Investments (Bodie, Kane & Marcus) deel 1

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Chapter 1: Investment environment

Real vs financial assets
The capacity to produce is defined by the real assets of the economy, for example land, buildings, machines and knowledge. These real assets ultimately determine the material wealth of a society. Financial assets, in contrast to real assets, are the means by which individuals can claim real assets, in other words, the claims on the income generated by real assets. Financial assets therefore allocate income or wealth among investors. As such, the financial assets of households are the liabilities of the issuers of those assets or securities. Ultimately, when aggregating the entire economy, these claims will cancel out, leaving only the real assets. These real assets are then the net national wealth, consisting of equipment, goods and land. This book almost exclusively treats financial assets.
Financial assets
We can distinguish between three types of financial assets:
1. Fixed-income or debt securities entail either a fixed stream of income or a stream of income determined by a formula. Therefore they are not strongly tied to the financial condition or performance of the issuer. These financial assets range from the money market, short term and low risk, to the capital market, long term and higher risk.
2. Equity, or common stock, represents a share of ownership in a corporation. The owners of equity are therefore not promised anything beforehand. The performance is directly tied to the success of the firm and its real assets. Risk is therefore much higher.
3. Derivative securities are determined by the performance and prices of other assets. So, the value of options and futures are based on the prices of stocks and bonds. Derivatives are now widely used to hedge risk or to transfer risk to other parties. They can be used to speculate, sometimes resulting in big losses. Derivatives will however stay very important in the financial system.

Financial markets
The ability for a firm to attract investor capital depends on the financial markets. Financial markets therefore play a crucial role in the allocation of resources. In the end, the financial markets decide which companies can survive and which ones cannot. Stock prices represent the collective judgment on the performance or perspectives of a firm.
Financial markets also play a crucial role in the timing of consumption by households. By storing wealth in financial assets, individuals can postpone the expenditure of their wealth.
Moreover, capital markets give the possibility to choose a level of risk appropriate to the level of risk aversion of the individual. The ones willing to bear a lot of risk are enabled to do so through capital markets. It also serves the companies that try to finance investments by raising capital.
A possibly large number of owners of financial assets, acquired through the capital markets, elect the management of the company. This separation between ownership and management, they are two different parties, results in a stable decision-making structure. Some

agency problems might arise however. The agency issue is the fact that the management of a company might not always act in the interests of the investors. Such agency conflicts can be countered by several instruments. First of all, often the compensation for executives is tied to the performance of the firm, the value of the stock. Also, the board of directors and external institutions can play an important role in controlling the executives. Lastly, there is the chance that bad performers will be taken over by others.
However, to make financial markets function, a certain quality of corporate governance and corporate ethics is necessary. As such, an acceptable level of transparency needs to be existent, to enable investors to make well-informed decisions.

The process

The portfolio of an investor is simply his collections of financial assets, such as stocks, bonds, real estate, commodities, etc. The investment choice between such broad classes of assets is called the asset allocation decision. The choice for particular securities within these classes is called the security selection decision.
A top down approach starts with the asset allocation decision, while a bottom up strategy approaches the issue the other way around.
Security analysis is the valuation of particular securities that might be included in the portfolio.

Competition

Financial markets are highly competitive markets and therefore investors should not expect easy wins. This high level of competition results in the so called risk-return trade-off.
Because investors cannot predict future returns precisely, there is always a risk involved in an investment. The assets with the highest expected return also entail a high level of risk. If this would not be the case, investors would collectively ask for these assets and thereby drive up the price. The assets will be less attractive.
To manage the risk of their total investment, investors try to diversify their portfolio. This means that the set of assets hold in a portfolio together, limit the risk of one of the assets. Modern portfolio theory is the knowledge gathered on this topic.
The efficient market hypothesis is the hypothesis that financial markets are capable of processing all available information about a security quickly and efficiently and that therefore the price of a security accurately reflects the value of the security. Accordingly, when any new piece of information comes available, the stock price will adjust immediately.
Investors have the choice to passively or actively manage their portfolio. Passive management means holding a highly diversified portfolio without attempting to improve its performance in other ways. Active management entails attempts to improve its performance in multiple ways. If the efficient market hypothesis is fully true, active portfolio management would only mean wasting resources on the analysis of securities. In reality however, we observe an almost efficient market, in which profit opportunities still exist.

Players

On a macro level there are three main players on the financial markets:

1. firms need to raise capital to invest and are therefore net borrowers.
2. Household are however net savers

3. Governments can be both net savers and net borrowers. Their position depends on the relation between the level of government spending and the level of taxation. When the government needs to cover a budget deficit, it is a net borrower.

Financial intermediaries play a crucial role on the financial markets. Financial intermediaries are financial institutions that stand between the issuer and the ultimate owner of a security. Financial intermediaries include banks, insurance companies, investment companies or credit unions. They issue their own securities to be able to purchase the securities of other corporations. Their primary function is to channel savings of households to the business sector, usually by pooling the resources together. Moreover, they can substantially diversify risk and accumulate valuable expertise on asset management. Economies of scale is an important reason for the profitable existence of for example investment companies. Investment bankers, that specialize in the assistance of firms when they issue new stock, offer their services and expertise to many corporations and lower the cost. For companies it is therefore much more affordable to deal with such an investment banker than to have an in-house security issuance division. Investment bankers in this role are called underwriters. They give advise and moreover they market the new securities in both the primary, first offer to the public, and secondary market, intermediaries trading among themselves.

Financial crisis of 2008

Before the financial crisis of 2008, the worst one since the Great Depression, the financial markets seemed to be in optima forma. The apparent success of monetary policy over the last few decades was called the Great Moderation. Low interest rates and a stable economy leaded to an historic boom in the American housing market. Also, since the 1970s a new system for financing housing had come into place. Now securitization, the process of pooling claims on mortgages and selling them as mortgage-backed securities, became most prevalent. Credit agencies had highly underestimated the risks of this securitization process and the trade in complicated derivative products. This financial system was full of systemic risk, which means that problems in one market would quickly spillover to other markets and lead to a potential breakdown of the entire system. The crisis of 2008 brought the financial system close to a full systemic breakdown.

Chapter 2: Asset Classes and Financial Instruments

In this chapter we will discuss the variety of securities traded on financial markets, making a distinction between those on the money market and the ones on the capital market.

Money market

The money market consists of trading short-term debt securities. Small investors can enter the market by buying mutual funds. We present here the most important financial assets that are traded on the money market, usually the ones that are highly marketable and have low credit risk.

2. *Treasury bills*
   Treasury bills are the most marketable and liquid product on the money market. Issuing treasury bills (and treasury notes and bonds) is one of the most important ways in which the government raises capital. The public buys the bills from the government at a certain discount price. At the maturity of the bill (4, 13, 26 or 52 weeks) the investor will earn the face value minus the purchase price.
3. *Certificates of deposit (CD)*
   CDs are the most common bank deposit made by the costumers of a bank. At the end of a chosen time interval, the bank pays interest to the investor. The investor must hold the deposit until maturity. He can cash it before by trading the deposit to another investor.
4. *Commercial papers (CP)*
   With this financial product large companies can make their own short-term debt notes to raise capital, instead of borrowing a large sum from banks. These assets are only fairly safe, because often firms issue CPs intending to roll it over at maturity. This means that they issue new CPs to pay the old ones, which make the deal riskier.
5. *Bankers' acceptance*
   Accepting a "bankers' acceptance" claimed by a bank costumer, the bank takes the responsibility to pay the holder of the contract on a future fixed date. In between, the contract can be traded on secondary markets.
6. *Eurodollars*
   Eurodollars are dollar-denominated deposits. These contracts are made with foreign banks. It's a way to avoid the Federal Reserve regulation in the USA.
7. *Repos and reverses*
   Repos are government securities sold by dealers to investors on an overnight payback policy. For reverse repos, the dealer buys government securities from investors, agreeing to sell them back on a "future date/higher price" policy.
8. *Federal funds*
   Banks have their own deposits at a Federal Reserve bank. It is the way in which banks fix their reserves. The magnitude of these reserves is regulated by Fed and it depends on the bank's costumers total deposits.

The bond market

The bond market involves long-term borrowing or long-term debt products.

9. *Treasury notes and bonds*

As said above, these belong to the main instruments for government to borrow funds. They differ with respect to their maturity (up to 10 years for the notes, 10-30 years for the bonds). Both of them make semi-annual interest payments. The ask price is the price the investor is willing to pay to the dealer for the asset. The bid price is the lowest price you receive when selling the asset to a dealer. The yield to maturity is the annual rate of return if you hold the asset until maturity.

10. *Inflation-protected treasury bonds (TIPS)*
    TIPS provide constant income in real dollars, by adjusting rates of return according to the Consumer Price Index.
11. *Federal agency debt*
    Bonds issued by a government-backed agency. Those agencies aim to give credit to certain sectors of the economy that are believed to not receive sufficient credit from private sources. This kind of debt is not ensured by the federal government, but commonly government will help agencies near default.
12. *Municipal bonds*
    State and local governments can issue their own bonds. They are used to finance particular projects, also private-purpose ones. This bonds allow firms to take advantage of municipality's possibility to borrow at tax-exempt rates.

To compare between taxable and tax-exempt bonds, let r_m be the rate on municipal bonds. The after-tax rate on the taxable bond is easy to compute: calling t the federal plus local marginal tax bracket and r the total before-tax rate of return on the taxable bond, the after-tax rate is $r(1-t)$. With small calculus, the investor can compute, given t, the interest rate of return the taxable bond should have to be indifferent to the tax-exempt one, which is:

$$r = r_m/(1-t) \qquad (equivalent\ taxable\ yield)$$

or, given r, the tax bracket that equate the after-tax rate to the tax-exempt one:

$$t = 1 - r_m/r \qquad (cutoff\ tax\ bracket)$$

It is clear that the ratio between the two rates determines the attractiveness of municipal bonds.

- *Corporate bonds*
  These bonds allow private firms to borrow money from the public. For investors corporate bonds are riskier than treasury ones,because the default probability is higher, but they work in the same way, paying semi-annual coupons and so on. The default risk can be handled with *secured bonds*, which are backed also in case of bankruptcy, and with *subordinates debentures*, also backed but with lower priority. Unsecured bonds (*debentures*) have none of these collaterals.
- *Mortgages and mortgage-backed securities*
  Conventional mortgages are written on the long term, with a fixed interest rate and equal fixed monthly payments. There are also *adjustable-rate* mortgages, which split between banks and costumers the risk of fluctuations in interest rates. *Mortgage-backed securities* are a type of asset-backed securities that are

secured by a mortgage, or a pool of them.

Equity securities

Common stock, or equity, represents shares of ownership in a corporation. With these shares the owner can participate in the decisionmaking process of the corporation, apropriate to the number of shares the investor holds. Shareholders vote for the board of directors (each year) and thesw directors select the managers who run the corporation. This separation between ownership and control is sometimes a problem, because stakeholders and managers can have different aims.

Stocks are characterized by its *residual claim*. In case of a liquidation of a firm, stockholders will only receive the assets that will be left after all other crediters have claimed their parts (taxation, employees, suppliers etc.). Moreover, management decides what to do with the residual, to reinvest it or to pay dividends to stakeholders. Common stock can have a *limited liability* feature, when stakeholders cannot claim anything in case of failure of the corporation.

The “numbers” to consider are:

- The daily closing price of the stock and its change from the previous trading day;
- The volume of stocks traded for that day;
- The highest and the lowest price for which the stock has been traded during the last 52 weeks;
- The dividend payment per share, ignoring prospective capital gains or losses driven by the future prices;
- The price-earning ratio (P/E), i.e. the ratio of the current stock price to last year earnings per share. In other words, the P/E ratio tells us how much needs to be spent on the stock to receive one dollar of dividends.

*Preferred stock*s are similar to perpetual bonds, because they give a fixed amount of income each year. Moreover, like a bond, they do not give the possibility to vote the board of directors. Like for common stocks, the firm decides to pay dividends or not. On the other hand, the firm has a contractual obligation to make interest payments on the debt. Finally, preferred stocks have a lower priority than bonds in case of bankruptcy. This higher risk results in higher yields than in the case of the less risky bonds.

Stock market indexes

Indexes measure the stock market performances. We discuss here the most important ones.

1. *Dow Jones Averages*
   This index is calculated by averaging the stock prices of 30, large, “blue chip” corporations, by storing that value for each day. The percent change of the index from the day before represents the rate at which a portfolio made of one stock for each of the 30 corporations rises or falls. Such a portfolio is then price-weighted, holding the same number of stocks for each corporation, so the money invested in each of those is proportional to their stock prices.
   Nowadays this index is adjusted to the fact that corporations can pay dividends, which can result in a misrepresented stock price.
2. *Standard & Poor’s indexes*
   This index involves 500 corporations, so it is better able to

track the stocks market than the Dow Jones index. Moreover, it is weighted based on the market-value. This means that it takes the absolute value of a stock into account and not only the changes over time. Therefore, when computing the value of the index, a corporation that sells shares at 100$ per share is ten times more important than a stock selling for 10$ per share. In other words, the index tracks the rate of return of an investor's portfolio using a number of stocks proportional to the market value of each of the 500 corporations.

3. *Equally weighted indexes*
   These indexes measure market performances by an equally weighted average of the returns of each stock. It corresponds to a portfolio investing equal dollar values in each stock. This result in a portfolio that can change quickly. A change in the value of a stock due to a price movement will change the weight given to that corporation in the index. So, such a portfolio is not a buy-and-hold one.
4. *Bond market indicators*
   As for stocks, there are many indexes that try to track the performances of the bond market. But often those indexes are not reliable, because the true rate of return for bonds is difficult to compute considering the timehorizon.

Derivative markets
A derivative is an asset whose value is derived from the values of other assets. Trading in derivatives can get very complicated. Here we only discuss options and futures contracts.
There are two kinds of options:

- *Call option*
  This derivative gives to the holder the right (not the obligation) to buy an asset at a given price (*strike price*) on (or before) a given expiration date. Then, if before that day the market price of the stock grows, the holder can profit by buying the stock for the strike price and selling it at the market price. On the contrary, if the price falls down, the holder will let the option expire.
- *Put option*
  This option is the opposite of a call option and it gives the holder the right to sell an asset at a given price on (or before) a given expiration date. Clearly, if the price falls down, the owner will use the call option, while if the price grows up he will let expire the option.

Futures contracts call for the delivery of an asset on a given future date and for a predetermined price. The *long position* is the one of the investor who will buy the asset, while the asset owner has the *short position*. Futures may seem to be very similar to options, but there is an important difference. A future contract *obliges* one part to buy and the other to sell the asset. For example, if an investor has a long futures position on an asset and the price goes down, he is obliged to buy it anyway but he will be losing money. This is the reason why futures contracts are costless and options are not (you pay a *premium price*): options give you the possibility to hedge risks, while futures do not give that possibility.

Chapter 3 Trading Securities

In this chapter we will see how securities are marketed to the public for the first time and how they are traded between investors. We focus also on the specific trading arenas and the specific way of trading that each of them entails. We will see how these stockmarkets compete between each other to attract investors.

How firms issue securities

The *Primary market* is the market where new issues of securities are brought to the public.

Once they have been sold, they can be traded among investors in the *secondary market*, so the total amount of securities does not change. On the primary market we find *Initial Public Offerings* (IPOs), which are stocks offered by a company that is entering the market for the first time, and *Seasoned* equities, when a company who is already on the market wants to augment the volume of its offered stocks. Concerning bonds, there are two kind of issues: *public offering* and *private placement*. Once bought you can trade the first kind of bonds on the secondary market, while you must keep the second one until maturity.

Investment banking

Investment bankers (here called *underwriters*) have the role to market bonds and stocks of a firm on the primary market. First, these issues have to be checked and registered by the *Securities and Exchange Commission* (SEC), which means that a statement must be filled and its final approved form is called *prospectus*. This process is not costless. On average it costs 7% of the funds raised. After the registration, the price offered to the public is announced: investment bankers buy the issues and sell them to the public at a higher price. They earn money from this price spread or from a given commission. Sometimes they may also receive shares of the firm.

Private placements

If the firm does not want to enter the public market, it is possible to sell securities in private placement offerings, which means to a small group of investors. A clear consequence is that the volumes of traded securities is much smaller. At the same time, this kind of placement is cheaper than the public one, because SEC allows the firm to skip the expensive registration/validation phase. These private placements cannot be traded on the secondary market.

Initial public offerings

Once the prospectus is ready investment bankers travel around the country to publicize the firms intentions. These *road shows* are the way in which firms create interest for their offers. So, depending on the magnitude of demand, they can adjust the selling price per share of the IPO. This process of pooling potential investors' information is called *bookbuilding*.

This price and the total amount of shares offered, is often revised responding to the feedback from the investing community. The higher the potential demand is, the higher the price will be. As a consequence potential investors can profit from a smaller price hiding their intentions to buy. To avoid this, the firm is forced to reward in some way the investors, hoping to obtain a truthful picture of the situation. The main strategy is to offer them the securities at a bargain price.

In any case, despite such efforts, obtaining perfect information is impossible and often IPOs are underpriced compared to the price at which they could be marketed. The biased information will lead to an outstanding performance of the new securities in the beginning and a worse one on the long term.
It can be very difficult to find a buyer for the assets you want to sell, or the other way around, without an organized information network. This is why financial markets have come to existence.
Types of Markets
We can differentiate four types of markets, ordered by increasing level of organization:

1. *Direct search markets*: The least organized type. Some example are advertisementnewspapers or Craiglists. Through such channels supply and demand can find each other directly, without an intermediary.
2. *Brokered markets*: In these markets brokers are the intermediaries who earn money by providing matchingservices to buyers and sellers. An example is the primary market, where investment banks play this role.
3. *Dealer markets*: These markets are more appropriate when the trading activities increase in volume. Here *dealers* buy securities for themselves, they create their own inventory, and they sell them later. The spread between the bid and ask price over time generates their profits. Holding such an inventory can be risky though, and that is why these markets need to be dynamic and large. Most bonds are traded in those markets.
4. *Auction markets*: This is the most integrated type. Buyers and sellers come together in the same place. In this way they are able to spend as little on searching activities as possible. Obviously these markets require very intens and frequent trading to maintain themselves. A famous auction market is the NYSE (New York Stock Exchange).

Types of orders
Now we can differentiate between the different types of trades you can find on these markets.

- *Market orders*: Orders that are to be executed immediately at the current market prices. The broker provides the investor with the best bid and ask prices. This may not be easy, because bid and ask quotes are linked to specific bounds on the number of securities traded. When the trades go beyond those limits multiple prices for one order can arise. Moreover the price may change before the order arrives, or another trader may beat the initial quote, whose investor will then receive a worse price.
- *Price-contingent orders*: The investor decides the maximum price for which he wants to buy and the minimum for which he would be willing to sell. These oreders are called *limit orders*. Afterwards he sends the order to the broker, who follows the given trading strategy. While waiting to be handled, these limit orders float on the *limit order book*, which basically is a table storing the price, the size and the date of the order.
  Bids are sorted from the more expensive to the less expensive ones, vice versa for Asks. The highest buying price and the lowest selling price on the table are called *inside quotes*. *Stop orders* instruct the broker to a certain trade only if the stock

hits specified price limits. Here we distinguish *stop-loss orders*, an order to sell if the price goes below a stipulated threshold, from *stop-buy orders*, stop to buy if the price rises above a stipulated threshold. These orders are clearly meant to limit potential losses.

Trading mechanisms
In each type of trading system different trading operations are allowed.

1. *Dealer markets*: in this OTC (over the counter) market thousands of brokers are registered through SEC as security dealers. Dealers can then quote their bid/ask prices. Let us take NASDAQ (National Association of Securities Dealers Automatic Quotation System) as an example. NASDAQ represents the computer network system through which brokers can scan bid/ask prices and choose the dealer. Nowadays the majority of trades are executed electronically.
2. *Electronic communication networks (ECNs)*: these networks provides a limit-order book where investors can place limit orders. Trading in such a network is not costless, but it is cheaper than paying the bid/ask price spread and the absence of dealers increases the speed of trading.
3. *Specialist markets*: in these markets brokers can trade only through specialists, who represent firms. They act as brokers who take care of executing tradings with other brokers for specific firms' issues. They can also buy/sell for their own inventory, as a proper dealer. As a consequence, specialists earn their income through firms commissions on managing orders and the bid/ask price spread. Basically, a specialist is a facilitator.

The New York Stock Exchange
The New York Stock Exchange is the largest stock exchange in the United States. Here investors send orders to brokerage firms, that have the task of managing the investor's or firm's communication. Small orders are traded automatically while bigger ones, if negotiation is needed, are sent to a floor broker, who contacts the relative specialist.

Block shares
Larger block transations (10000+ shares) are no longer managed by specialists. In this case we have *Block houses* to handle the problem of matching offer and demand. If, for example, a buyer cannot be found, a block house may purchases part of the sale for its own account, trading them later to public.

Electronic trading on the NYSE
Today, due to computer lines, brokerage firms can send orders directly to the specialist. The electronic system managing this for the NYSE is called SuperDot. NYSE has also implemented a fully automated trade-execution system, called Direct+. This system can match orders and bid/ask prices in fractions of seconds. The majority of NYSE trades are now executed in this way.

Electronic communication networks
The large majority of all trades executed belongs to such electronic markets (as NASDAQ, ArcaEx, and others). These networks link buyers and sellers directly and are completely electronic. These features speed up trading execution time so substantially that is

possible to execute trades in 0.0025 seconds or less. This is subject to concern among market regulators, because with such a speed a lot of foggy operations are allowed.

Bond trading

When marketing bonds dealers can set up big inventories, because unlike stocks, those markets are "thin". This means that it is harder to match demand and supply and therefore the dealer runs more risk. This slow speed of transactions results in liquidity risk.

Trading costs

We can make a distinction between the explicit and the implicit costs of trading.

- *Explicit costs*: the main example is the commission the broker asks. This commission can vary a lot, because investors have the possibility to trade with different kinds of brokers:
    1. *Full service brokers*: these brokers can help investors in making decisions, because they have a research staff that studies the market and tries to forecast its future behavior. Sometimes clients have so much confidence in their broker that they allow him to make decisions on their behalf. The broker gets a *discretionary account* to make the operations. The risk for the client is that the broker mainly trades to generate a higher commission for himself.
    2. *Discount brokers*: these brokers provide no more than basic services, which means buying and selling securities, scanning the market quotes, offering margin loans etc.
- *Implicit costs*: these costs are for example the spread between the bidprice and the askprice of the dealer, or the price concession an investor may be forced to make for trading quantities greater than the quotes.

Buying on margin

An investor is buying on margin if he borrows a part of the capital he wants to invest in an asset from his broker. This source of debt financing is called *broker's call loans*.

The steps are the followings: the investor borrows part of the purchase price from a broker; the broker borrows money from banks at a certain interest rate to finance the purchase; he then charges his client the bank's cost and to one for his trading service. The *margin* is then the portion of the investment contributed by the investor.

$$Margin = (Equity\ in\ account) \ / \ (Value\ of\ the\ stock)$$

The Board of Governors of Federal Reserve System bounded the minimum margin to be above 50%.

With a bit of calculus it is easy to understand that buying on margin uses the leverage effect to spread out performances of the investment. The investor can earn a bigger rate of interest in case of the best scenario (compared with a normal investment) and lose a lot more in case of the worst one. The broker, on the other hand, must be guaranteed in case of big losses: sometimes the margin of a bad investment can become negative, which means that the investor cannot pay his debt to the broker by selling the asset. To get it back, the broker sets a *maintenance margin*. When the margin falls below this threshold the broker will issue a *margin call*, asking the investor

to put more cash/equities on the table to increase the margin.
If the investor does not act, the broker sells the stocks until the margin is above the maintenance level.

Short sales

An investor is short selling if he sells stocks he do not possess: he borrows stocks from a broker, and sells these shares. Later he must purchase the stock to give it back to the broker (the investor is *covering the short position*). Clearly, short selling is profitable if the price of the stocks sold goes down (you sell at a certain price and buy at a lower one).
Also in this case *margin calls* exist, when the price increases too much. If the margin falls below the maintenance level, the short seller will receive a margin call. The investor can also set up a *stop buying order* to limit his losses: he chooses the maximum buying price he wants to pay if the price rises. In other words he fixes the maximum loss he I willing to take

Regulation of securities markets

The major laws that regulate trading in securities are the following:

1. 1933: the *security act* imposes firms to clearly highlight their financial prospect before entering the market (i.e., to make the *prospectus* mentioned above)
2. 1934: the *security exchange act* empowers SEC to register and regulate tradings, brokers, dealers, etc.
3. The CFTC (*Commodity futures trading commission*) regulates trading in futures market
4. The Federal reserve sets margin requirements on stocks and stock options, and regulate bank lending to security market actors
5. 1970: the SIPC (*Securities Investor Protection Corporation*) is established to protect investors if their brokerage firms fail.
6. Securities trading is also subject to state laws.

Inside trading

Inside trading is prohibited by law and regulation. Inside trading is making profits from non-public information. Generally, using some private information is legal, for example a supplier can forecast the situation of the client. But it is not clear where to draw the line between legal and illegal private information. Therefore inside trading is difficult to trace.

Chapter 4: Mutual funds and other investment companies

Investment companies
Investment companies collect funds from investors, pool them and reinvest these funds in a potentially wide range of other assets. These companies function as financial intermediaries. They perform several important functions:

- Record keeping and administration
- Diversification and divisibility
- Professional management
- Lower transaction costs

Investors buy shares in such an investment company and the value of each share is called the **net asset value (NAV)**:

$$Net\ asset\ value = \frac{market\ value\ of\ assets\ minus\ liabilities}{shares\ outstanding}$$

There are various kinds of investment companies.
Unit investment trusts invest their funds in a portfolio that is fixed for the lifetime of the fund. The shares sold are called redeemable trust certificates. There is little management involved since the portfolio composition is fixed.
Managed investment companies are able to manage the portfolios they have. There is a difference between open-end funds and closed-end funds. The former enables investors to sell their shares back to the fund. The latter does not and obliges the investor who wants to sell his shares on the market. Consequently there exists a market for such shares, often traded by brokers. The price often diverges widely from the net asset value, but this remains a great puzzle.
Other investment organizations are for example commingled funds, similar to open-end mutual funds, or Real Estate Investment Trusts (REITs), similar to a closed-end fund with loans secured by real estate. Of the latter (REITs) there exist two kinds: equity trusts and mortgage trusts. Hedge funds are vehicles that allow private investors to pool assets. They are constructed as private partnerships and therefore are subject to minimal regulation. They often request lock-ups that allow them to invest in illiquid assets without worrying about the demands for redemption of funds.
Mutual funds
Mutual funds are the common name for open-end investment companies. Each mutual fund has its own investment policy, described in the prospectus. Management companies manage a family, or complex, of mutual funds. The following groups exist:

4. Money market funds
5. Equity funds
6. Sector funds
7. Bond funds
8. International funds (global, regional or emerging market for example)
9. Balanced funds (covering an individual's entire investment

portfolio

10. Asset allocation and flexible funds (holding both stocks and bonds)

11. Index funds (trying to match the performance of a market index.

Mutual funds are either directly sold either through brokers acting on behalf of. It is important to realize that brokers have a conflict of interest due to revenue sharing. This might lead them to recommend mutual funds on the basis of criteria other than the best interest of their clients.

Costs of mutual funds

Investors in mutual funds often have to bear several costs, such as management fees. Operating expenses include administrative expenses, advisory fees, but also marketing and distribution costs. A front-end load is charged when shares are purchased by the investor. Back-end loads are similar but charged when the investor wants to sell the shares. Another category of costs is 12b-1 charges, used to pay for distribution costs.

East investor must choose the best combination of fees. Knowledgeable investors might not need these services, but many investors are willing to pay for advice.

The rate of return on an investment in a mutual fund is the following:

$$\text{Rate of return} = (NAV_1 - NAV_0 + \text{Income and capital gain distributions}) / NAV_0$$

Fees can have a big effect on performance, but it is often difficult to measure the true expenses accurately. This is due to the use of so-called soft dollars, being a kind of credit with a brokerage firm on the basis of which the broker can pay for other expenses.

Late trading refers to the practice of accepting to trade in orders after the market closes and the NAV is determined. This enables investors to buy them and redeem them the next day.

In the US only the investor is asked to pay taxes, not the fund itself. When you invest through a fund, you however lose the ability to engage in tax management. A fund with a high portfolio turnover rate can be particularly tax inefficient. The turnover is the ratio of the trading activity of a portfolio to the assets of the portfolio.

Exchange traded funds

These ETFs are offshoots of mutual funds that allow investors to trade index portfolios just as they do with shares of stock. These ETFs offer various advantages over normal mutual funds. Firstly the price of an ETFs is continuously known, instead of published once a day. Secondly they can be sold short or purchased on margin. They can moreover provide tax advantages over mutual funds. ETFs are also cheaper than mutual funds.

Performance

Because investors delegate portfolio management to investment professionals, they can only choose the percentages of the portfolio that should be invested in equity, bonds or other assets. A good performance measure for mutual funds is needed. But what should be the proper benchmark against which the investment performance ought to be evaluated.

Many studies are done to find out if superior performance in a particular year is due to luck, and therefore random, or due to skill, and therefore consistent. Empirical data show that at least part of a fund's performance is determined by skill.

Information on mutual funds is first and foremost to be found in its prospectus. The Statement of Additional Information of the prospectus includes a list of the securities in the portfolio at the end of the fiscal year, audited financial statements, a list of the directors etc. The SAI is however not often used. Other comparative sources are the Wiesenberger *Investment Companies*, and Morningstar's *Mutual Fund Sourcebook*.

Chapter 5 History of interest rates and risk premiums

In this chapter we will discuss the historical performance of the major asset classes. We will use a risk free asset as a benchmark to evaluate that performance. The risk free asset is the Treasury Bill or T-Bill because it is regarded as the safest asset, the main reason for this is that the US government issues these bills and maintains its credit worthiness via the tax payers money. We will start with a review of the determinants of the risk free rate, the rate available on T-bills and we will focus on the important distinction between real and nominal returns. Second we will discuss the measurement of the expected returns and volatility of risky assets, and show how historical data can be used to construct such estimates. The purpose of this is that we will construct on optimal investment portfolio and in order to construct it we need some idea how risk can be measured. Finally we will review the historical record of several portfolios of interest to provide some insight how different portfolios have performed over time.

Determinants of the level of interest rates
Forecasting interest rates is very difficult, But we do however have a good understanding of the fundamental determinants of the level of interest rates:

1. The supply of finds from savers, primary households
2. The demand for funds from businesses to be used to finance investments in plant, equipment and inventories.
3. The government's net supply of or demand for funds as modified by actions of the Federal Reserve Bank.

Real versus Nominal risk
Now we will focus on the important distinction between real and nominal returns. The real rate of interest is the nominal rate of interest minus the expected rate of inflation. In general, we can observe only the nominal interest rates. From these nominal interest rates we can derive expected real rates using inflation forecasts. The equilibrium expected rate of return on any security is the sum of the equilibrium real rate of interest, the expected rate of inflation and a security-specific risk premium.

Real versus nominal interest rates an example:
General
Fisher effect: Approximation
nominal rate = real rate + inflation premium
$R = r + i$ or $r = R – i$

Example

r = 3%, i = 6%
R = 9% = 3% + 6% or 3% = 9% - 6%

Fisher effect: Exact
r = (R - i) / (1 + i)
2.83% = (9%-6%) / (1.06)

The empirical relationship is that inflation and interest rates move closely together.

The holding period return:

$$HPR = \frac{P_1 - P_0 + D_1}{P_0}$$

HPR = Holding Period Return
P0 = Beginning price
P1 = Ending price
D1 = Dividend during period

This holding period return is always uncertain. The expected rate of return is a probability weighted average of the rates of return in each scenario. P(s) is the probability of each scenario, and r(s) is the HPR in each scenario:

$$E(r) = \sum_s p(s) r(s)$$

To quantify the volatility of this HPR, the risk, the standard deviation (square root of the variance) is used as a measure:

$$variance: \sigma^2 = \sum_s p(s) [r(s) - E(r)]^2$$

An investment decision first of all depends on the expected reward, which is the difference between the expected HPR (E(r)) and the risk free rate, which is the rate of return on a risk free asset, such as Treasury bills. This difference is called the **risk premium**.

Excess return is the actual difference between the risk free rate of return and the actual rate of return of a risky asset. The risk premium is therefore the expected value of the excess return.

Investors are said to be risk averse, which means that they always want to be compensated by a premium for taking risk.

A single period example:

Ending Price =	48
Beginning Price =	40
Dividend =	2

HPR = (48 - 40 + 2)/ (40) = 25%

Time series
The probability distributions of these rates of return must be inferred from the data at hand, historical data. The average rate of return can be calculated in two ways:

1. The Arithmetic average of rates of return, giving an unbiased estimate of the expected rate of return:
$$E(r) = \sum_{s=1}^{n} p(s)r(s) = \frac{1}{n}\sum_{s=1}^{n} r(s)$$
2. The geometric average (g) is a time-weighted average return:
$$terminal\ value = (1+g)^n = (1+r) \times (1+r_2) \times \ldots \times (1+r_n)$$

An estimate of the variance is usually based on the estimate of the expected return, the arithmetic average ($\overline{r}$). Using historical data the estimated variance looks like this:
$$\hat{\sigma}^2 = \frac{1}{n}\sum_{s=1}^{n}[r(s) - \overline{r}]^2$$
This estimate needs to be compensated for the degrees of freedom bias, which is the result of the estimation error resulting from using $\overline{r}$. It is resolved by multiplying it with n/(n-1):
$$\hat{\sigma}^2 = \left(\frac{n}{n-1}\right) \times \frac{1}{n}\sum_{s=1}^{n}[r(s) - \overline{r}]^2 = \left(\frac{1}{n-1}\right)\sum_{s=1}^{n}[r(s) - \overline{r}]^2$$

$\hat{\sigma} = \sqrt{\left(\frac{1}{n-1}\right)\sum_{s=1}^{n}[r(s) - \overline{r}]^2}$ which is the standard deviation.

The trade off between reward and risk is important and represented by the **sharpe ratio:**
$$Sharpe\ ratio = \frac{Risk\ premium}{SD\ of\ excess\ return}$$
Assuming that expectations are rational, the actual rates of return should be normally distributed around the expectations. Because the normal distribution is symmetric, stable and binary, this assumption is very practical in investment and portfolio management.

Deviations from normality are so common, that we cannot leave it undiscussed. Skew is a measure of symmetry:
$$Skew = Average\left[\frac{(R-\overline{R})^3}{\hat{\sigma}^3}\right]$$
(cubing these deviations ensures that the sign is maintained.

Kurtosis is a measure of fat tails:
$$Kurtosis = Average\left[\frac{(R-\overline{R})^4}{\hat{\sigma}^4}\right] - 3$$

Historical returns on stock have more frequent large negative deviations from the mean than would be predicted from a normal distribution.

The lower partial standard deviation (LPSD) of the actual distribution quantify the deviation from normality. The LPSD, instead of the standard deviation, is sometimes used by professionals as a measurement of risk. A more widely used measurement of risk is value at risk (VaR). VaR measures the loss that will be exceeded with a specified probability such as 5%. The VaR does not add new information when returns are normally distributed. When negative deviations from the average are larger and more frequent than the normal distribution, the 5% VaR will be more than 1.65 standard deviations below the average return.

A global view of the historical record
Historical rates of return over the twentieth century in developed capital markets suggest the US history of stock returns is not an outlier compared to other countries. The arithmetic average of the risk premiums on stocks over the period 1926-2002 is arguably too optimistic as a forecast for the long term as we can see on page 155 of BKM figures 5.8 and 5.9. Some evidence suggests returns over the later half of the twentieth century were unexpected high, and hence the full-century average is upward biased. Another argument is that the arithmetic average returns may five upward biased estimates of long-term cumulative return. Long-term forecasts require compounding at an average of the geometric and arithmetic historical means, which reduces the forecast.

Long term investments

A compounding portfolio with a terminal value has a strong positive skew. It converges to a lognormal rather than a normal distribution. In a lognormal distribution the logarithms of a variable are normally distributed. For example, if an investment has low rates of returnmm the expected rate of return of the continuously compounded investment is close to the normal rate: $r_{cc} = \ln(1+r) \approx r$. This changes however if it concerns longer periods or hinger r's.

Chapter 6 Risk and Risk Aversion

In this chapter we will discuss three themes in portfolio theory, all of them centering around risk. The first theme is that investors avoid risk and demand a reward for engaging in a risky investment. The reward is taken as a risk premium, the difference between the expected rate of return and that rate of return on a risk free investment. The second theme allows us to quantify investor's personal trade-offs between portfolio risk and expected return. To do this we introduce the utility function which assumes that investors can assign a welfare/benefit or "utility" score to any investment portfolio depending on its risk and return. Finally, the third theme is that we cannot evaluate the risk of an asset separate from the portfolio of which it is a part; that is the proper way to measure the risk of an individual asset is to assess its impact on the volatility of the entire portfolio of investments. Taking this approach, we find that seemingly risky securities may be portfolio stabilizers and actually low risk assets. In appendix A of this chapter we will describe the theory and practice of measuring portfolio risk by variance or standard deviations of returns. In Appendix B we will discuss the classical theory of risk aversion.

Risk and Risk aversion

One definition of speculation is: the assumption of considerable business risk obtaining commensurate gain. With commensurate gain we mean a positive risk premium, that is, an expected profit greater than the risk-free alternative.
By considerable risk we mean that risk is sufficient to affect the decision. Gambling is to bet with an uncertain outcome. If you compare this definition to that of speculation, you will see that the central difference is the lack of commensurate gain. Economically speaking, a gamble is the assumption of risk for no purpose but enjoyment of risk itself, whereas speculation is undertaken in spite of risk involved because one perceives a favourable risk return trade off. Hence, risk aversion and speculation are not necessarily inconsistent.

A prospect that has a zero risk premium is called a fair game. Investors who are risk averse reject investment portfolios that are fair games or worse. Risk averse investors are willing to consider only risk free or speculative prospects with a positive risk premium. In a certain way risk-averse investors penalizes the expected rate of return of a risky portfolio to account for the risk involved. We can formalize the notion of a risk penalty system. In order to do so, we will assume that each investor can assign a welfare or utility, score to competing investment portfolios based on the expected return and risk of those portfolios.

We can formulate this concept into a formula:

Utility Function
$U = E(r) - 1/2A\sigma^2$

A is the insexof the investor's risk aversion

Investors can have three different views of risk:

- risk averse: investor will consider risky portfolios only if they provide compensation for risk via a risk premium.
- risk neutral: investor finds the level of risk irrelevant and considers only the expected return of risk prospects.
- risk seeking: is willing to accept lower expected returns on

prospects with higher amounts of risk.

The utility function weighs the return and the risk, taking the risk aversion of the investor into account. Based on comparing the utility values of different scenarios an investor can make a profound decision. Simply said, portfolio A dominated B if its expected return is higher and if the risk is lower. Using this utility function, indifference curves can be drawn, comparing all possible portfolios.

Because we can compare utility values to the rate offered on risk-free investments when choosing between a risky portfolio and a safe one, we may interpret a portfolio's utility value as its "certainty equivalent "rate of return to an investor. That is, the certainty equivalent rate of a portfolio is the rate that risk-free investments would need to offer with certainty to be considered equally attractive as the risky portfolio.

Figure 6.1. on page 193 describes the trade-off between risk and return of a potential investment portfolio. We can see expected return E(r) on the y-axis and risk represented as variance on the x-axis). We say that this is the mean variance criterion. When we plot different mean variance combinations we can draw a line which results into the indifference curve as graphed in figure 6.2. on page 173.

Capital allocation across risky and risk-free portfolios
Shifting funds from the risky portfolio to the risk-free asset is the simplest way to reduce risk. Other methods involve diversification of the risky portfolio and hedging. In allocating capital across risky and risk free portfolios we consider T-bills the risk free asset and stocks as the risky asset. Issues we need to examine are risk versus return trade-off. We will demonstrate how different degrees of risk aversion affect allocation between risk free and risky assets.

The risk free asset
T-bills provide a perfectly risk free asset in nominal terms only. Nevertheless, the standard deviation of real rates on short-term T-bills is small compared to that of other assets such as long-term bonds and common stocks, so for the purpose of our analysis we consider T-bills as the risk-free asset. Money market funds hold, in addition to T-bills, relatively safe obligations such as CP and CDs. These entail some default risk, but again, the additional risk is small relative to most other risky assets. For convenience, we often refer to money market funds as risk-free assets.

Portfolio's
So investors compose complete portfolios containing both risky investments and low-risk, even risk-free, assets. Only the government can issue default-free bonds. Although such treasury bills are in fact not entirely risk-free, it is common sense to use the rates of return of treasury bills as the risk-free rate.

The rate of return of a complete portfolio is calculated as follows:
$r_C = yr_{risk} + (1-y)r_{riskfree}$
You can take expectations of this portfolio rate of return.
It can be rearranged to:
$E(r_C) = r_{riskfree} + y[E(r_{risk}) - r_{riskfree}]$
Concerning the volatility, only the standard deviation of the risky asset is relevant, and its weight:
$\sigma_C = y\sigma_{risk}$
Using that y is the division of both standard deviations, the relationship between the expected rate of return of the complete portfolio and the risk is as follows:
$$S = \frac{E(r_{risk}) - r_{riskfree}}{\sigma_{risk}}$$

S is the slope of the **capital asset allocation line** (CAL). (see page 200, figure 6.4) This line represents all the risk-return combinations available to the investor. The slope (S) is called the **reward-to-volatility ratio**. Other things equal, an investor would prefer a steeper-sloping CAL, because that means higher expected return for any level of risk. If the borrowing rate is greater than the lending rate, the CAL will be "kinked" at the point of the risky asset.

Risk tolerance and asset allocation
The investor's degree of risk aversion is characterized by the slope of his or her indifference curve. Indifference curves show, at any level of expected return and risk, the required risk premium for taking on one additional percentage of standard deviation. More risk-averse investors have steeper indifference curves; that is, they require a greater risk premium for taking on more risk.
The optimal position, y*, in the risky asset, is proportional to the risk premium and inversely proportional to the variance and degree of risk aversion:
$$y^* = \frac{E(r_P) - r_f}{.01A\sigma_P^2}$$

In other words, when we look at the optimal position of the risky asset shown as y* we can see that this is also strongly depended on A or in other words the level of risk averseness of the investor. Recall that A = 0 means a risk neutral investor and A > 0 are risk averse investors. The next step is to look for the optimal portfolio for a given level of risk aversion. To fully understand the level of risk aversion we need to construct a indifference curve to graphically plot the indifference curve for the level of risk aversion. An example of how an indifference curve can be plotted can be seen on page 208 in table 7.2. and figure 7.5, where we can see several indifference curves for a given several given levels of risk aversion. The next step is to find the optimal complete portfolio by using indifference curves. This can be graphically seen in figure 7.6 on page 209 where the tangent line of the indifference curve and the CAL depicts the optimal complete portfolio, this is also shown in table 7.3.

Passive strategies: the capital market line
A passive investment strategy disregards security analysis, targeting instead the risk-free asset and a broad portfolio of risky assets such as the S&P 500 stock portfolio. We call it a passive strategy because it describes a portfolio decision that avoids any direct or indirect security This can also be conceptually be drawn, this line is comprised by a 1-month T-bills and a broad index of common stocks and is called the capital market line (CML). There are several reasons why an investor would choose a passive strategy. The first reason is that an active strategy is not free, in involves for example research costs, analysing the different securities and buying or selling these securities, transaction costs. The second reason is the free-rider benefit. If markets work perfectly there is no need to try to outperform the market, better to hold a well diversified portfolio that represents the market, in other words if you can beat them, join them. The box on page 213 describes that passive strategies outperform active strategies.

Chapter 7 Optimal risky portfolios

In this chapter we explain how to construct that optimal risky portfolio. We begin with a discussion of how diversification can reduce the variability of portfolio returns. After establishing this basic point we examine efficient diversification strategies at the asset allocation and security selection levels. We start a simple example of asset allocation that excludes the risk-free asset. To that effect we use two risky mutual funds: a long-term bond fund and a stock fund. With this example we investigate the relationship between investment proportions and the resulting portfolio expected return and standard deviation. We then add a risk-free asset to the menu and determine the optimal asset allocation. We do so by combining the principals of optimal allocation between risky assets and risk-free assets with the risky portfolio construction methodology. Moving from asset allocation to security selection, we first generalize asset allocation to a universe of many risky securities. We show how the best attainable capital allocation line emerges from the efficient portfolio algorithm, so that portfolio optimalization can be conducted in two stages, asset allocation and security selection. We examine in two appendixes common fallacies relating the power of diversification to the insurance principal and to investing for the long run.

Diversification and portfolio risk
The reduction of risk to very low levels in the case of independent risk sources is sometimes called the insurance principal, because of the notion that an insurance company depends on the risk reduction achieved through diversification when it writes insurance policies insuring against many independent sources of risk, each policy being

a small part of the company's overall portfolio.

The risk that remains even after extensive diversification is called **market risk**, risk that is attributable to market-wide risk sources. Such risk is also called **systematic risk**, or **non-diversifiable risk**. In contrast, the risk that can be eliminated by diversification is called unique risk, firm-specific risk, non-systemic risk or diversifiable risk.

Portfolios of two risky assets
We will now move on and study efficient diversification, whereby we construct risky portfolios to provide for the lowest possible risk for any given level of expected return. We will start with considering a portfolio of two risky assets because they are relatively easy to analyze and illustrate the principal and considerations that apply to portfolios of many assets.

Return
We will consider a portfolio of two risky assets. We can formalize this as:

$r_p = w_D r_D + w_E r_E$: this is the return on such a portfolio.

Wd = Proportion of funds in Security 1
We = Proportion of funds in Security 2
rd = Expected return on Security 1
re = Expected return on Security

and the weights need to add up to 1: $\sum_{i=1}^{n} w_i = 1$
Risk

The risk of the portfolio with two risky assets can also be formalized as:
$\sigma_P{}^2 = w_D^2 \sigma_D^2 + w_E^2 \sigma_E^2 + 2 w_D w_E Cov(r_D, r_E)$
σ_D^2 = Variance of Security 1
σ_E^2 = Variance of Security 2

$Cov(r_D, r_E)$= Covariance of returns for Security 1 and Security 2

This covariance is calculated by using the correlation between security 1 and 2:
$Cov(r_D, r_E) = \rho_{DE} \sigma_D \sigma_E$
ρ_{DE} = Correlation coefficient of returns
σ_D = Standard deviation of returns for Security 1
σ_E= Standard deviation of returns for Security 2

The correlation between the two risky assets is important. Because it tells us in what way these two risky assets move together. When the securities are positively correlated they will move together. When they are negatively correlated they will move the opposite way of each other.

Portfolios of less than perfectly correlated assets always offer better risk-return opportunities than the components on their own. This is because the standard deviation is less than the weighted average of both components, as the expected return actually is. Here the diversification opportunities arise. A minimum-variance portfolio has a standard deviation that is smaller than that of either of the individual component assets. This is the effect of diversification. . In the extreme case of perfect negative correlation, there is a perfect hedging opportunity and it would be possible to construct a zero-variance portfolio.

Portfolios with different correlations:
We use assets with different correlations to reduce the risk of the overall portfolio. The correlation effects can b summarized as:
The relationship depends on correlation coefficient.
$-1.0 \leq \rho \leq +1.0$
The smaller the correlation, the greater the risk reduction potential.
If r = +1.0, no risk reduction is possible

Range of values for ρ 1,2
$+ 1.0 \geq$ r $\geq$ -1.0
If r= 1.0, the securities would be perfectly positively correlated
If r= - 1.0, the securities would be perfectly negatively correlated

The relationship of expected return and standard deviation in relation to different levels of correlation can be seen in the graph below. This graph is also called the portfolio opportunity set. Here we can clearly see the different levels of expected return associated with different levels of correlation between the two risky assets. A correlation of r = 1 achieves a lower expected return than a r = -1.

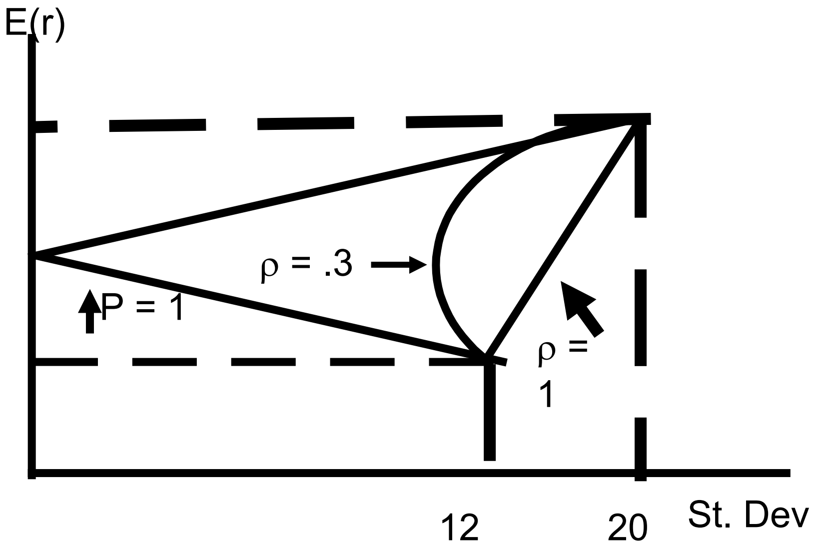


Figure 1: portfolio opportunity set

Asset allocation with stocks, bonds and bills
This is our next step in our refinement process of understanding portfolio selection. In the previous section we have looked at the simplest asset allocation decision. That involves the choice of how much of the portfolio to leave in risk-free money market securities versus in a risky portfolio. We will now take it a bit further by specifying the risky portfolio as comprised of a stock and bond fund. We will investigate this more refined selection of the risky part of the portfolio in this section.

Optimal risky portfolio with two risky assets and a risk-free asset
We will start our analysis with plotting two different capital allocation lines for two different portfolios. This can be seen in figure 7.6 on page 234 where the opportunity set of the debt and equity funds and two feasible CALs are shown. By calculating the different sharp ratios we can see which Cal dominates the other, when we calculate this we can see that portfolio B dominates portfolio A.

The next step is to think why do we stop here? We can continue to create the optimal portfolio. We do this by plotting the optimal CAL which is tangent to the opportunity set of risky assets, which is shown in figure 7.7 on page 236. P in this graph is the optimal portfolio. In practice, the process of creating an optimal risky portfolio is done with more than two risky assets we do this in a spread sheet or another computer program.

A numerical example of creating a optimal complete portfolio can be seen in examples 7.2 and 7.3 on pages 236-237 of the book. In general, we take the following steps to arrive at the complete portfolio:
`

1. Specify the return characteristics of all securities (expected returns, variances, covariances)
2. Establish the risk portfolio:
   a. Calculate the optimal risky portfolio using the following formula:
      $W1 = \sigma 1\text{^}2 \ - Cov(r_1 r_2) / \sigma 1\text{^}2 + \sigma 2\text{^}2 – 2COV(r1,r2)$

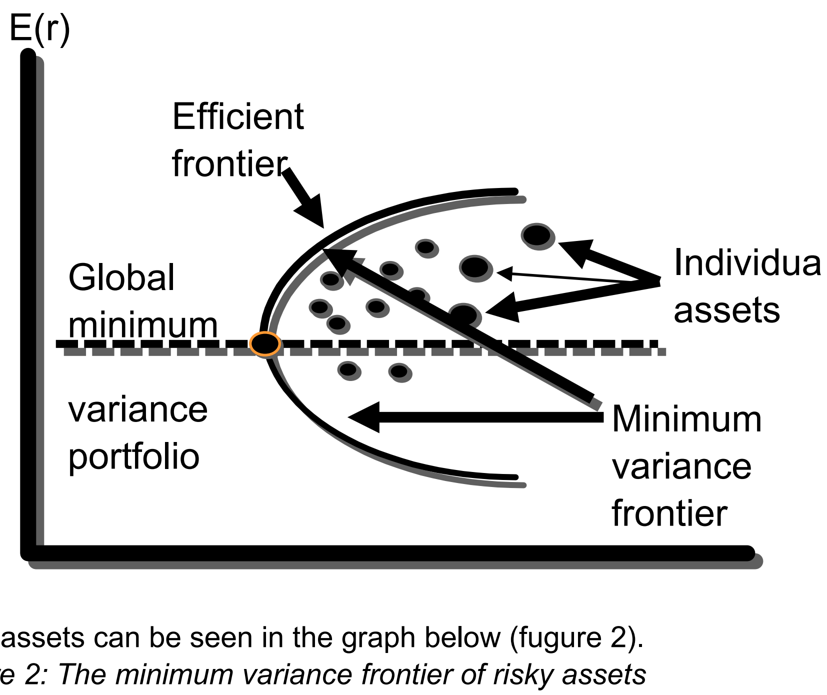
      W2 = 1-W1
   b. Calculate the properties of Portfolio P using the weights we have calculated.
3. Allocate funds between the risky portfolio and the risk-free asset:
   a. Calculate the fraction of the complete portfolio allocated to Portfolio P (the risky portfolio) and to T-bills (the risk-free asset)
   b. Calculate the share of the complete portfolio invested in each asset and in t-bills.

The Markowitz portfolio selection model

Security selection
In general, we can divide the security selection problem in three phases. First, we identify the risk-return combinations available from the set of risky assets. Second, we identify the optimal portfolio of risky assets by finding the portfolio weights that result in the steepest CAL. And third and finally, we choose an appropriate complete portfolio by mixing the risk-free asset with the optimal risky portfolio.

Harry Markowitz (1952), published a formal model of portfolio selection embodying diversification principals. For his work he received the nobel prize in 1990. His model is precisely step one of portfolio management: identification of the efficient set of portfolios or as we have seen and named the *efficient frontier of risky assets*. The critical idea behind the frontier set of risky portfolios is that, for any risk level, we are interested only in that portfolio with the highest expected return. An alternative we can view the frontier as asset of portfolios that minimize the variance of any target expected return.

In more detail, the first step is to determine the risk-return opportunities available to the investor. These are summarized by the minimum-variance frontier of risky assets. This is a graph of the lowest possible variance that can be attained for a given portfolio expected return. With data about expected returns, variances, and covariances we can calculate the minimum-variance portfolio for any targeted expected return. The plot of the minimum variance frontier of



risky assets can be seen in the graph below (fugure 2).
Figure 2: The minimum variance frontier of risky assets

All the portfolios that lie on the minimum variance frontier from the global minimum variance portfolio are candidates for the optimal portfolio. The part of the frontier that lies above the global minimum-variance portfolio is therefore called the efficient frontier of risky assets. The second step of the optimization plan involves the risk-free asset. As we can see in figure 7.11 on page 240 we can see that the portfolio P is tangent with the efficient frontier. Portfolio P is clearly the optimal portfolio. The final step, is where the individual investor chooses the optimal mix between the risky portfolio P and T-bills as we can see in figure 7.8 on page 238.

Optimal portfolios with restrictions on the risk-free asset

In this section we briefly describe how we can create an optimal portfolio with a spread sheet program like MS excel. This we can do with a data set as shown in table 7.4 and the section describes how we can plot an efficient frontier as shown in figure 7.13 with excel with the dataset.

Capital allocation and the separation property
Let us assume that we now have established the efficient frontier with excel. The next step is to introduce the risk-free asset. Whatever the preference of the client, the client will always choose portfolio P, because it is the optimal risky portfolio. The assumption with this conclusion is that the risk-free asset is available and that the input lists are identical for every investor. This result is called a **separation property**.

The separation property tells us that the portfolio choice problem may be separated into two tasks.

5. determination of the optimal risky portfolio which is a purely technical part. Given the manager’s input list (list of securities), the best risky portfolio is the same for all clients, regardless of risk aversion.
6. allocation of the complete portfolio to T-bills versus risky portfolio depends on personal preferences in this part of the task the client is the decision maker.

The critical point is that the optimal portfolio P that the manager offers is the same for all clients. This result makes professional management more efficient and hence less costly. In practice however the differentiating factor of great portfolio managers and the rest is the quality of security analysis in other words the input list analysis as the universal rule also applies here garbage in is garbage out. This is the factor that makes great versus poor portfolio managers.

Asset allocation and security selection
We have seen that the that the theories of asset allocation and security selection are identical. So the next logical question is: Why do we make a distinction between asset allocation and security selection? There are three reasons:

5. There is a great need and ability to save (pensions, healthcare, college etc.), the demand for sophisticated investment management has increased enormously.
6. The widening spectrum of financial markets and financial instruments has put sophisticated investment beyond the capacity of many amateur investors.
7. There are strong economies of scale in investment analysis. The result is that the size of a competitive investment company has grown with the industry, and efficiency in organization has become an important issue.

Long term risk diversification

Risk pooling is the collection of uncorrelated assets in one portfolio. This is widely seen as the insurance principle, but it is based on the misunderstanding that adding several bets would reduce the risk. Despite the fact that risk pooling benefit from uncorrelatedness, it does not reduce risk by itself. Risk only increases less than proportionally to the number of securities. The probability of loss however does diminish.

Risk sharing is selling shares in an attractive risky portfolio to limit risk an yet maintain the profitability of the resultant position. Risk sharing combined with risk pooling is the key to the insurance industry. Adding insurance policies increases the sharpe ratio, or the profitability, and steadily reduces the risk to each shareholder.

Chapter 8 Indexing

Single-factor model
This chapter introduces index models that simplify estimation of the covariances and greatly enhances analysis if risk premiums. Risk is explicitly decomposed in systematic and unsystematic risk. This simplifies the analysis because positive covariances among security returns arise from common economic forces that affect the fortunes of most firms, for example business cycles, interest rates or natural resources. Covariances and correlations are more easily estimated now.

We assume in the single factor security market that just one variable drives the normally distributed returns. Statistical implications of this normality assumption give the following model:
$r_i = E(r_i) + \beta_i m + e_i$

Whereas,

- r_i is rate of return on security i,
- $E(r_i)$ is the expected rate of return on security i,
- e_i is the unexpected component of the rate of return on security i,
- m is a parameter measuring macroeconomic components, unanticipated macro surprises,
- β_i is the sensitivity coefficient of the specific security i (relating to a specific firm, some respond differently to m than others).

This beta coefficient gives the sign of the systemic risk. Cyclical firms for example respond greater to the market, resulting in a higher beta.

Total risk of security i is given by a composition of beta and standard deviations:
$\sigma_i^2 = \beta_i^2 \sigma_m^2 + \sigma^2(e_i)$

Also the covariance between a pair of securities is determined by its beta's:
$Cov(r_i, r_j) = Cov(\beta_i m + e_i, \beta_j m + e_j) = \beta_i \beta_j \sigma_m^2$

Single-index model

The single index model uses the market index to estimate the common macroeconomic factor. Since the model is linear, the beta coefficient of a security can be estimated using single-variable linear regression. The basis is regressing the excess return of a security i on the excess return of the market index using historical data (from for example the S&P500):

$R_i(t) = \alpha_i + \beta_i R_M(t) + e_i(t)$

Whereas,

- R_i is the excess return of a security i
- α_i is the expected excess return when the market excess return is zero,
- β_i is the security's sensitivity to the market index,
- R_M is the excess return of the market index,
- e_i is the residual, the estimation error, with $E(e_i) = 0$.

Taking expectations of this model results in the following:

$E(R_i) = \alpha_i + \beta_i E(R_M)$

The first term (alpha) on the right hand side is the **nonmarket risk premium**. The second part, derived from the market risk premium, is the **systemic risk premium**.

This model simplifies the analysis because less separate coefficients need to be estimated. This model also enables specialization of effort in the analysis. The model however simplifies the World of risks, dividing them into a Sharp dichotomy: market versus firm-specific risk.

Estimating the model

Page 283 until 289 describe the simplified estimation process of the model using six large corporations. The regressions of the rate of returns of these (six in total) corporations describe the **security characteristic line (SCL)**, drawn through a scatter diagram. (basic econometrics)

This regression is complemented by an analysis of the variance (ANOVA), the estimate of the alpha, the estimate of the beta, and the covariance and correlation matrix.

Portfolio Construction

In the context of portfolio Construction the alpha term is crucial. The beta's are widely known and standardized. A sound estimation of the alpha however tells the manager if the security is good or bad. Intuitively: a positive alpha provides a premium on top of the premium that would result from following macroeconomic movements.

To optimize a portfolio, the goal is to maximize the Sharpe ratio. The procedure is summarized as follows:

1. Compute the initial position of the securities in weights: $w_i^0 = \alpha_i / \sigma^2(e_i)$
2. Scale them: $w_i = \frac{w_i^0}{\sum_{i=1}^n w_i^0}$
3. Compute the alpha of the active portfolio: $\alpha_A = \sum_{i=1}^n w_i \alpha_i$
4. Compute the residual variance of the active portfolio: $\sigma^2(e_A) = \sum_{i=1}^n w_i^2 \sigma^2(e_i)$
5. Compute the initial position of the active portfolio:

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

6. Compute the beta of the active portfolio: $\beta_A = \sum_{i=1}^n w_i \beta_i$
7. Adjust the initial position in the active portfolio:

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

8. The optimal portfolio now has weights: $w_M^* = 1 - w_A^*$ and $w_i^* = w_A^* w_i$
9. Calculate the premium of the optimal portfolio from the premium of the index portfolio and the alpha of the active portfolio:

   $$E(R_P) = (w_M^* + w_A^* \beta_A) E(R_M) + w_A^* \alpha_A$$

10. Compute the variance of the optimum:

   $$\sigma_P^2 = (w_M^* + w_A^* \beta_A)^2 \sigma_M^2 + [w_A^* \sigma(e_A)]^2$$

Practical aspects
The full Markowitz model would be a better model in principle, since all necessary estimations would have to be made. However the great number of possible estimation errors cumulatively could account for a major failure. The single-index framework has a clear practical advantage.

Another practical issue is the estimation of betas. betas seem to drift toward 1 over time, meaning that estimating a beta based on past betas is usually not the best option. Forecasting models have been developed that use regression to estimate the beta's from various variables, such as variance of earnings, market capitalization, and dividend yield or debt-to-asset ratio.

Beta capture is the procedure of constructing a **tracking portfolio** which has the same beta as the portfolio of interest. This tracking portfolio captures the systemic risk. Buying this tracking portfolio short combined with the portfolio of interest long, the systemic risk is cancelled out. This is characteristic for many hedge funds.

Chapter 9 CAPM

The capital asset pricing model (CAPM) is the core of modern finance. It provides a prediction of the relationship between risk and expected return that should be observed. As such it is a benchmark and it provides ground for educated guesses on non-traded securities.

The model
The model is based on six assumptions:

1. Perfect competition: there are many investors with each a small fraction of the total endowments, which implies that they are price takers.
2. Investors show myopic behavior: they plan for one identical holding period.
3. They can only invest in publicly traded Financial assets. They may borrow at a fixed risk-free rate.
4. No taxes or transaction costs exist.
5. All investors are rational mean-variance optimizers, using the Markowitz portfolio selection model.

6. Homogeneous expectations: all investors have identical estimates of the probability distributions.

Although these assumptions are often not realistic, they provide insight in many real-world complexities.

These assumptions will result in the following equilibrium:

- All investors will choose to hold a risky portfolio in the same proportions as the market portfolio (M) is composed. M is on the efficient frontier. This results logically from the assumptions above, since if all investors have identical information and identical analytical tools, they will hold the same portfolio. Consequently this has to be M.

- The capital market line (CML) is the best capital allocation line (CAL).

- The risk premium on M will be proportional to its risk and the risk aversion of the investor: $E(r_M) - r_f = \overline{A}\sigma_M^2$ where $\overline{A}$ is the average degree of risk aversion, and σ_M^2 is the variance of the market portfolio (or in this case the systemic risk of the universe).

- The risk premium on individual assets will be proportional to the risk premium on M. Beta measures the extent to which returns on the stock and the market move together: $\beta_i = \frac{Cov(r_i, r_M)}{\sigma_M^2}$. So the risk premium on individual securities is:
$$E(r_i) - r_f = \frac{Cov(r_i, r_M)}{\sigma_M^2}[E(r_M) - r_f] = \beta_i[E(r_M) - r_f].$$

The **mutual fund theorem** is the result that the passive strategy of investing in a market index portfolio is efficient. If this is true, it would imply that attempts to beat the passive strategy only generates trading and research costs with no offsetting benefits. However, in the real world, investors do choose different portfolios from M.

The **market price of risk** is the extra return that investors demand to bear portfolio risk. It is represented by the following ratio:
$$\frac{market\ risk\ premium}{market\ variance} = \frac{E(r_M) - r_f}{\sigma_M^2}$$

A basic principle of equilibrium is that all investments should offer the same reward-to-risk ratio, otherwise trading a rearranging would be beneficial. That is why the reward-to-risk ratio of an individual security needs to equal the market price of risk.

$$\frac{E(r_M) - r_f}{\sigma_M^2} = \frac{E(r_i) - r_f}{Cov(r_i, r_M)}$$

Rearranging terms results in the **expected return-beta relationship:**

$$\boldsymbol{E(r_i) = r_f + \beta_i[E(r_M) - r_f]}$$

In which β_i is the ratio that measures the contribution of this individual security to the variance of the market portfolio as a fraction of the total variance of the market portfolio:

$$\beta_i = \frac{Cov(r_i, r_M)}{\sigma_M^2}.$$

If this holds for every i, this would have to hold for the entire portfolio.
This expected return-beta relationship can graphically be represented by the **security market line (SML)**, see figure 9.2 on page 317. The SML graphs the individual asset risk premiums as a function of asset risk. Relevant in this case is the contribution of the asset to the portfolio variance, measures by beta. The capital market line (CML) in contrast graphs the risk premiums of efficient portfolios as a function of portfolio standard deviation.

Practicality of CAPM
Testing the implication of CAPM is difficult. First of all because all traded risky assets would need to be considered, which is immense. Second, the CAPM implies relationships among expected returns and such expected values are never actually observed.

A model, consisting of assumptions, logical/mathematical manipulation of these assumptions, and predictions, can be tested normatively and positively. Normative tests test the assumptions, positive tests test the predictions. Few models can pass the normative test. In case of the CAPM the positive test implies testing the efficiency of the market portfolio and the accurateness of security market line. The principle problem with testing these, is that the market portfolio M is unobservable.

This leaves us with empirical tests of the expected return-beta relationship, but the CAPM miserably fails these tests.

Despite its empirical shortcomings, the CAPM is the accepted norm in the US and other developed countries. The first reason is that the theoretical decomposition of systematic risk from firm-specific risk is compelling. Second, there is impressive evidence that the central conclusion of CAPM, which is the efficiency of M, may be close to truth.

Extensions of CAPM
Greater accuracy could be gained by adding complexity to the model.

Zero-beta model
Efficient frontier portfolios have some interesting implications:

- A combination of two efficient frontier portfolios is in itself efficient.
- The expected return of any asset can be expressed as an exact linear function of the expected return on any two efficient-frontier portfolios P and Q:
$$E(r_i) - E(r_Q) = [E(r_P) - E(r_Q)]\frac{Cov(r_i,r_P)-Cov(r_P,r_Q)}{\sigma_P^2-Cov(r_P,r_Q)}$$
- Every portfolio on the efficient frontier has a companion portfolio (**the zero-beta portfolio**) on the inefficient half of the frontier, which is uncorrelated. Choosing M and its zero-beta companion Z, then :
$$E(r_Q) - E(r_Z) = [E(R_M) - E(R_Z)]\frac{Cov(r_i,r_M)}{\sigma_M^2} = \beta_i[E(r_M) - E(r_Z)]$$
which resembles the SML of CAPM.

Labor income
Two important assets are not traded, human capital and privately held businesses. Such capital is less portable across time and thus may be more difficult to hedge with using traded securities. Such facts may put pressure on security prices and results in departures from CAPM.

Multiperiod model
Robert C. Merton has relaxed the assumption of myopic investors. He envisions investors who optimize a lifetime consumption or investment plan and who adapt their decisions to changes. His model however predicts the same expected return-beta relationship when the only source of risk is the

uncertainty about portfolio returns. Other sources of risk could be changes in the parameters such ask the risk-free rate or expected returns. Another possibility would be the prices of consumption goods, inflation risk for example. All these risks would require hedging activities, highly complicating the model.

Consumption based CAPM

It might be useful to center the model on consumption, assuming that an investor would try to optimally smooth maximum consumption. In a lifetime consumption plan, he must in each period balance the allocation of current wealth between today's consumption and the savings and investment that will support future consumption. When optimized, the utility value from an additional dollar of consumption today must be equal to the utility value of the expected future consumption that can be financed by that additional dollar of wealth.
Investors will value additional income more highly during difficult economic times. An asset will therefore be viewed as riskier in terms of consumption if it has positive covariance with consumption growth. Equilibrium risk premiums will be greater for assets that exhibit higher covariance with consumption growth.

Liquidity

The liquidity of an asset is the ease and speed with which it can be sold at fair market value. Illiquidity is measures by the discount that a seller must accept if the asset is to be sold quickly. Liquidity is increasingly seen as an important determinant of prices. Investors are likely to act on expected liquidity constraints or changes in such constraints. Liquidity premises might change unexpectedly as well. Therefore, investors may demand compensation for their exposure to liquidity risk.

Chapter 11 The efficient market hypothesis

Random walk & EMH

The efficient market hypothesis (EMH) is the notion that stocks already reflect all available information. As market participants try to anticipate on all available information, in principle stock prices should contain all information that could possibly be used to predict them. Consequently stock prices that respond to information must move unpredictably. Prices should follow a **random walk**.

The *weak-form* of the EMH asserts that stock prices already reflect all information that can be derived by examining market trading data. The *semi strong-form* states that all publicly available information regarding the prospects of a firm must be reflected already in the stock price. The *strong-form* of the hypothesis, the most extreme position, claims that all information relevant to a firm is reflected.

Implications

The EMH implies that technical analysis is of no merit. Technical analysis is the search for recurrent and predictable patterns in stock prices. Well-known concepts of such technical analysis are *resistance levels* and *support levels*, respectively probable upper and lower levels of stock prices.
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. Just as technical analysis, most fundamental analysis is useless following the reasoning of EMH. The trick is to identify firms that are better than everyone else's estimate.

Proponents of the EMH are advocates of passive investment strategy, because the costs of active management is unlikely to be compensated by benefits. Such passive management simply aims for a well-diversified portfolio of securities. One common strategy is creating an index fund, designed to replicate the performance of a broad-based index.

Even in an efficient market there is a role for portfolio management. Optimal positions depend on such things as tax, risk aversion and employment. The role of the portfolio manager is to adjust the portfolio to these factors, not to beat the market.

Event studies

An event study is empirical financial research to assess the impact of a certain event on a firm's stock price. The general approach commences with an estimate of the stock price if the event would not have occurred. The abnormal return is then the difference between the actual return and this benchmark.
Index models are widely used to estimate these abnormal returns. Rewriting the mathematical formula for stock return ($r_t = a + br_{Mt} + e_t$) gives the following equation to estimate:
$e_t = r_t - (a + br_{Mt})$

Whereas

- e_t is the part of a security's return resulting from firm-specific events,
- r_t is the actual rate of return of this stock,
- r_{Mt} is the return on the market portfolio,
- b is the sensitivity of this particular stock to market return,
- a is the average rate of return the stock would realize in a period with a zero market return.

This model can be easily upgraded to include all kinds of sophisticated factors. Estimation of the parameters a and b is a delicate issue. The standard estimate of abnormal return is easily complicated by leakage of information. The **cumulative abnormal return** is a better measure in such a case. Event studies are widely used nowadays.

Efficiency

EMH has never been widely accepted on Wall Street. Three important issues are important: the magnitude issue, the selection bias issue and the lucky event issue. With these in mind, we can discuss the empirical test of EMH.

Weak-form tests

One way of finding trends in stock prices is measuring the serial correlation of returns. This reflects the tendency of returns to be related to past returns. Broad market indexes only reflect very weak serial correlation. There seems to be a stronger relationship across specific sectors.

Some studies have shown the predictive power of particular easily collected variables. On the one hand this could imply the violation of the EMH. On the other hand, such variables probably account for variation in market return.

Semi strong-form

Fundamental analysis is always in line with the semi strong-form of the hypothesis, since fundamental analysis uses publicly available information to clarify and predict stock prices. Examples of such fundamental analysis and its findings are the small-firm effect, the neglected-firm effect, the book-to-market effects, and the post-earnings-announcement price drift.

Strong-form
It is very common sense that insiders are able to make superior profits trading in their own stock. This practice is regulated and limited. This however implies that the strong-form of the hypothesis is not very likely to appear.

Anomalies
Lots of literature has been produced on the anomalies of the financial markets. Are these markets just inefficient? Some argue that the anomaly effect named above are actually in line with efficiency and just reflect manifestations of risk premiums. The opposite interpretation is also provided, claiming that these effects are proof of inefficiency.

Prices can also lose their grounding in reality. Such bubbles show prices that depart from any semblance of intrinsic value. These bubbles are usually only acknowledged in retrospect.

Market professionals
Can market professionals outperform the passive index funds? This provides a short discussion of the professionals, stock market analysts and mutual fund managers.

Stock market analysts recommend investment positions based on their analysis. Only the relative performance of these analysts is really of interest. Literature suggests that they add some value, but ambiguity remains. The same accounts for mutual fund managers, who actually manage portfolios.

Chapter 12 behavioral finance and technical analysis

Behavioral finance is a relatively new school in finance, arguing that the literature on finance strategies has overlooked the most important point: the correctness of security prices. Conventional financial theory ignores how people really make decisions. Behavioral finance starts with the assumption that investors might not be rational. Irrationalities fall into two categories: people do not always process information correctly, and people make often inconsistent decisions.

1. Information processing: this leads to misestimating of probabilities. Four important biases have been identified.

a. Investors make forecasting errors.

b. Investors tend to overestimate their own insights and abilities.

c. Investors are slow in updating their beliefs in response to new evidence (conservatism)

d. Investors to quickly trust information inferred from relatively small samples (representativeness).

2. Behavioral biases

    a. Decisions are affected by the framing of an issue.

    b. Mental accounting: investors treat cases differently or separately per case.

    c. Investors experience greater regret when they failed in some unconventional case.

    d. Prospect theory modifies the analytic description of rational risk averse investors found in standard financial theory.

3. The above biases would not lead to inefficient markets if some rational arbitrageurs would operate. For the following reasons, such arbitrage is limited:

    a. There is always a degree of fundamental risk.

    b. Implementation costs limit possibilities.

    c. There is always a risk in trusting on models.

    d. Even the law of one price is in some cases violated (see pages 416 to 418)

Behavioral finance is not uncontroversial yet. It does make important points on the limits of rationality. It however does not provide investment opportunities based on its insights, for example. Some believe that the behavioral critique is too unstructured.

Technical analysis
Technical analysis attempts to exploit recurring and predictable

patterns in stock prices to generate superior investment performance. This section discusses the relation between technical analysis and behavioral finance. Technical analysis reflects all kinds of behavioral biases.

Technical analysis mostly uncovers trends. **Dow theory** is one of the oldest of trend analysis. According to Dow, three major trends influence stock prices:

1. Primary trend: long term
2. Secondary or intermediate trend: short term deviations, usually corrected.
3. Tertiary or minor trend: daily fluctuation of little importance.

This model is built on the notion of predictability. EHM argues however that in this case investors would exploit these possibilities, affecting the prices and resulting in a self-destructing strategy. These trends are thus only observed after the fact.

Two other measures are (1) the moving average, and (2) the breadth, a measure of the extent to which movements in the market index are reflected widely in the price movements of all the stocks in the market.

There are three indicators of the investor's sentiment to be named here:

1. Trin statistic: when rising prices go with rising volumes, technicians consider the market advances to be favorable. The trin statistic is such a measure:

   $$Trin = \frac{Volume\ declining\ /Number\ declining}{volume\ advancing/\ number\ advancing}$$

2. Confidence index is the ratio of the average yield on 10 top-rated corporate bonds divided by the average yield on 10 intermediate-grade corporate bonds.

3. Put/call ratio is the ratio of outstanding put options to outstanding call options. Because put options do well in falling markets while for call options it's the other way around, deviations of the ratio from historical data are considered to be a signal of market performance.

Chapter 13 Empirical evidence on security returns

The index model and the single-factor APT
The mostly tested implication of the CAPM and APT models is the expected return-beta relationship of a security:
$E(r_i) = r_f + [E(r_m) - r_f]\beta_i$

To test this condition 3 steps are necessary:

1. *Setting up the sample data*: first determine a sample period (e.g., 5 years), divide it in subperiods (e.g. months), and for each of them you collect the rate of return of a chosen number of stocks (r_{it}). Over the sample period you store also a market-portfolio proxy, e.g. S&P 500 (r_{Mt}) and 1-month risk-free T-bills (r_{ft}).
2. *Estimating the SCL*: interpret the equation above as a security characteristic line. For each stock you estimate the beta coefficient as the slope of the *first-pass regression* (there will be a second one later):
   $r_{it} - r_{ft} = a_i + b_i(r_{Mt} - r_{ft}) + e_{it}$
   then you compute the following statistics for the next step:
   $avg(r_i - r_f) = sample\ average\ of\ the\ excess\ return\ for\ each\ stock$
   $b_i = sample\ estimate\ of\ the\ beta\ coeff.\ for\ each\ stock$
   $avg(r_M - r_f) = sample\ average\ of\ the\ excess\ return\ of\ the\ market\ index$
   $\sigma^2(e_i) = estimate\ of\ the\ variance\ of\ the\ residuals\ for\ each\ stock$
   .
3. *Estimating the SML*: interpret the equation above as a security market line. Here you estimate coefficient for the *second-pass regression*:
   $avg(r_i - r_f) = \gamma_0 + \gamma_1 b_i$
   You should find the conclusion that, if the CAPM is valid, this last estimated coefficient should satisfy
   $\gamma_0 = 0$ and $\gamma_1 = avg(r_M - r_f)$

Myller and Scholes constructed this test using annual data on 631 NYSE stocks for 10 years. The results were inconsistent with CAPM. It turns out that there were several difficulties with this approach. Firstly, the extreme volatility of stock returns make any test of average return problematic and less precise. Another source of errors is that the market index used is not the market portfolio of the CAPM. Moreover, the second-pass regression uses coefficients estimated on the first-step regression, having substantial sampling errors.
Now we investigate the implications of these problems.
The market index
Richard Rolled pointed out that the usual CAPM test is a test of the mean-variance efficiency of a market proxy and therefore tests of the linearity of the expected return-beta relationship cannot be transferred to validate the CAPM model.
Measurement error in beta

Scholes made new tests to overcome the measurement problem described above. He decided to use portfolios rather than individual securities to estimate the betas. Those betas were then estimated with more precision, because combining securities into portfolios cancels out most of the specific-firm part of the return on the portfolio of securities.
The negative consequence is that this process reduces the number of observations for the second-pass regression (e.g.: if you combine 100 stocks in 5 portfolios, then you'll have 5 observation for the second step).
Therefore, a good trade-off must be set to have reliable results. One way is to construct portfolios with the largest possible dispersion of the beta coefficients. If we have a great dispersion of market returns, we have more chance on properly estimating the effect of a change in the market return on the return of the stock.
This test, in the end, provides mixed evidence on the validity of the theory:

1. The expected rate of return increases linearly with beta
2. The expected rate of return is not affected by non-systematic risk.

The bottom line is that the CAPM model seems qualitatively correct, but empirical tests do not validate its quantitative predictions.
The EMH and the CAPM
Roll also pointed out that the return-beta relationship follows directly from the efficiency of the market portfolio. You need to test if the market is efficient, because CAPM and APT depend on this attribute. The only (weak) proof of the efficiency of the market is that S&P500 and the NYSE index have shown to be difficult to beat by professional investors.
Accounting for human capital and cyclical variations in asset betas
The above mentioned tests have two important deficiencies:

1. They do not take into account human capital (which is a non-traded asset)
2. They do not take into account that betas are cyclical

For these reasons, conventional first-pass estimates of security betas are affected by big errors. They do not capture cyclicality of stock returns and thus they are less accurate in measuring the systematic risk of stocks.
However, it may be possible to replace the simple betas with better estimates of systematic risk and transfer the explanatory power of instrumental variables such as size and the default premium to the index rate of return.
Tests of multifactor CAPM and APT
Multifactor CAPM and APT models are including which factors ought to result in risk premiums. There are three stages to test this hypothesis:

1. Specification of risk factors
2. Identification of portfolios that edge the chosen risk factors
3. Test of explanatory power and risk premiums of the hedge portfolios

The regression steps are made just as in the single factor model.
The Fama-French three-factor model
The systematic factors of this model are firm size, book-to-market ratio and the market index.
To make the model operational we take two steps:

- We measure the risk factor in each period as the differential return on small firms versus large ones. This is the SMB (small minus big) factor.
- The other extra-market factor is measured as the return of dfirms with high book-to-market ratios minus that on firms with a low ratio. This is the HML (high minus low) factor.

This is the three-factor asset-pricing Fama-French model:
$E(r_i) - r_f = a_i + b_i[E(r_m) - r_f] + s_i E[SMB] + h_i E[HML]$

The coefficients b_i, s_i and h_i are the betas on each factor. They are called *factor loadings*.
In the end, if the arbitrage pricing model is correct, the return should be fully explained by factors, and thus the intercept of the equation should be zero. To test this, Fama and French form nine portfolios with a range of sensitivities to each factor. They sorted the firms into three size group (small, medium, large) and three book-to-market groups (high, medium, low).
Their results were the following:

1. The intercepts a_i were small and in general statistically insignificant
2. Large R-squared, which shows that the three factors explain the rates of return well
3. Large t-statistics on size and value, which shows that these factors contribute significally to explanatory power.

Consumption-based asset pricing and the equity premium puzzle
The "puzzle" refers to a lack of consensus among economists on why the demand for bonds is so high, given the small return they provide with respect to stocks. An intuitive answer could be that stocks are much more risky than bonds. This is correct, but insufficient to explain the disparity between the two returns (i.e. the equity risk premium), which implies a level of risk aversion beyond reason.
Proposed explanation
Here we list a number of proposed explanations to this puzzle

1. Survivorship bias: the US market was the most successful stock market in the 20th century. Other countries displayed lower long-run returns. Picking the best observation (US) from a sample leads to biased estimates of the premium. Moreover, other countries' markets are weaker than the US one, and firms can come and go before the end of the study. It is essential to take this risk into account to have a truly unbiased and explanatory model.
2. Fama and French show that the puzzle emerges because of excess returns on the last 50 years.
3. The puzzle exists because the common practice of computing risk does not properly account for liquidity risk, only for the volatility of returns.
4. Behavioral explanation: the puzzle is an outcome of irrational investor behavior. In experimental settings it was observed that investors value every risk they take in isolation, i.e. without considering if a correlation between them exists. therefore, they require a higher risk premium.

Chapter 14 Bond Prices and Yields

We will start with analysing debt securities. A debt security is a claim on a specified periodic stream of income. Debt securities are often called fixed-income securities, because they promise a (fixed) stream of income that is determined according to a specified formula. These securities have the advantage of being relatively easy to understand because the payment formulas are specified in advance. Risk considerations are minimal as long as the issuer of the security is sufficiently creditworthy.

The bond is the basic debt security. We will start with an overview of the universe of bond markets. This includes Treasury, corporate, and international bonds. We next turn to bond pricing, showing how bond prices are set in accordance with market interest rates and why bond prices change with those rates. Given this background we compare the different measures of bond returns such as yield to maturity, yield to call, holding-period return or realized compound yield to maturity. We show how bond prices evolve over time. Finally we consider the impact of default or credit risk on bond pricing and look at the determinants of credit risk and the default premium built into bond yields.

Bond characteristics
A bond is a security that is issued in connection with a borrowing arrangement. The borrower issues (i.e., sells) a bond to the lender for some amount of cash; the bond is a “IOU” of the borrower. The arrangement obligates the issues to make specified payments to the bondholder on specified dates. A typical coupon bond obligates the issuer to make semiannual payments of interest to the bondholder for the life of the bond. These are called coupon payments. When the bond matures, the issuer repays the debt by paying the bondholder the bond’s par value another word for par value is face value. The coupon rate of the bond serves to determine the interest payment: the annual payment is the coupon rate times the bond’s par value. The coupon rate, maturity date, and par value of the bond are part of the bond indenture, which is the contract between the issuer and the bondholder.

Bonds are usually issued with coupon rates set high enough to induce investors to pay par value to buy the bond. Sometimes, however, zero-coupon bonds are issued that make no coupon payments. In this case, investors receive par value at the maturity date but receive no interest payment until then. The bond has a coupon of zero. This type of bond is issued at priced considerably below par value, and the investor's return comes solely from the difference between issued price and the payment of par value at maturity.

Treasury bonds and notes
Figure 14.1 on page 468 is an excerpt from the listing of treasury issues of the Wall Street Journal. Aside from the differing initial maturities, the only major distinction between T-notes and T-bonds is that in the past, some T-bonds were callable for a given period. The US treasury no longer issues callable bonds, but some previously issued callable bonds still outstanding. Page 468 explains how to read a bond price quote in the Wall Street Journal (WSJ).

Accrued interest and quoted bond prices. The bond prices that you see quoted in the financial pages are not the actual prices that investors pay for the bond. This is because the quoted price does not include the interest that accrues between coupon payment dates.

In general, the formula for the amount of accrued interest between two dates is:

Accrued interest = (Annual coupon payment / 2) × (days since last coupon payment/ dayssseparating coupon payments)

Corporate bonds. These are bonds issued by corporations. An example is given in figure 14.2 on page 451 here you can a sample from the WSJ.

- *Call provisions on Corporate bonds.* The US treasury no longer issues callable bonds, some corporate bonds are issued with call provisions allowing the issuer to repurchase the bond at a specified call price before the maturity date. The option to call the bond is valuable to the firm, allowing it to buy back the bond and refinance at lower interest rates when market rates fall

- *Convertible bonds.* These bonds give bondholders an option to exchange each bond for a specified number of shares of common stock of the firm. The conversion ratio is the number of shares for which each bond may be exchanged.

- *Puttable bonds.* While the callable bond gives the issuer the option to extend or retire the bond at the call date, the extendable or put bond gives this option to the bond holder.

- *Floating-rate bonds.* These bonds make interest payments that are tied to some measure of current market rates.

Preferred Stock. Although preferred stock strictly speaking is considered to be equity, it often is included in the fixed-income universe. This is because like bonds preferred stock promises to pay a specified stream of cash in the form of dividends.

Other Issuers*.* There are also other issuers of bonds. For example local governments and federal agencies as discussed in chapter 2.

International Bonds. International bonds can be divided into two categories: foreign bonds and Eurobonds. Foreign bonds are issued by a borrower from a country other than the one in which the bond is sold. The bond is denominated in the currency of the country in which it is market. Foreign bonds sold in the US are called Yankee bonds, for example German BMW issues a bond in dollars in the US are called Yankee bonds. Foreign bonds in Japan are called Samurai bonds and foreign bonds in the UK are called bulldog bonds.

Innovation in the bond market. Below we will describe some innovations in the bond market:

- *Inverse floaters.* These are similar to the floating bonds, except that the coupon rate on these bonds falls when the general level of interest rises. Investors in these bonds suffer doubly when rates rise.

- *Asset-backed Bonds***.** An example BMW has issued bonds with coupon rates tied to the financial performance of the firm. This is what is meant with asset backed bonds.

- *Catastrophe bonds***.** An example Winterthur (the insurer) has issued a bond whose payment depend on whether there has been a sever hailstorm in Switzerland. The bond is a way to transfer “catestrophe risk” from the firm to the capital markets.

- *Indexed Bonds*. Indexed bonds make payments that are tied to a general price index or the price of a particular commodity. For example Mexico has issued 20-year bonds with payments that depend on the price of oil.

Bond pricing
A bond's coupon and principal payment all occur months or years in the future, the price an investor would be willing to pay for a claim to those payment depends on the value of dollars to be received in the future compared to dollars in hand today. This sort of present value calculation depends in turn on market interest rates. The nominal risk-free interest rate equals: 1) a real risk-free rate of return 2) a premium above the real rate to compensate for expected inflation. In addition a premium reflects bond specific characteristics such as default risk, liquidity, tax attributes, call risk etc. To value a security we discount its expected cash flows by the appropriate discount rate.

Bond value = Present value of coupons + Present value of par value

$$P_B = \sum_{t=1}^{T} \frac{C_t}{(1+r)^T} + \frac{ParValue_T}{(1+r)^T}$$

PB	=	price of the bond
Ct	=	interest or coupon payments
T	=	number of periods to maturity
y	=	semi-annual discount rate or the semi-annual yield to maturity

An example:

What is the price of the bond?

We know:
10 year bond
Face value or Par value 1000
8% Coupon

Calculations:
$$P = 40\sum_{t=1}^{20} \frac{1}{(1.03)^t} + \frac{1000}{(1.03)^{20}}$$
$$P = \$1,148.77$$

Ct = 40 (SA)
P = 1000
T = 20 periods
r = 3% (SA)

An important insight is that with a higher interest rate, the present value of the payments to be received by the bondholder is lower. Therefore, the price of the bond will fall as market interest rates rise. This illustrates a crucial general rule in bond valuation. When interest rates rise, bond prices must fall because the present value of the bond's payments are obtained by discounting at a higher interest rate.

Figure 14.3 on page 476 explains the inverse relationship between bond prices and yields. The price of an 8% coupon bond with 30-year maturity making semiannual payments. An important insight from this figure is that the shape of the curve implies that an increase in the interest rate results in a price decline that is smaller than the price gain resulting from a decrease of equal magnitude in the interest rate. This property of bond prices is called convexity because of the convex shape of the bond price curve. This curvature reflects the fact that progressive increases in the interest rate result in progressively smaller reductions in the pond price. Therefore, the price curve becomes flatter with higher interest rates. Prices and Yields (required rates of return) have an inverse relationship

We can say that when yields get very high the value of the bond will be very low. When yields approach zero, the value of the bond approaches the sum of the cash flows.

A general rule in evaluating bond price risk is that, keeping all other factors the same, the longer the maturity of the bond, the greater the sensitivity of price to fluctuations in the interest rate. This is also the reason why short-term Treasury securities such as T-bills are considered to be the safest. They are free not only of default risk but also largely of price risk attributable to interest rate volatility.

Bond yields
We would like a measure to rate of return that accounts for both current income and the price increase or decrease over the bond's life. The yield to maturity is the standard measure of

total rate of return. The yield to maturity is defined as the interest rate that makes the present value of a bond's payments equal to its price.

In Formula:

$$P_B = \sum_{t=1}^{T} \frac{C_t}{(1+r)^T} + \frac{ParValue_T}{(1+r)^T}$$

An example:

$$950 = \sum_{t=1}^{20} \frac{35}{(1+r)^t} + \frac{1000}{(1+r)^T}$$

10 yr Maturity Coupon Rate = 7%
Price = $950
Solve for r = semiannual rate

Answer: r = 3.8635%

The financial press reports on an annualized basis, and annualizes the bond's semiannual yield using simple interest techniques, resulting in an annual percentage rate, or APR. Yields annualized using simple interest are also called "bond equivalent yields". Therefore, the semiannual yield would be doubled and reported in the newspaper as a bond equivalent of 6%. The effective annual yield of the bond, however, accounts for compound interest. If one earns 3% interest every 6 months, then after 1 year, each dollar invested grows with interest to $1 X (1,03)^2 = $ 1,0609, and the effective annual interest rate on the bond is 6,06%.

Yield to maturity is different from the current yield of a bond, which is the bond's annual coupon payment divided by the bond price.

A general rule is that for premium bonds (bonds selling above par value), coupon rate is greater than current yield, which in turn is greater than yield to maturity. For discount bonds (bonds selling below par value), these relationships are reversed. Some numeral examples:

Bond Equivalent Yield
7.72% = 3.86% x 2
Effective Annual Yield
(1.0386)2 - 1 = 7.88%

Current Yield
Annual Interest / Market Price
$70 / $950 = 7.37 %

Bond prices over time
A bond sell at par value when its coupon rate equals the market interest rate. We shall now discuss the *Yield to maturity* versus *holding-period return*. The difference between yield to maturity and holding period return is that yield to maturity depends only on the bond's coupon, current price and par value at maturity. All of these values can de observed today, so it is relatively easy to calculate. In other words we can see the yield to maturity as a measure of the average rate of return if we hold the bond until the bonds maturity. The holding-period return is the rate of return over a particular investment period and depends on changes in rates affects returns, reinvestment of coupon payments and change in price of the bond.

Zero coupon bonds. Original issue discount bonds are less common than coupon bonds issued at par. There are bonds that are issued intentionally with low coupon rates that cause the bond to sell at a discount from par value. An extreme example are zero-coupon bonds, which carries no coupons and provides all its return in the form of price appreciation. Zeros provide only one cash flow to their owners, on the maturity date of the bond.

Default risk and bond pricing
Although bonds generally promise a fixed flow of income, that income stream is not risk less unless the investor can be sure the issuer will not default on obligation. Bond default risk, is usually called credit risk, this risk is measured by rating agencies such as Moody's, Fitch and Standard and Poor. They give a bond a rating such as in figure 1.8 on page 472.

To determine the safety of a bond we can use some ratios to analyze. We will discuss five of them briefly:

4. Coverage ratio. Ratios of company earnings and fixed costs.
5. Leverage ratios. Debt-to equity ratios
6. Liquidity ratio. Two common liquidity ratios are:
    a. Current ratio (asset/current liability)
    b. Quick ratio (current assets excluding inventories/current liabilities)

7. Profitability ratios. Measures of rates of return on assets or equity.
8. Cash flow to debt ratio. This is the ratio of cash flow to outstanding debt.

Bond indentures.
A bond is issued with an indenture, which is the contract between the issuer and the bondholder. Part of the indenture is a set of restrictions that protect the rights of bondholders. To make sure the bond issuer does not come into a cash flow problem the firm agrees to establish a sinking fund to spread the payment burden over several years. The sinking fund may operate in one of two ways:

1. The firm may repurchase a fraction of outstanding bonds in the open market each year.
2. The firm may purchase a fraction of the outstanding bonds at a special call price associated with the sinking fund provision.

The firm has an option to purchase the bonds at either the market price or the sinking fund price, whichever is lower. To allocate the burden of the sinking fund call fairly among bondholders, the bonds chosen for the call are selected at random based on serial number. Other issues are subordination of further debt in case of liquidation, dividend restrictions and collateral.

Bonds with a relatively high risk of default yield lower prices and consequently its rate of return will rise. Following the same reasoning implies that collateralized bonds usually yield a lower rate of return, because the risk of losses in case of default is smaller. The default premium is the compensation that corporate bonds offer for the possibility of default. The development over time of these default premiums on these risky bonds is sometimes called the structure of interest rates.

A credit default swap (CDS) is in short an insurance on the default risk of an investment. By using such a CDS a highly risky bond can be repackaged as a very safe investment. These CDSs have widely been used to speculate, resulting in the credit boom that led to the financial crisis of 2008.

Another example of such a financial product dealing with risk mitigation is the Collateralized Debt Obligation (CDO). A separate legal financial institution would first raise funds, collect different kinds of debt obligations, pool them togehter, and resell the total in small ‘slices’ or ‘tranches’ in different priority-scales varying in the risk they would entail.

Chapter 15 The term structure of interest rates

Until now we have assumed for the sake of simplicity that the same constant interest rate is used to discount cash flows of any maturity. In the real world this is rarely the case. In this chapter we explore the pattern of interest rates for different-term assets. We will try to identify the factors that account for that pattern and determine what information may be derived from an analysis of the so called term structure of interest rates, the structure of interest rates for discounting cash flows of different maturities. We will show how traders use the term structure to compute forward rates that represent interest rates on “forward” or deferred loans, and consider the relationship between forward rates and future interest rates. Finally, we give an overview of some issues involved in measuring the term structure.

The term structure under certainty
We could conclude that longer-term bonds usually offer higher yields of maturity because longer-term bonds are riskier and that the higher yields are evidence of a risk premium that compensates for interest rate risk. Another reason is that at these times investors expect interest rates to rise and that the higher average yields on long-term bonds reflect the anticipation of high interest rates in the latter years of the bond’s life.

Bond pricing. The interest rate for a given time interval is called the short interest rate for that period. Table 15.1 on page 509 shows the Interest rates on 1-year bonds in coming years. Expected one-rear rates in coming Years:

Year	Interest Rate
0 (today)	8%
1	10%
2	11%
3	11%

The interest rates are the expected interest rates in the future from today. We can price a bond using these expected interest rates with the following formula:

$$PV_n = \frac{1}{(1+r_1)(1+r_2)...(1+r_n)}$$

PVn = Present Value of $1 in n periods
r1 = One-year rate for period 1
r2 = One-year rate for period 2
rn = One-year rate for period n

We use this table to calculate the prices and yields of zero coupon bonds

Time to Maturity	Price of Zero*	Yield to Maturity
1	$925.93	8.00%
2	841.75	8.995
3	758.33	9.660
4	683.18	9.993

* $1,000 Par value zero

. An important note is that the yield to maturity on zero-coupon bonds is sometimes called the spot rate that prevails today for a period corresponding to the maturity of the zero.

Interest rate uncertainty and forward rates

The forward interest rate is the interest rate that is inferred from the growth rate of the observed interest rates of the years before. Consequently, and since future interest rates are uncertain, this forward interest rate does not need to equal the interest rates that will actually prevail. With the following formula we can calculate the forward rates from the observed rates.

$$(1+f_n)=\frac{(1+y_n)^n}{(1+y_{n-1})^{n-1}}$$

fn = one-year forward rate for period n
yn = yield for a security with a maturity of n

$$(1+y_n)^n=(1+y_{n-1})^{n-1}(1+f_n)$$

An example as explained in the BKM: How to calculate a forward?

4 yr = 9.993 3yr = 9.660 fn = ?
(1.0993)^4 = (1.0966)^3 (1+fn)
(1.46373) / (1.31870) = (1+fn)
fn = .10998 or 11%

Note: this is expected rate that was used in the prior example.

Downward Sloping Spot Yield Curve

Zero-Coupon Rates	Bond Maturity
12%	1
11.75%	2
11.25%	3
10.00%	4
9.25%	5

1yr Forward Rates downward sloping yield curve

1yr	[(1.1175)2 / 1.12] - 1	=	0.115006
2yrs	[(1.1125)3 / (1.1175)2] - 1	=	0.102567
3yrs	[(1.1)4 / (1.1125)3] - 1	=	0.063336
4yrs	[(1.0925)5 / (1.1)4] - 1	=	0.063008

Theories of the term structure
In general there are three theories concerning term structure:

4. Expectations
5. Liquidity Preference (Upward bias over expectations)
6. Market Segmentation / Preferred Habitat

We will explain each theory briefly:

1. *Expectations theory*

This is the simplest theory of the term structure. A common version of this hypothesis states that the forward rate equals the market consensus expectation of the future short interest rate. The assumptions of this theory are:

4. Observed long-term rate is a function of today's short-term rate and expected future short-term rates.
5. Long-term and short-term securities are perfect substitutes.
6. Forward rates that are calculated from the yield on long-term securities are market consensus expected future short-term rates. An upward-sloping curve would be clear evidence that investors anticipate increases in interest rates.

2. *Liquidity preference:*

This theory states that the forward rate exceeds expected future interest rates. It assumes that 1) Long-term bonds are more risky. 2) Investors will demand a premium for the risk associated with long-term bonds. 3) The yield curve has an upward bias built into the long-term rates because of the risk premium. 4) Forward rates contain a liquidity premium and are not equal to expected future short-term rates.

3. *Market segmentation theory / preferred habit theory:*

This is the theory that long- and short-maturity bonds are traded in essentially distinct or segmented markets and that prices in one market do not affect those in the other. It assumes that 1) Short- and long-term bonds are traded in distinct markets. 2) Trading in the distinct segments determines the various rates. 3) Observed rates are not directly influenced by expectations. 4) Investors will switch out of preferred maturity segments if premiums are adequate.

Interpreting the term structure

A common version of the expectations hypothesis holds that forward interest rates are unbiased estimates of expected future interest rates. However, there are good reasons to believe that forward rates differ from expected short rates because of a risk premium know as a liquidity premium. A liquidity premium can cause the yield curve to slope upward even if no increase in short rates is anticipated.

The existence of liquidity premiums makes it very difficult to infer expected future interest rates from the yield curve. Such an inference would be made easier if we could assume the liquidity premium remains reasonable stable over time. However, both empirical and theoretic; considerations cast doubt on the constancy of that premium.

A pure yield curve could be plotted easily from a complete set of zero-coupon bonds. In practice, however, most bonds carry coupons, payable at different future times, so that yield-curve estimates are often inferred from prices of coupon bonds. Measurement of the term structure is complicated by tax issues such as tax timing options and the different tax brackets of different investors.

Forward rates as forward contracts

Forward rates are market interest rates in the important sense that commitments to forward (deferred) borrowing or lending arrangements can be made at these rates. Even though the forward rates eventually won’t equal the realized interest rates in the future.

Chapter 16 Managing Bond portfolios

In this chapter we will discuss several strategies bond portfolio managers can pursue. We make the following distinction between these strategies. Active and passive bond strategies. Active strategies are strategies that trade on interest rate predictions and trade on market inefficiencies. In contrast, passive strategies focus on control risk and balance risk and return. We will start with discussing interest rate risk and the important concept of duration. Second, we will move to convexity. Third, passive bond management. Fourth, active bond management and finally interest rate SWAPS.

Interest rate risk

We have seen in the previous chapter that there is an inverse relationship between bond prices and yields, and we know that interest rate fluctuate. As we can imagine the sensitivity of bond prices to changes in market interest rates is obviously of great concern to investors. Six propositions underlie this sensitivity:

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 high-coupon bonds are less sensitive to changes in interest rates than prices if low-coupon bonds.
6. The sensitivity of a bond's price to a change in its yield is inversely related to the yield to maturity at which the bond currently is selling.

Duration

We need a measurement as guide to the sensitivity of a bond to interest rate changes, because the price sensitivity tends to increase with time to maturity. This measurement is called duration.

Duration is the effective measure of the duration of a bond.

Duration is shorter than maturity for all bonds except zero coupon bonds. Duration is equal to maturity for zero coupon bonds.
For three reasons duration is a usefull concept for fixed-income portfolio management. First it is a simple summary statistic of the effective average maturity of the portfolio. Second, it is a useful tool to immunize portfolios from interest rate risk. Third, it is a measure of interest rate sensitivity.

In formula duration:

$$w_t = \left[CF_t / (1+y)^t \right] / \mathrm{Price}$$

$$D = \sum_{t=1}^{T} t \times w_t \qquad CF_t = Cash\ Flow\ for\ period\ t$$

An example to calculate duration

8% bond	time years	Payment	PV of CF(10%)	Weight	C1*C4	
	0,5	40	38.095	0.395	0.0197	
	1	40	36.281	0.0376	0.0376	
	1,5	40	34.553	0.357	0.537	
	2	1040	855.611	0.8871	17.742	
Sum			964.540	1	18.852	**Duration**

Duration price relationship

CPrice change is proportional to duration and not to maturity.
ΔP/P = -D x [Δ(1+y) / (1+y)
D* = *modified duration*
D* = D / (1+y)
ΔP/P = - D* x Δy
Note the convexity of this function. The price-yield relationship is a convex relationship. Convexity is the rate of change of the slope of the curve as a fraction of the bond price:

Rules for duration

Rule 1: the duration of a zero-coupon bond equals its time to maturity.
Rule 2: holding maturity constant, a bond's duration is higher when the coupon rate is lower.
Rule 3: holding the coupon rate constant, a bond's duration generally increases with its time to maturity.
Rule 4: holding other factors constant, the duration of a coupon bond is higher when the bond's yield to maturity is lower.
Rules 5: the duration of a level perpetuity is equal to: $\frac{(1+y)}{y}$

Different sort of durations:
Duration. A measure of the average life of a bond, defined as the weighted average of the times until each payment is made, with weights proportional to the present value of the payment.
Macauly's duration. Effective maturity of bond, equal to weighted average of the times until each payment, with weights proportional to the present value of the payment.
Modified duration. Macauly's duration divided by 1 + yield to maturity. Measures the sensitivity of the bond.
Effective duration. Percentage change in bond price per change in the level of market interest rates.

Convexity
As a measure of interest rate sensitivity, duration is a critical tool in fixed-income portfolio management. But the duration rule for the impact of interest rates on bonds is only an approximation. The duration rule is a good approximation for small changes in bond yield, but it is less accurate for large changes. This point is illustrated in figure 16.4 on page 532. The true price-yield relationship is a curvature. Curves with shapes such as the price-yield relationship are said to be convex, and the curvature of the price-yield curve is called the convexity of the bond. As figure 16.4 shows we want to compensate for the convex curvature of the bond. We do this with the following formula:

$$Convexity = \frac{1}{P \times (1+y)^2} \sum_{t=1}^{n} \left[\frac{CF_t}{(1+y)^t} (t^2 + t) \right]$$

If we correct the formula for convexity we get:

$$\frac{\Delta P}{P} = -D * \Delta y + \tfrac{1}{2}[Conveixity \times (\Delta y)^2]$$

Investors think that convexity is a desirable characteristic of a bond. The reason is that bonds with greater curvature gain more in price when yields fall than they lose when yields rise. Although convexity is desirable it is not available for free, investors have to pay more and accept lower yields on bonds with greater convexity.

Passive bond management
Passive fixed-income portfolio management has two broad categories, indexing and immunization strategies.

Bond indexing basically composes a portfolio that mirrors the broad market and is similar to stock market indexing. Some differences exist however. It is for example much more complicated to keep track of the owners of bonds, and the bonds available at the market change continuously. A cellular approach is used to solve such practical problems.
Immunization strategies attempt to render the individual of firm immune from movements in interest rates. This may take the form of immunizing net worth or instead immunize the future accumulated value if a fixed income portfolio. We can accomplish immunization by matching the durations of assets and liabilities. If we want to maintain an immunized position we need to rebalance the portfolio over time, the reason is that as time passes interest rates pass as well.
This classical approach to immunization also depends on parallel shifts in a flat yield curve. Given that this assumption is unrealistic, immunization generally will be less than complete. To solve this problem, multifactor duration models can be used to allow for variation in the shape of the yield curve. A more direct form of immunization is dedication or cash flow matching. If the portfolio is perfectly matched in cash flow with projected liabilities, rebalancing will not be needed.

Active bond management
Active bond management could be divided in two broad categories. First there is interest rate forecasting, when managers use techniques to adjust their portfiolios to movements across the markets. An example of such a technique is horizon analysis, adjusting its strategies based on a particular holding period.
The second categorie is searching for relative mispricing within the fixed-income market. Interest rate swaps are common techniques of active bond management:
Interest rate swaps are major recent developments in the fixed income market. In these deals parties trade the cash flows of different securities without actually exchanging any security directly. This is a useful tool to manage the interest-rate exposure of a portfolio. Five categories of swaps can be identified:

4. Substation swaps (temporarily), using identical substitutes.
5. Intermarket spread swaps (temporarily), when two markets are temporarily out of line.
6. Rate anticipation swaps, closely linked to interest rate forecasting.
7. Pure yield pickup swaps, just to increase returns

8. Tax swaps, to exploit tax advantages.