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Swaps

- Swaps are usually a long-term agreement to exchange two repeatedly made payments.
- We will discuss their use and their valuation here.

# Definition of swaps

- ▶ Swaps allow investors to exchange one payment flow for a different payment flow
- ▶ Only the differences in the payment flows are exchanged
- ▶ Swaps are all agreed with a bank and are bespoke in the specific terms
- ▶ Swaps are often long-term agreements
- ▶ Central banks also use swaps as part of their monetary policy
- ▶ The most common forms of swaps are interest rate swaps and currency swaps

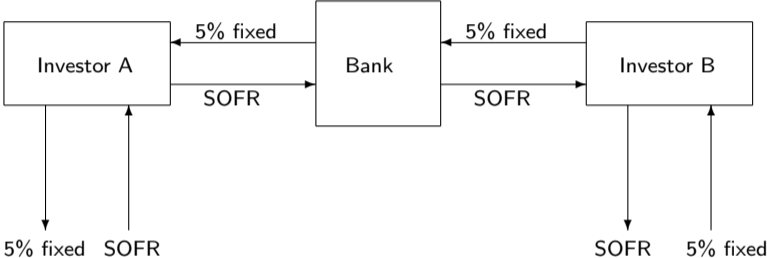
- Swaps are long-term agree agreements to exchange payments that are determined differently.
- ▶ Swaps are designed to exchange one payment against another, and these payments are to be made repeatedly for the duration of the swap.
- ▶ In practice only the difference sin these payments are actually transferred between the contract partners.
- ▶ Swaps are normally agreed between a company or other larger institution and a bank, or between banks. The terms are bespoke in that the payments exchanged are specified individually and also the length of the agreement (time to maturity).
- ▶ Although not necessarily, but often swaps are very long-term agreements. Swap agreements might lat for 30 years in some instances and time lengths of 10 years are not uncommon.
- ▶ In some cases central banks also use swap agreements as part of their monetary policy. This might be used in cases where monetary policy would be difficult if not sufficient collateral is available to banks in order to receive central bank funding.
- ▶
  - While many swaps are possible, the most common swaps are interest rate swaps, where different interest payments are exchanged
  - and currency swaps, where payments in different currencies are exchanged.
- We will look at these swaps in more detail now.

# Interest rate swaps

- ▶ Interest rate swaps exchange payments on a fixed interest rate against that of a variable interest rate
- ▶ The fixed interest rate is derived from a long-term bond
- ▶ The variable interest rate is usually based on a benchmark interest rate, such as the Secured Overnight Financing Rate (SOFR)
- ▶ Investors use swaps to hedge their exposure to interest rates by matching incoming and outgoing payments

- Interest rate swaps are the main swap used in the market, which is dominated by banks. Interest rate swaps (as currency swaps) became popular in the 1970s as a tool to hedge interest rate volatility in the aftermath of the breakdown of the Bretton Woods agreement on fixed exchange rates.
  - ▶ With an interest rate swap parties exchange a fixed interest payment against a variable interest rate.
  - ▶ The fixed interest payment is typically derived from a bond with a time to maturity similar to the time to maturity of the swap. It could also be a loan obtained from a bank.
  - ▶ The variable interest rate commonly uses a recognised benchmark, potentially adjusted for any risks.
  - ▶ The aim of a swap is to hedge the exposure to interest rate risk arising from the variable interest rate, which will be changing over time. If incoming payments or outgoing payments are linked to the variable interest rate, but opposite payments are fixed, this causes risks.
- We will now describe how swaps can be used to hedge interest rate risk.

# Hedging with interest rate swaps



# Hedging with interest rate swaps

- We will now see how companies can hedge their interest rate risk and through banks this risk might be eliminated completely.
- ▶ We consider two investors with different payment structures.
- ▶ The first investor has to make a fixed interest payment; such a fixed interest payment may be the result of the company having agreed a loan at a fixed rate.
- ▶ From the investments the company has made, it receives payments that are strongly related to a variable interest rate. Such investment could be into variable bonds, or the 'company' is a bank, it could be the payments from loans they have given at variable loan rates and the deposits receive fixed rates. For a company, using the variable rate might be a good approximation for the returns they generate otherwise, for example if these returns are linked to the state of the economy, which will be reflected in the level of interest rates.
- ▶ We now have a second company that has the opposite exposure to interest rate risks.
- ▶ They might have agreed a loan with a variable interest rate and have to make these payments.
- ▶ In return their investment might yield a fixed return. This might be because they have long-standing contracts that allows a steady return on their investment or they are operating in an industry that is not much affected by the state of the economy. If this 'company' were a bank, they would pay variable deposit rates and have agreed loans at fixed rates.
- ▶ Both companies could hedge their exposure to interest rate risk if they were able to exchange fixed for variable interest payments. This can be achieved with the help of a swap. In practice such a swap is arranged via a bank, but in principle this could be arranged directly between these companies if they would know about their respective needs.
- ▶ The swap agreement of company A would see them making a variable interest payment to the bank.
- ▶ In return, the bank pays the company a fixed interest rate. We now see that company A is fully hedged; it receives a variable interest payment and hands this on to the bank. The bank then makes a fixed interest payment to the company, who hands this on to their lenders. The interest rate risk has not disappeared, however, instead now the bank takes this risk as they receive a variable interest payment and make a fixed interest payment.
- ▶ Banks can offset this risk now by entering a second swap contract with company B. The swap agreement requires the bank to make a variable interest rate payment to the company.
- ▶ The company in return makes a fixed payment to the bank. We see now that as company A, company B is also not exposed to the interest rate risk. The bank has taken that risk on as for company A. However, this risk is opposite to the risk of company A, hence these two risks cancel each other out and the overall risk has been eliminated.
- ▶ We see that the variable interest payment company A receives is passed on towards company B, through the bank, and company B uses it to make its payments.
- ▶ Similarly, the fixed interest payment is handed from company B to company A, through the bank, and company A uses this to make its payments.
- Thus we see that companies can use swaps to transfer their interest rate risk to a bank; this the bank may be able to offset the risk they have taken on by entering an offsetting swap with another company.



## Valuing interest rate swaps

- ▶ Value of the long-term fixed-rate bond is the present value of all future payments, discounted at the current long-term interest rate
- ▶ 
$$B_{\text{fix}} = \sum_{\tau=1}^T \frac{C_{\text{fix}}}{(1+r_{\text{fix}})^{\tau}} + \frac{B_0}{(1+r_{\text{fix}})^T}$$
- ▶ The variable bond will revert to its face value if the interest rate is adjusted to the market rate
- ▶ For the period to the next coupon payment the investor obtains interest, and this is discounted by the current short-term interest rate
- ▶ 
$$B_{\text{var}} = \frac{B_0 + C_{\text{var}} \Delta\tau}{(1+r_{\text{var}})^{\Delta\tau}}$$
- ▶ The swap value is the difference between these values:  $V = B_{\text{fix}} - B_{\text{var}}$

→ We can now determine the value of such interest rate swaps.

- ▶
  - We exchange a (hypothetical) long-term bond with a fixed interest rate. Such a bond has a value which is the present value of all future payments received from this bond; the future payments are the coupon payments and the repayment of the loan.
  - The discount rate would be the current yield for such long-term bonds.

▶ *Formula*

▶ Variable rate bonds are having their coupons adjusted regularly, often quarterly. At the change of interest rates, the coupon reflects the market value and hence the bond value will be recerting to its face value.

- ▶
  - The bondholder will for the time period until the next interest rate change obtain the coupon payment due for that time period, and then retain the face value of the bond.
  - This payment will discounted at the short-term interest rate, and discounted only for the time length until the next interest rate change.

▶ *Formula*

▶ The value of the swap is then the difference between the value of these two bonds. If the swap agreement entails that the fixed interest rate is obtained and the variable interest rate paid, the value is given by the *formula*. If the swap is the other way around, the values of the fixed and variable bonds are reversed.

→ We have thus determined the value of a swap and can now introduce the concept of a swap rate.

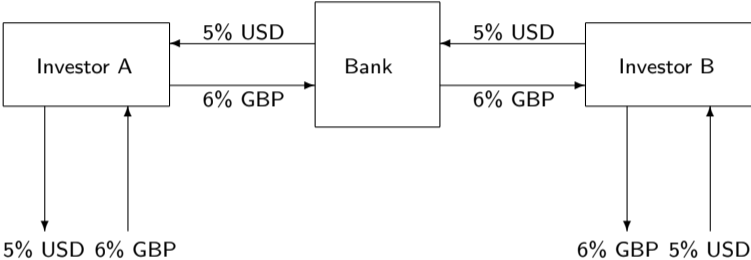
# Swap rate for interest rates

- ▶ The value of a swap can be positive or negative
- ▶ Whether a premium is to be paid, depends on the agreed conditions
- ▶ The fixed rate at which the swap has no value,  $V = 0$ , is referred to as the swap rate

# Swap rate for interest rates

- We can now look at the value of the swap and determine the so-called swap rate.
- ▶ Depending on the interest rates of the bonds involved, the value of a swap can be positive or negative.
- ▶ The sign of the value depends mostly on the fixed interest rate as the variable interest rate has only a small influence on the bond value given the frequent changes of the interest rate.
- ▶ We can now determine the fixed rate at which the value of the swap would be zero; this fixed rate is known as the swap rate.
- We can now look at the other common swap, the currency swap.

# Hedging with currency swaps



- We will now see how companies can hedge their currency risk and through banks this risk might be eliminated completely.
- ▶ We consider two investors who make and receive payments in different currencies.
- ▶ The first investor has to make a fixed interest payment in one currency; this might be the payments on a loan the company took out in that currency.
- ▶ From the investments the company has made, it receives payments in a different currency. If investments are made abroad this might result in returns on these investments being paid in a different currency, exposing the company to currency risk.
- ▶ We now have a second company that has the opposite exposure to currency risks.
- ▶ They might have agreed a loan in the other currency.
- ▶ If investments are made abroad (from the perspective of this company) this might result in returns on these investments being paid in a different currency, exposing the company to currency risk.
- ▶ Both companies could hedge their exposure to currency risk if they were able to exchange their respective payments. This can be achieved with the help of a swap. In practice such a swap is arranged via a bank, but in principle this could be arranged directly between these companies if they would know about their respective needs.
- ▶ The swap agreement of company A would see them making payment in one currency to the bank.
- ▶ In return, the bank pays the company in another currency. We now see that company A is fully hedged; it receives payment in one currency and hands this on to the bank. The bank then makes a payment to the company in another currency, who hands this on to their lenders. The currency risk has not disappeared, however, instead now the bank takes this risk as they receive a payment in one currency and make a payment in another currency.
- ▶ Banks can offset this risk now by entering a second, off-setting, swap contract with company B.
- ▶ The company makes a payment to the bank in one currency and receives payments in the other currency. We see now that as company A, company B is also not exposed to the currency risk. The bank has taken that risk on as for company A. However, this risk is opposite to the risk of company A, hence these two risks cancel each other out and the overall risk has been eliminated.
- ▶ We see that the payment company A receives is passed on towards company B, through the bank, and company B uses it to make its payments.
- ▶ Similarly, the other payment is handed from company B to company A, through the bank, and company A uses this to make its payments.
- Thus we see that companies can use swaps to transfer their currency risk to a bank; this the bank may be able to offset the risk they have taken on by entering an offsetting swap with another company.

## Valuing currency swaps

- ▶ Value of a bond in the domestic currency is the present value of all future payments, discounted at the current long-term interest rate
- ▶ 
$$B_{\text{domestic}} = \sum_{\tau=1}^T \frac{C_{\text{domestic}}}{(1+r_{\text{domestic}})^{\tau}} + \frac{B_0}{(1+r_{\text{domestic}})^T}$$
- ▶ Value of a bond in the foreign currency is the present value of all future payments, discounted at the current long-term interest rate
- ▶ 
$$B_{\text{foreign}} = \sum_{\tau=1}^T \frac{C_{\text{foreign}}}{(1+r_{\text{foreign}})^{\tau}} + \frac{B_0}{(1+r_{\text{foreign}})^T}$$
- ▶ The swap value is the difference between these values, adjusted for the exchange rate:  $V = B_{\text{domestic}} - eB_{\text{foreign}}$

- We can now determine the value of such a currency swap.
  - ▶
    - We first consider the value of a fixed rate bond in the domestic currency, which is the basis for the exchange of the regular 'interest' payments; this bond has the same maturity of the swap. This value will be the present value of all future coupon payments and the repayment of the face value.
    - The discount rate is the long-term domestic interest rate.
  - ▶ *Formula*
  - ▶
    - We then consider the value of a fixed rate bond in the foreign currency, which is the basis for the exchange of the regular 'interest' payments; this bond has the same maturity of the swap. This value will be the present value of all future coupon payments and the repayment of the face value.
    - The discount rate is the long-term foreign interest rate.
  - ▶ *Formula*
  - ▶ The value of the swap is then the difference between the two bond values, where we need to consider that the foreign bond is denominated in a foreign currency and hence we need to apply the current exchange rate. This is the value for a swap in which the payment in the domestic currency is obtained and the payment in the foreign currency is made. If the swap is the other way around, the values of the fixed and variable bonds are reversed.
- Similar to interest rate swaps, we can now also determine the swap rate implied by currency swaps.



# Swap rate for currencies

- ▶ The value of a swap can be positive or negative
- ▶ Whether a premium is to be paid, depends on the agreed conditions
- ▶ The exchange rate at which the swap has no value,  $V = 0$ , is referred to as the swap rate

# Swap rate for currencies

- We can now look at the value of the swap and determine the so-called swap rate.
  - ▶ As with interest rate swaps, currency swaps can have a positive or negative value.
  - ▶ The sign of the value depends on the payments received relative to the current yields in both countries, in addition to the current exchange rate.
  - ▶ We can now determine the exchange rate at which the value of the swap would be zero; this exchange rate is known as the swap rate. It can easily be calculated as the ratio of the two bond values.
- In addition to interest rate and currency swaps, we also have cross-currency swaps. In such swaps we exchange a fixed interest rate in one currency against a variable interest rate in another currency. The value of this swap is then easily achieved by replacing the fixed-rate bond with the variable-rate bond in the relevant currency.



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