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Valuing Futures and swaps

- We will be looking at some key derivatives, how they can be used, and how their value can be determined.
- We will focus on futures and swaps, the most widely used derivatives.

Arbitrage pricing

- ▶ Derivatives are securities or contracts whose values are derived from the value of other securities or assets
- ▶ A common way to determine their value is by arbitrage
- ▶ The principle of arbitrage is that if two securities provide the same payment in all circumstances, their value must be identical
- ▶ This technique is used particularly in option pricing

- We will briefly explain the principle of arbitrage, which is used to obtain the value of derivatives.
- ▶ A derivative is a security or contract whose final payment depends on the value of another security or asset; thus its value is 'derived' from the value of this security of asset.
- ▶ The determination of the value is done by means of arbitrage.
- ▶ The idea is that if at any point in time two securities, or combination of securities, must have the same value, then their value must be the same at any time. To see this suppose they are not identical at some point, say the price A is larger than B. We can sell A and use these proceeds to purchase a slightly larger number of B (as the price is lower); thus we made no net investment. At that time the price of the securities is equal, you repurchase A, costing you the value at that time, and you sell B, which has the same value; but you have bought more of B and hence will receive more monies from selling B. Thus you have made a profit. But this profit was made without any initial investment. There is also no risk involved as you know the two values must be the same. Such a 'free lunch' where someone makes money out of nothing cannot exist as everyone would do it.
- ▶ Arbitrage is most explicitly applied in options pricing, but it also used when pricing forwards and swaps, although this is not immediately obvious.
- We will thus use arbitrage implicitly when determining the value of forwards and swaps.

The use of derivatives

- ▶ Most derivatives have originally been developed to allow investors to hedge risks
- ▶ Their characteristics also allow investors to take large risks without making large investments, making them attractive to traders
- ▶ The value of a derivative is often referred to as its premium and this premium is small compared to the potential profits and losses

- We briefly look at the purpose of derivatives in financial markets.
- ▶ The origin of derivatives lie in the desire of investors to hedge their risks. Derivatives do not eliminate risks, but they redistribute them from one party to the other. If two investors have opposing risks, they can use derivatives to jointly eliminate them.
- ▶
 - Although developed to hedge risks, their nature allows investors to take large risks as well. Although they usually have lower value than the securities they are based on, they often can generate the same profits or losses as an investment in the security itself. Thus, given the smaller investment the potential for profits, but also for losses are much higher.
 - These high potential profits makes derivatives interesting for investors, despite the large risk they expose investors to.
- ▶
 - The value of a derivative is often called the premium, in particular in option pricing, but other derivatives use a similar terminology.
 - This premium is in most cases only a small fraction of the value of the asset on which the derivative is based.
- We can now discuss the use of futures and how they are valued.

Use of futures

- ▶ Suppose a company will receive a payment from a customer in the future and in a foreign currency
- ▶ This exposes the company to currency risk
- ▶ Suppose a company will have to obtain a commodity for its production in the future
- ▶ This exposes the company to commodity price risk
- ▶ Futures and forwards allow the company to avoid such risk
- ▶ We will first look at the valuation and use of such forward and future contracts

- We will start by giving a few examples of risks companies might be exposed to and then suggest we can use futures to eliminate this risk.
 - ▶ As an example consider a company that will receive a payment from its customer in the future and this payment is in a foreign currency, as this is what the contract stipulates.
 - ▶ The company therefore is exposed to the risk that the foreign currency will depreciate until payment is received.
 - ▶ Another example is a company needs to purchase some commodities in the future, for example some oil or metals.
 - ▶ The company therefore is exposed to the risk that the commodity price increases until the purchase is necessary.
 - ▶ Companies can use futures and forwards to eliminate this risk.
 - ▶ We will now look at who such contracts work and how they can be valued.
- In conducting our analysis, we will focus only on the key features of forwards and futures, leaving many, although important, details aside for clarity.



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Forwards and futures

→ The first derivative we will look at are forwards and futures and we will focus on their valuation first.

Key characteristics of futures and forwards

- ▶ Futures and forwards are a contract in which the buyer (seller) has the obligation to buy (sell) the underlying asset at the agreed time and agreed price
- ▶ The value of a futures and forwards can be obtained from the profits expected at maturity, adjusted for the net costs of obtaining the underlying asset instantly
- ? Would anyone purchase a futures which has a negative value?
- ! If a futures has a negative value, the purchaser would be paid for buying the futures, compensating him for the negative value

- Now that we have derived the main results of the model, as far as relevant for us, we will briefly discuss some implications as well as limitations of this model. This will allow us to interpret the model in its context of the initial problem and enables us to apply it appropriately in a realistic context.
- ▶ With a future or forward, the buyer has to buy the underlying asset as agreed and the seller has to sell it as agreed, even if this causes them a loss.
- ▶
 - The value of such contracts is determined by the profits that can be made at maturity.
 - These profits are adjusted for funding costs.
- ▶ Futures can have a negative value, why would anyone purchase something that has a negative value?
- ▶ If the value is negative, it implies that the purchaser is receiving a payment, offsetting the negative value of the futures. This is a peculiar situation in which the buyer of a security receives payment and the seller pays to offload a security.
- We can now look at how futures and forwards can be used to hedge the risks of companies or investors.

Futures and forwards for hedging

- ▶ Futures are available for a range of standard financial securities, currencies and commodities and more contracts can be agreed using forwards
- ▶ We will see how futures and forwards can be used to eliminate risks for investors
- ▶ Not for all investments futures can be found or forwards be agreed, investors will use an imperfect hedge with a closely related underlying asset to reduce risks
- ▶ If portfolios with many components are to be hedged, the costs may also prevent the use of a large number of futures and forwards

- We will now see how forwards and futures can be used to hedge the risk of assets.
- ▶
 - We have futures available for a many financial securities, such as stock market index and interest rates.
 - They are also available for the main currency pairs,
 - and many standard commodities, agricultural products and similar.
 - Individual forward contracts on any underlying asset could be agreed in principle.
- ▶ We will now see how such contracts are used to eliminate the risk for investors, by transferring this risk to another investor.
- ▶
 - Despite futures being available for many assets, not all possible assets are covered and it will not always be possible or practicable to agree forward contracts, either.
 - In this case we can reduce the risk of investors by using a similar underlying asset.
- ▶ Even if contracts for all assets are available, the costs of agreeing these for large portfolios might be prohibitively large and an imperfect elimination of risks might be more cost-effective.
- We will now look at how futures can be used to eliminate risks.



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Hedging with futures

→ We will look at perfect hedges of the exposure from assets and how approximate hedges can work.

Futures and forwards eliminating risks and opportunities

- ▶ Futures and forwards allow to eliminate risks completely if the underlying asset matches the risk
- ▶ These contracts also eliminate any possible gains that investors could make
- ▶ Most futures are short-term and for long-term hedges, contracts need to be rolled over frequently
- ▶ Forwards can be agreed to provide more long-term hedging

- Now that we have derived the main results of the model, as far as relevant for us, we will briefly discuss some implications as well as limitations of this model. This will allow us to interpret the model in its context of the initial problem and enables us to apply it appropriately in a realistic context.
- ▶
 - Futures and forwards allow to eliminate any risks the assets pose to the investor,
 - provided the underlying asset is identical to the asset that is hedged.
- ▶ Futures and forwards allow to eliminate any possible losses (beyond the premium), but this also eliminates any possible profits from the asset.
- ▶
 - Futures contracts are mostly short-term in that the time to maturity is often below three months.
 - For hedges that require a longer times to maturity, these futures can be rolled over into a new contract as and when needed.
- ▶ Forwards are bespoke contracts agreed with a counterparty, usually a bank, and can therefore be long-term.
- Futures and forwards are widely used to hedge risks and easily understood.

Use of swaps

- ▶ A company has obtained a loan in their home country and invest this loan into an overseas subsidiary
- ▶ The investment takes the form of a loan, which is denominated in the subsidiary's currency
- ▶ Receiving payments from the subsidiary in a different currency is exposing the company to currency risk
- ▶ A bank attracts deposits on which it agrees to pay interest that tracks the current interest rate in the money market
- ▶ These deposits are used to provide loans for which fixed conditions, including the loan rate, are agreed
- ▶ This exposes the bank to interest rate risk
- ▶ Swaps can be used in both cases to eliminate these risks

- We can now consider another derivative, a swap. We start with two examples of the risks a company faces and which it seeks to hedge.
- ▶ Suppose a company has obtained a loan in their local currency, but use this money to make an investment abroad. They have set up a subsidiary in the country they seek to invest in to this effect.
- ▶ The parent company now provides their subsidiary a loan, but this loan is denominated in the subsidiary's currency, thus a foreign currency for the parent company.
- ▶ The parent company receives interest payments from the subsidiary on the loan, but as the loan is in a foreign currency, these payments will be in a foreign currency. Having to transfer the currency into their own, imposes the parent company to currency risk.
- ▶ In another example, a bank has accepted deposits and agrees to pay depositors the money market rate.
- ▶ The bank has used these deposits to provide loans, but the interest rate on these loans has been fixed at the current competitive level.
- ▶ The bank is therefore exposed to interest rate risk as the deposit rate is variable.
- ▶ We will see how we can use swaps to eliminate these risks from the company and from the bank using swaps.
- We will look at how swaps can eliminate these risks.



→ We can now see how swaps work and how they can be priced.

Swaps allowing to hedge multiple payments

- ▶ Swaps can be used to exchange payments that are determined differently, in different currencies or at different interest rates
- ▶ As with futures, swaps eliminate any opportunity to make gains
- ? Why would investors use a swap rather than hedge their risks with futures?
- ! Swaps hedge multiple payments over a long period of time, negating the need for a large number of futures contracts and avoiding the problem of having no long-term futures contracts available

Swaps allowing to hedge multiple payments

- Swaps allow to hedge the risks from a large number of similar payments with a single derivative.
 - ▶
 - We can use swaps to exchange payments that are determined on different terms.
 - This might be because they are in different currencies
 - or the interest rates are determined differently, mainly where one is fixed and the other variable, but we could also exchange two variable interest rates.
 - ▶ Swaps prevent investors from making losses, but similar to forwards and futures, they also eliminate the possibility of making gains.
 - ▶ Swaps and futures both perfectly hedge any risks, why do we need swaps if we could achieve perfect hedges with futures?
 - ▶ Futures allow to hedge for a single payment in the future, but swaps hedge multiple, recurring future payments. In principle a swap is nothing but a collection of forward contracts where the risky payment (variable interest rate or foreign currency payment) is hedged at different points in time. Thus a swap is a more convenient way of achieving this hedge, and it circumvents the problems of futures not being available for long times to maturity.
- Thus we can see swaps a collection of forward contracts.

Summary

- ▶ Futures, forwards, and swaps allow to hedge against adverse movements in markets, but they also eliminate any possible gains
- ▶ These instruments have been designed to eliminate the risks arising from future payments, either to be made or to be received
- ▶ The value of these derivatives depends on the payments that are made and/or received, adjusted for any costs

- We can now summarize the key results we have obtained about forwards, futures and swaps.
 - ▶
 - These instruments are able to perfect (or partially) hedge risks that investors may face.
 - However, in doing so, they also eliminate any possibility for gains if the market is in the investors' favour.
 - ▶ Futures, forwards, and swaps are primarily designed to hedge the risks of future payments, whether they are made or received. The introduction of stock in futures and futures on individual stocks saw a deviation from this idea as they hedge against the value of these assets rather than any payments that may be necessary.
 - ▶ The value of these derivatives is based on these payments, adjusted for any costs or benefits that may arise from the use of derivatives rather than purchasing the underlying asset directly.
- Forwards and swaps are the basic derivatives used for hedging risks in financial markets. They are widely used and well understood, but in many investors' view face the downside of not only providing insurance against any losses, but also eliminating any possible gains.



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