changes.
  - the loss only the difference between the values of the fixed-rate and floating-rate obligations, not the total value of the payments that the floating-rate payer was obligated to make.
- Credit default swap
  - acts like an insurance against some certain event (e.g bankruptcy)
  - the purchaser pays the issuer a fee.
  - If such an event happens, the issuer pays the purchaser the value of the insurance.

23.5 Commodity futures pricing

- Commodities are harder to store since it is not just money (e.g. livestock, cargo)
- It has additional costs such as storage, spoilage and insurance costs.
- Therefore:
  - $F_0 = P_0(1+r_f) + C$ with C = all noninterest carrying costs
  - $F_0 = P_0(1+r_f+c)$ with $c = C/P_0$ → percentage rate of carrying costs
  - This only applies for commodities that are being stored (thus not for e.g. crop or electricity, which are unfeasible to store)
- Future pricing across seasons therefore require a different approach that is not based on storage across harvest periods. → this is due to the harvest seasons for agricultural products.

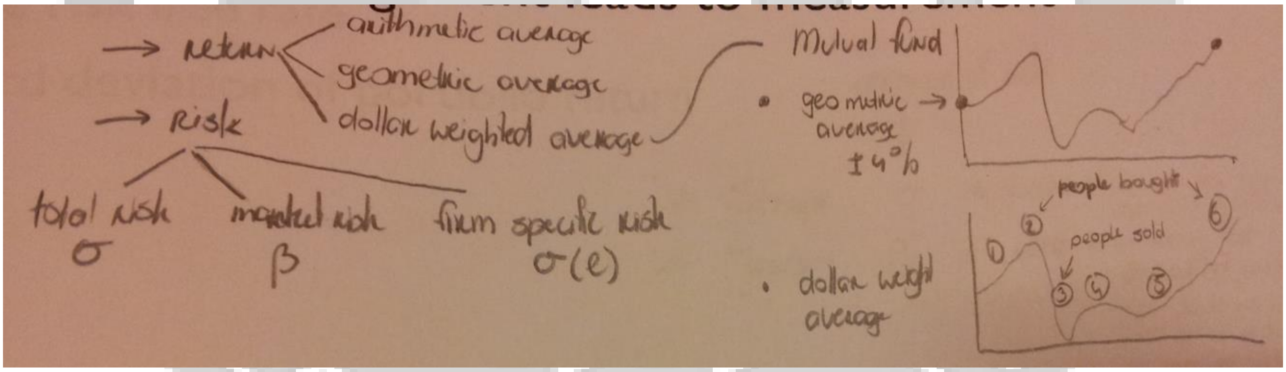
- When commodities are not stored for investment purposes, the correct futures price must be determined using the general rule.



- $\frac{F_0}{(1+r_f)^T} = \frac{E(P_T)}{(1+k)^T}$ or $F_0 = E(P_T)\left(\frac{1+r_f}{1+k}\right)^T$

Chapter 24: Portfolio performance evaluation

24.1 The conventional Theory of performance evaluation



- Time-weighted return versus dollar-weighted returns
    - The geometric average of performance is referred as *time-weighted average.*
    - Not weighted by investment amount
    - Equal weighting
- *Dollar-weighted rate of return*: equating the present values of the cash inflows and outflows:
    - Internal rate of return considering the cash flow from or to investment
    - Returns are weighted by the amount invested in each stock
- Adjusting return for risk
    - Returns must be adjusted for risk before they can be compared meaningfully
    - E.g. comparing managers with similar portfolios
    - *Comparison universe*: The collection of money managers of similar investment style used for assessing relative performance of a portfolio manager.

- Possible risk adjusted performance measures of a portfolio (Higher rate = better):
  - Sharpe measure: $(\underline{r_p} - \underline{r_f}) / \sigma_p$
    - → it divides average portfolio excess return over the sample period by the standard deviation of returns over that period. It measures the rewards to (total) volatility trade-off. → interesting for started up portfolios, useful for non-diversified portfolios
  - Treynor measure: $(\underline{r_p} - \underline{r_f}) / \beta_p$
    - → gives excess return per unit of risk, but it uses systematic risk instead of total risk → interesting for market portfolios, or fully diversified portfolios
  - Jensen's measure (portfolio alpha): $\alpha_p = \underline{r_p} - [\underline{r_f} + \beta_p(\underline{r_M} - \underline{r_f})]$
    - → is the average return on the portfolio over and above that predicted by the CAPM, given the portfolio's beta and the average market return.
    - Estimation of a regression, you get a coefficient and a standard deviation → determine statistical significance
  - Information ratio: $\alpha_p / \sigma(e_p)$ (measures increase in sharpe ratio)
    - → divides the alpha of the portfolio by the non-systematic risk of the portfolio, called ''tracking error'' in the industry. It measures abnormal return per unit of risk in principle could be diversified away by holding a market index portfolio. Used to measure the ability of investors
- The M^2 measure of performance
  - M^2 measure focuses on total volatility as a measure of risk, but its risk-adjusted measure of performance has the easy interpretation of a differential return relative to the benchmark index.
  - Equates the volatility of the managed portfolio with the market by creating a hypothetical portfolio made up of T-bills and the managed portfolio.
  - $M^2 = r_{p*} - r_M$ with p* adjusted portfolio (e.g. ⅔ in assets ⅓ in bills)
  - Example
      - managed portfolio: return 35%; σ 42%
      - Market portfolio: return 28%; σ 30%
      - T-bill: return 6%
    - Hypothetical portfolio:
      - Base weights on standard deviation

- $30/42 = 0.714 \rightarrow 0.714$ in portfolio, 0.286 in T-bills
- Apply to the managed portfolio
- $0.714 * 35\% + 0.286 * 6\% = 26.7\%$

- Since this return is less than market return, the managed portfolio underperformed.

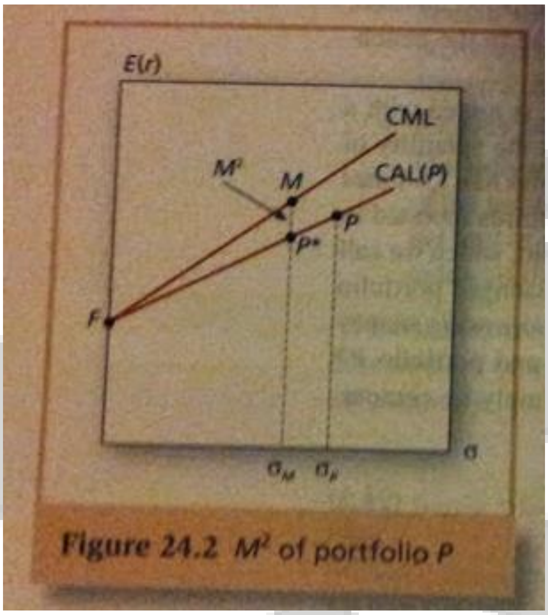


Figure 24.2 M^2 of portfolio P

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- Which measure is appropriate?
  - It depends on investment assumptions
    - If the portfolio represents the only investment for an individual, compare the Sharpe Index to the Sharpe Index for the market
    - If the portfolio is combined with other portfolios into a large investment fund, use Jensen α or Treynor's measure. (e.g market portfolios)
- Treynor's measure → is a percentage

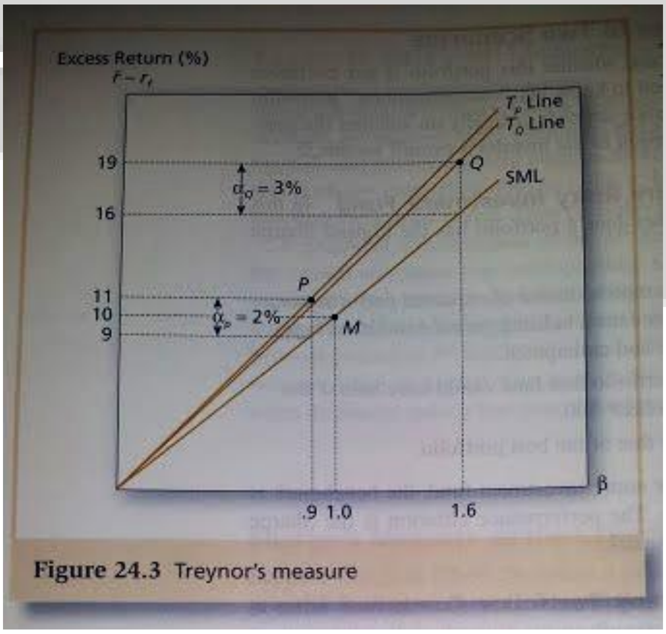

Figure 24.3 Treynor's measure

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    - This measure is appealing because when an asset is part of a large investment portfolio one should weigh its mean excess return against its systematic risk rather than against total risk to evaluate contribution to performance.
- Past performances are not a predictor for the future

24.2 Performance measurement for Hedge funds

- Hedge funds primarily focus on arbitraging opportunities and therefore are majorly driven by *alpha* → and therefore more fit as additions to core positions in more traditional portfolios who are more diversified.
- Hedge funds best measured as a mix with diversified core position, thus *information ratio* is best performance measure
    - $IR_p = \alpha_p / \sigma(e_p)$
    - Higher information ratios are prefered
- Difficulties of assessing performance hedge funds
    1. Risk profile of hedge funds (both volatility and systematic risk exposure) may change rapidly
    2. Hedge funds tend to invest in illiquid assets (hard to accurately price, and to determine expected rate of return)
    3. Many hedge funds pursue strategies that may provide apparent profits over long periods of time, but expose the fund to infrequent but severe losses. → long periods of time may be required to create realistic picture of their true risk-return trade of
    4. When hedge funds are evaluated as a group, survivorship bias (only those who survived few selections are included) can be a major consideration, because turnover in this industry is far higher than for investment companies such as mutual funds

24.4 Market timing.

- *Market timing*: shifting funds between market-index portfolio and a safe asset (t-bills or money market fund) depending on whether the market as a whole is expected to outperform the safe asset
- If bullish market you would switch to more into the market (because the markets go up)
- If bearish market you would switch more into T-bills (Because markets go down)

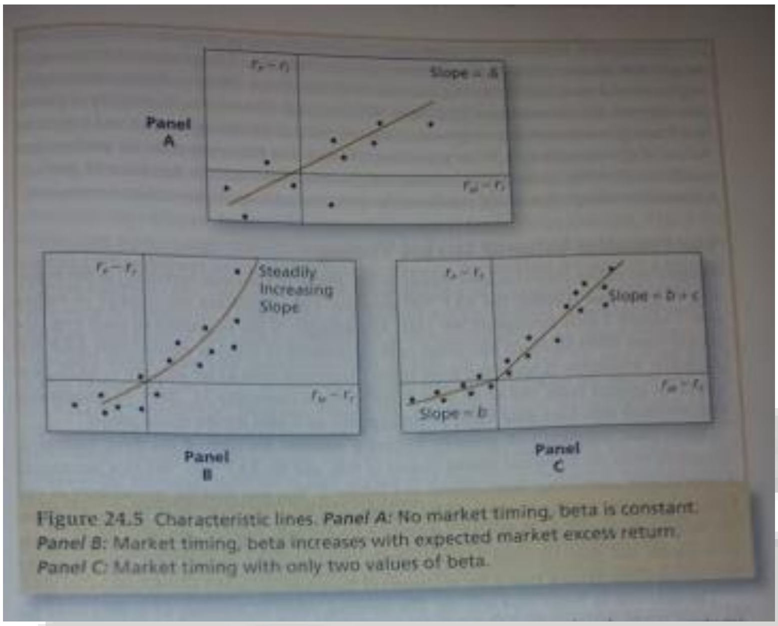


Figure 24.5 Characteristic lines. *Panel A:* No market timing, beta is constant. *Panel B:* Market timing, beta increases with expected market excess return. *Panel C:* Market timing with only two values of beta.

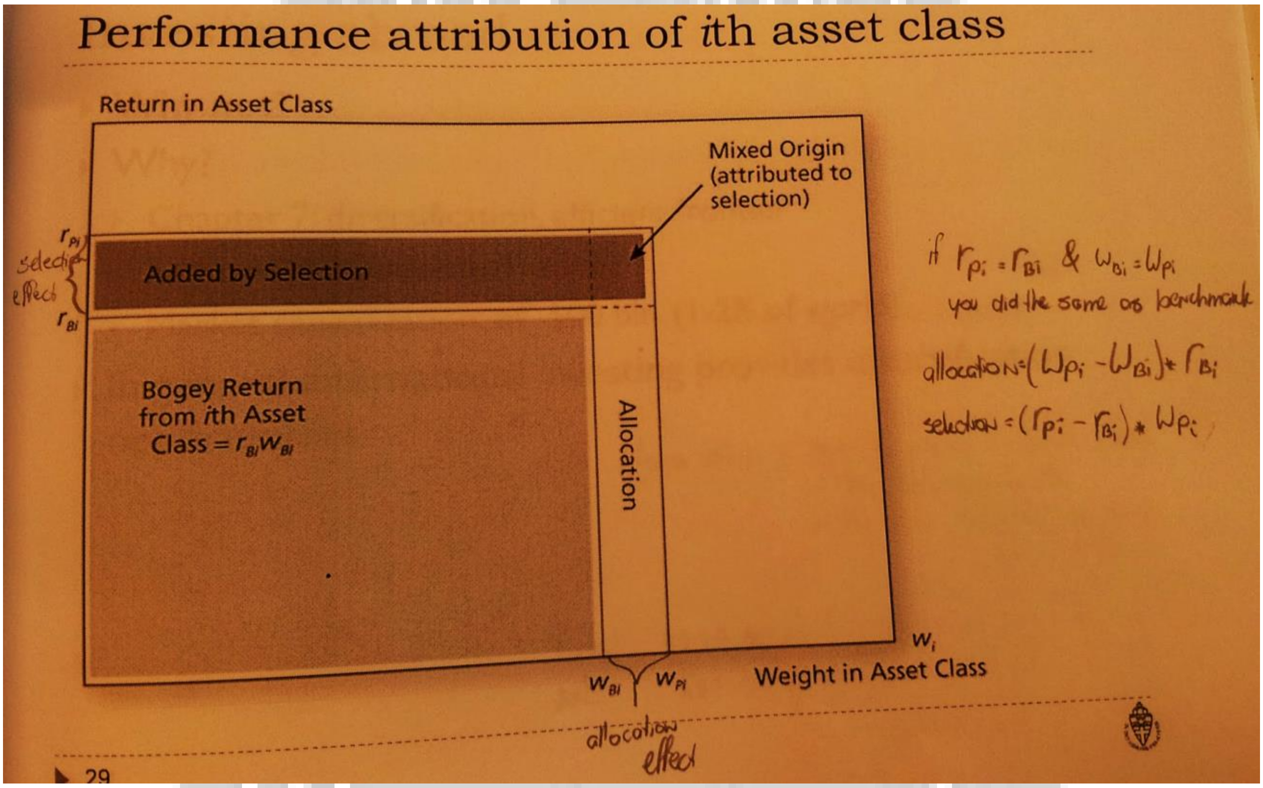
- The best indication of the performance of the timer is a lower partial standard deviation, LPSD, in which we calculate (the square root of the) average squared deviation below the risk-free rate (rather than below the mean
- The *perfect* timer portfolio has no risk and so receives no discount for risk.
- A perfect timer can be compared as a call option on the equity portfolio
    - Thus option-pricing can be used to determine the maximum potential of perfect timing
- MV(Perfect timer per $ of assets) = $C = 2N(\frac{1}{2}\sigma_M\sqrt{T}) - 1$
- MV(Imperfect timer) = $P * C = (P_1 + P_2 - 1)[2N(\frac{1}{2}\sigma_M\sqrt{T}) - 1]$
    - with P_1 = proportions of correct forecasts of bull markets ($r_M > r_f$)
    - with P_2 = proportions of correct forecasts of bearish markets ($r_M < r_f$)
- If the timer does not shift fully from one asset to the other, because he/she knows his/her forecasts are not perfect the formula becomes
    - MV(Imperfect timer) = $\omega * P * C = \omega * (P_1 + P_2 - 1)[2N(\frac{1}{2}\sigma_M\sqrt{T}) - 1]$
    - ω = fraction of portfolio shifted

24.5 Style analysis

- Style analysis
    - Passive investment → Go with the market
    - Active investment → actively look for outperformance
        - Allocation effect: across investment categories
        - Selection effect: selection within the category
- Style analysis: regress fund returns on indexes representing a range of asset classes. The regression coefficient on each index would then measure the fund's implicit allocation to that style
    - the R-squared of the regression would measure the percentage of return variability attributable to style or asset allocation, while the remaining would

be attributable either to security selection or to market timing by periodic changes in the asset-class weights.
- Style analysis imposes extra constraints on the regression coefficients: it forces them to be positive and to sum to 1.0.

- The Security Market Line (SML) benchmark is a better representation of performance relative to the theoretically prescribed passive portfolio, that is, the broadest market index available.
- Style analysis reveals the strategy that most closely tracks the fund's activity and measures performance relative to this strategy.
- Use of any benchmark other than the fund's single-index benchmark is legitimate only if we assume that the factor portfolios in question are part of the fund's alternative passive strategy.



24.6 Morningstar's Risk-adjusted rating

- *Risk adjusted rating (RAR)*: based on a comparison of each fund to a peer group. The peer group for each fund is selected on the basis of the fund's investment universe (international, growth vs value, fixed income) as well as portfolio characteristics (average price-to-book value, price-earnings ratio)
- Morningstar computes fund returns (adjusted for loads) as well as risk measure based primarily on fund performance in its worst years, and then ranks them according to:

Percentile	Stars
0–10	1
10–32.5	2
32.5–67.5	3
67.5–90	4
90–100	5

-

Chapter 11: The efficient market hypothesis

11.1 Random walks and the efficient market hypothesis

- A forecast about favourable *future* performance leads instead to favourable *current* performance, as market participants all try to get in on the action before the price jump.
- This would also mean that new information is already incorporated into the stock price
- However, new information is unpredictable → thus price changes are unpredictable
- *Random walk*: price changes should be random and unpredictable. It is the natural result of prices that always reflect all current knowledge.
- *Efficient market hypothesis*: Stocks already reflect all available information
    - Do security prices reflect information?
- e.g an announcement of takeover attempt should cause the stock price to jump (since the party that wants to take over will pay a premium on top of the current market price)
- When information is costly to uncover and analyze, one would expect investment analysis calling for such expenditures to result in an increased expected return.
    - Investors will have an incentive to spend time and resources to analyze and uncover new information only is fusch activity is likely to generate higher investment returns.
    - Thus, in market equilibrium, efficient information-gathering should be fruitful
    - Therefore, high competition to acquire best and most information
- There are three versions of the Efficient Market Hypothesis
    - *Weak form*: (majorly based on historical information)
        - Stock price reflect all information that can be derived by examining market trading data such as history of past prices, trading volume or short interest
        - → Trend analysis is thus fruitful
        - History data is costly and publicly available
    - *Semi strong-form:* (based on historical + public information)
        - All publicly available information regarding the prospects of a firm must be reflected already in the stock price.
        - Includes past prices, fundamental data on the firm's last product line, quality of management, balance sheet composition, patents held, earning forecast and accounting.
    - *Strong form:* (based on historical + public + insiders' information)
        - Stock prices reflect all information relevant to the firm, even including information available to only company insiders.

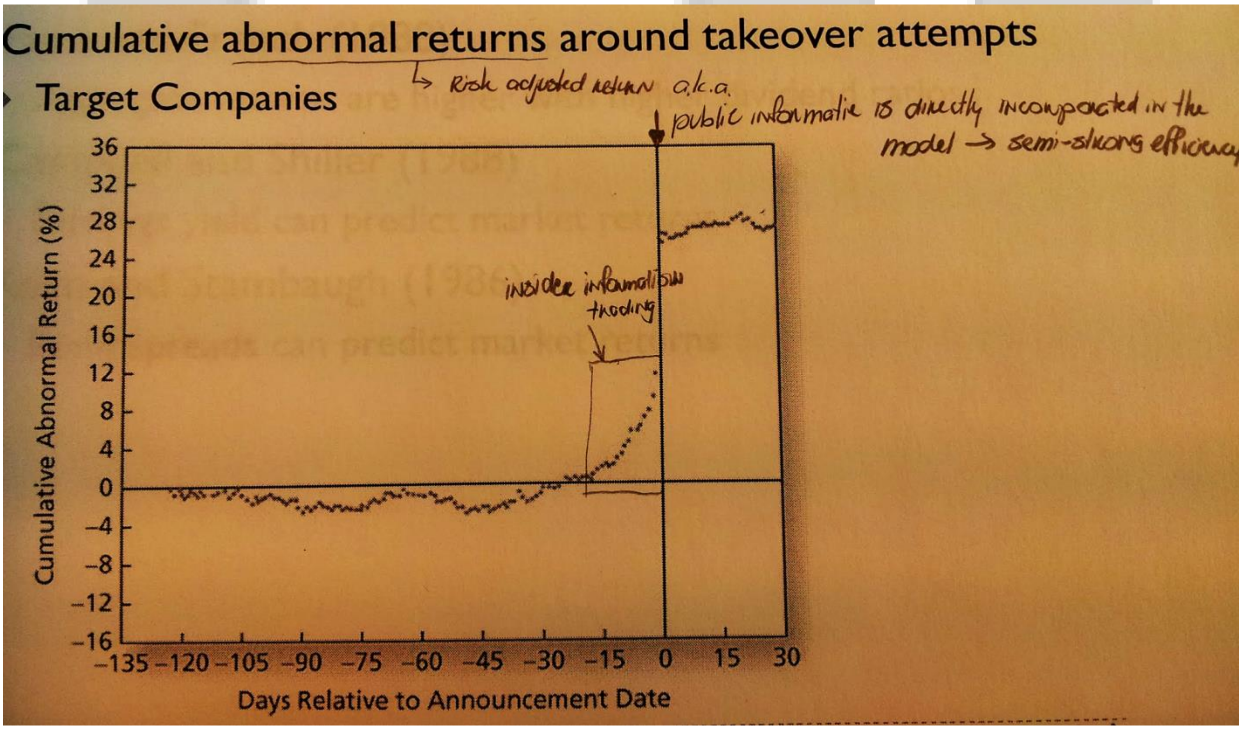
- This form is quite extreme → insiders are limited to trade in order to keep them from exploiting their information

11.2 Implications of the Efficient Market Hypothesis

- *Technical analysis:* the search for recurrent and predictable patterns in stock prices.
  - Although information regarding economic prospects is important, it is not necessary for a successful trading strategy
  - Successful technical analysis → is a sluggish response of stock prices to fundamental supply-and-demand factors. → opposes efficient market hypothesis
  - Study often records or charts of past stock prices, hoping to find a pattern
  - Useful if there is weak form of market efficiency
- *Resistance levels / Support levels*: These values are said to be price levels above which it is difficult for stock prices to rise, or below which it is unlikely for them to fall, they are determined by market psychology.
  - This could create a spiral, if $72 is the resistance level, no one will buy a stock at $71.50 since there is almost no room for profit. Due to this actually $71.50 becomes the new resistance level, and therefore no one will buy the stock at $71… and so on.
- *Fundamental analysis*: uses earnings and dividend prospects of the firm, expectations of future interest rates and risk evaluation of the firm to determine proper stock prices.
  - Tries to determine the present discounted value of all the payments a stockholder will receive from each share of stock. If value > stock price, then the analysis will recommend purchasing the stock
  - Efficient market hypothesis possesses the fundamental analysts.
  - If everyone has all available information, you need even more insight to be better than your competitors
  - Useful in semi-strong market efficiency
- *Passive investment strategy:* aims only at establishing a well-diversified portfolio of securities without attempting to find under-or overvalued stocks.
  - Common strategy → create *index fund*: fund designed to replicate the performance of a broad-based index of stock (e.g. replicates S&P 500)
  - Other strategy → Exchange-traded funds: are shares in diversified portfolios that can be bought or sold just like shares of individuals stock.
- Rational portfolio management
  - Diversification is important
  - Tax considerations
  - Risk profile of the investor: e.g. age, risk aversion and employment

11.3 Event studies

- *Event study*: a technique of empirical financial research that enables an observer to assess the impact of a particular event on a firm's stock price.
    - Particular events such as: Buyback of stocks, introduction on an index (AEX)
- *Abnormal return*: the difference between the stock's actual return and what it would have been in the absence of the event.
- Stock return: $r_t = a + br_{Mt} + e_t$
    - r_t = stock return
    - t = period
    - r_{Mt} = market's rate of return
    - e_t = firm specific rate
    - a = average rate of return in period with zero market return
    - b = sensitivity to the market return
- Abnormal return therefore equals
    - $e_t = r_t - (a + br_{Mt})$
    - e_t = the component presumably due to the event in question, is the stock's return over and above what one would predict based on broad market movements in that period, given the stock's sensitivity to the market
- *Cumulative abnormal return*: sum of all abnormal returns over the time period of interest → captures the total firm-specific stock movement for the entire period when the market might be responding to new information
- Abnormal return
    - Observed return minus expected return
        - CAPM
        - Fama-French 3 factor
    - Risk adjusted return



- Event study is used in fraud cases, and to measure illicit gains by inside information

11.4 Are markets efficient?

- *Magnitude issue*: Only managers with really large portfolios will earn enough to make minor mispricing worthwhile
- *Selection bias issue*: The outcomes we are able to observe have been preselected in favour of failed attempts → we cannot fairly evaluate the true ability
- *Lucky event issue*: Some abnormal good investments are just pure luck
- Empirical tests of the efficient market hypothesis:
  - Weak-form tests:
    - returns over short horizon → serial correlation
    - returns over medium horizon → momentum (past winners will remain)
    - returns over long horizon → reversals (past winners will be future losers)
    - predictors of broad market returns
  - Semi strong tests:
    - Small-firm effect: investments in stocks of small firms appear to have earned abnormal returns
    - Neglected-firm effect: investments in stock of less well-known firms have generated abnormal returns
    - P/E effect
    - Book-to-market ratios
    - Post-earnings-announcement price drift
    - Calendar effect (January effect: expectation that in January stock prices rise)
  - Strong-form tests:
    - Insider information
- Market bubbles defy all rules of market efficiency

11.5 Mutual fund and analyst performance

- Stock market analysts
  - Stock market analysts work for brokers → analysts tend to be overwhelmingly positive in their assessment of the prospects of firms
- Markets are generally very efficient, but that rewards to the especially diligent, intelligent, or creative may in fact be waiting.
- Passive management
  - Buy and hold
  - Index funds
- Active management
  - Security analysis

- Timing
- Performance
    - Some evidence of persistent positive and negative performance
    - Survivorship bias (only the securities with a high return will remain in a portfolio)
    - Performance issues → costs

Chapter 12: Behavioral Finance and Technical Analysis

12.1 The behavioural critique

- *Behavioural finance*: conventional financial theory ignores how real people make decision and that people make a difference. → the anomalies are irrationalities that seem to characterize individuals making complicated decisions. two type of irrationalities
    - Investors do not always process information correctly and therefore infer incorrect probability distributions about futures rates of return.
    - Even given a probability distribution of returns, they often make inconsistent or systematically suboptimal decisions.
- Second theory: in practice the actions of arbitrageurs are limited and therefore insufficient to force prices to match intrinsic value
- If behaviourists are correct about limits to arbitrage activity, then the absence of profit opportunities does not necessarily imply that markets are efficient.
- Information processing:
    - Errors in information processing can lead to misestimate of true probabilities of possible events or associated rate of returns. There are 4 important types:
        - Forecasting errors: people give too much weight to recent experience compared to prior beliefs when making forecasts and tend to make forecasts that are too extreme given the uncertainty inherent in their information.
        - Overconfidence: people tend to overestimate the precision of their beliefs or forecasts, and tend to overestimate their abilities. (e.g much more active than passive investment management)
        - Conservatism: investors are too slow in updating their beliefs in response to new evidence → new info will be reflected gradually
        - Sample size neglect and representativeness: people commonly do not take into account the size of a sample. → may infer a pattern to quickly and extrapolate these apparent trends too far into the future.

- Behavioural bias: individuals would tend to make less-than-fully rational decision using information
- Framing: Decisions seem to be affected by how choices are framed (e.g. X% change in winning, or X-1% chance in losing) (positive vs negative framing)
- Mental Accounting: is a specific form of framing in which people segregate certain decision. E.g. an investor may take a lot of risk with one investment account, but can be very conservative with another account that is dedicated to her child's education.
    - *The house money effect:* gamblers' greater willingness to accept new bets if they currently are ahead. Thus if they use their ''winnings account'' they are willing to take more risk
- Regret avoidance: individuals who make decisions that turn out badly have more regret when that decision was more unconventional. E.g. if a blue-chip portfolio turns down it is less painful than the same losses on an unknown start-up firm.
- Prospect theory: modifies the analytic description of rational risk-averse investors found in standard financial theory. → people become risk seeking when confronted with losses.

Disposition effect: the tendency for investors to hold on to losing stocks for too long and sell winning stocks too soon

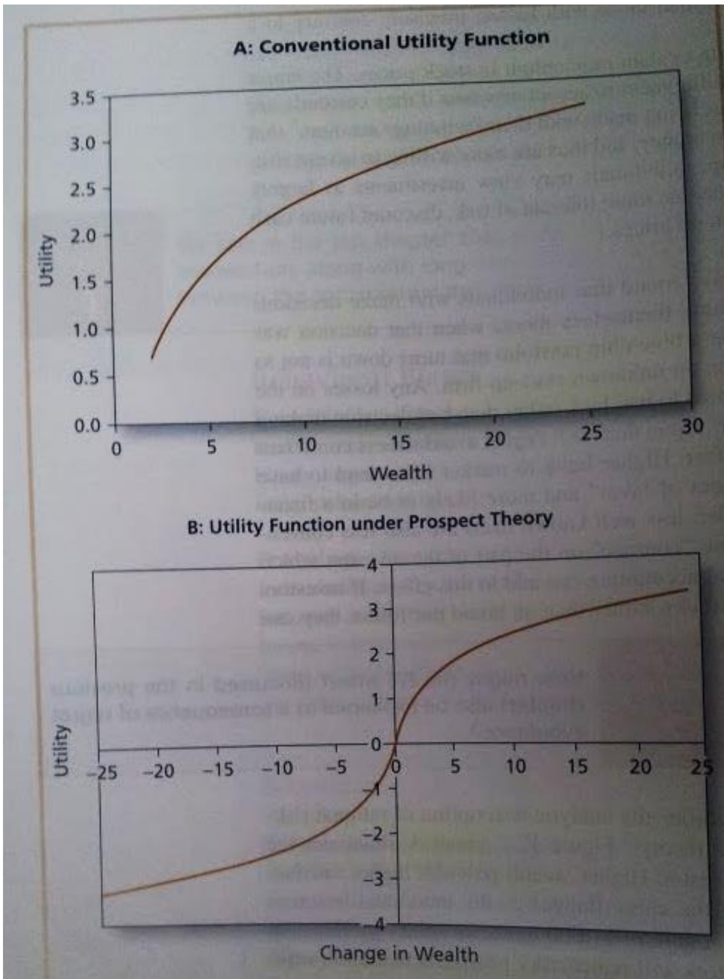


Figure 12.1 Prospect theory. *Panel A:* A conventional utility function is defined in terms of wealth and is concave, resulting in risk aversion. *Panel B:* Under loss aversion, the utility function is defined in terms of losses relative to current wealth. It is also convex to the left of the origin, giving rise to risk-seeking behavior in terms of losses.

- Limits to arbitrage: Behavioural biases would not matter for stock pricing if rational arbitrageurs could fully exploit the mistakes of behavioural investors. → in practice, several factors limit the ability to profit from mispricing.
    - *Fundamental risk:* Risk that if an asset is misprices, there is still no arbitrage opportunity, because the mispricing can widen before price eventually converges to intrinsic value.
    - Implementation costs: short selling a security entails costs → this can limit the ability of arbitrage activity to force prices to fair value
    - Model risk: Sometimes models look better than reality. perhaps your intrinsic value model is wrong, and the price is the real price.
- Limits to arbitrage and the law of one price:
    - Law of one price: effectively identical assets should have identical price in every country in every currency
    - Equity carve-outs = a business sells shares in a business unit
- Bubbles and behavioural economics
    - Investors were increasingly confident of the investment prowess (overconfidence bias) and willing to extrapolate short-term patterns into distant future (representativeness bias)
- Evaluating the behavioural critique
    - For investors the question is still whether there is money to be made from mispricing, and the behavioural literature is largely silent on this point
    - Debate that behavioural approach of economy is unstructured
    - Its critique of full rationality in investor decision making is well taken, but the extent to which limited rationality affects asset pricing is controversial.

12.2 Technical analysis and behavioural finance

- Technical analysis: Attempts to exploit recurring and predictable patterns in stock prices to generate superior investment performance.
    - Do not deny the value of fundamental information, but they think it is applied gradually
- *Disposition effect*: the tendency of investors to hold on to losing investments. → can lead to momentum in stock prices even if fundamental values follow a random walk.
- Trends and corrections:
    - Technical analysis: uncover trends in market prices → or search for momentum
    - Dow theory: three forces simultaneously affecting stock prices
        - Primary trend: long term movement of prices, from months to years
        - Secondary / intermediate trend: short term deviations, these are eliminated through corrections
        - Tertiary or minor trends: daily fluctuations of little importance

- Dow theory is based on predictable recurring price patterns
- Moving averages
  - The moving average of a stock index is the average level of the index over a given interval of time.
  - The average can be higher than current index after a period of falling prices, and be lower than average when prices are rising
- Breadth
  - *Breadth*: is a measure of the extent to which movement in a market index is reflected widely in the price movements of all the stocks in the market.
  - Most often: spread between the number of stocks that advance and decline in price.
- Trin statistic
  - = defined as $Trin = \frac{Volume\ declining\ /\ Number\ declining}{Volume\ advancing\ /\ Number\ advancing}$
  - Trin = the ratio of average volume in declining issues to average volume in advancing issues.
  - Ratios > 1 → bearish → could be interpret that there is more buying activity in declining issues
- Confidence index
  - = the ratio of the average yield on 10 top-rated corporate bonds divided by the average yield on 10 intermediate-grade corporate bonds
  - Ratio is always < 100%
  - Higher values of the confidence index are bullish signals
- Put/Call ratio
  - = the ratio of outstanding put option to outstanding call options
  - Put options do well in falling markets, while call options do well in rising markets
  - → so, can be used as a signal of market movement
- In evaluating trading rules, you should always ask whether the rule would have seemed reasonable before you looked at the data.

L E A R N I N G O B J E C T I V E S

At the end of the course the student will be able to:

1. make an analysis of an investment portfolio on the dimensions of risk and return;
2. identify risks related to a stock and bond portfolio;
3. develop a performance analysis of an investment portfolio;
4. apply modern financial tools like options to create a desired risk-return profile for a portfolio;
5. explain the most important theoretical foundations of investment management;
6. work with valuation models for call and put options;
7. value and apply futures contracts

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