Derivatives – Advanced

Overview

- ❑ Currency Futures and Forwards
- ❑ Credit Derivatives
- ❑ Swaps
- ❑ Caps, Floors and Collars
- ~~❑ Bond Options~~
- ~~❑ Economic Derivatives~~
- ~~❑ Other Derivatives~~

Sources

- ❑ An Introduction to CME Weather Products

Buying & Selling currency at some future point. There is an exact pricing mechanism. Credit derivatives, if I have debt on a bank with a customer and I want to hedge credit risk on that customer I can use credit derivatives to do so. There are many different forms of credit derivatives. Swap market. Swaps are a sequence of forwards contracts packaged. Caps, Floors, and Collars package options, buying a sequence of options.

Currency Futures and Forwards

- ❑ The forward market in foreign exchange is fairly informal
  - ∗ Network of banks and brokers
  - ∗ Allows customers to enter forward contracts to purchase or sell currency in the future at a currently agreed-upon rate of exchange
- ❑ Currency futures are formal markets on exchanges
  - ∗ CME, LIFFE (major markets)

I agree to buy or sell a currency at some point in the future for a price agreed upon today. Forward market, OTC, informal, is huge, trillions of dollars. Done through a network of banks and brokers.

How can we calculate futures prices? Simple using law of one price or arbitrage.

Interest Rate Parity

EXAMPLE BP£ & US$, this is how a Futures Price is calculated.

- Suppose E_0 dollars are required to purchase one pound (£).
- F_0 is the **FORWARD PRICE** (aka futures price): the **number of dollars** that is agreed to today for **purchase of one pound** at time **T** in the future
- Define the **risk free rates** in the UK and US as r_{UK} and r_{US} (per period) [so if we have **T periods** we will have to **compound** those rates]
  This is an arbitrage scheme.
  We are assuming we can barrow at the risk free rate.

❑ Now suppose we **borrow M BP£** costing us r_{UK} per period for **T** periods

- In **T periods** we will **owe the bank**: $M \times (1 + r_{UK})^T$ BP£. Original amount barrowed compounded for T periods. This amount is in pounds sterling, must be careful.

❑ Convert this in to US$ at today's spot rate (M is in BP£)
  E_0 is the number of dollars it takes to buy a pound.
- We will have $E_0 \times M$ in the denomination of US$

exam

❑ **Invest these dollars** at r_{US} for **T** periods (US risk free rate)

- This will grow to $E_0 \times M \times (1 + r_{US})^T$ at the end of T periods.

So we **owe** $M \times (1 + r_{UK})^T$ in BP£, and **have** $E_0 \times M \times (1 + r_{US})^T$ in US$

❑ **INTEREST RATE PARITY** tells us that the forward price that existed at the beginning must set the **amount we owe** in BP£, to the **amount we have** in US$, so that:

$F_0 \times M \times (1 + r_{UK})^T = E_0 \times M \times (1 + r_{US})^T$ which reduces to:

$$F_0 = E_0 \left(\frac{1 + r_{US}}{1 + r_{UK}} \right)^T$$

HW

F_0 is the Forward Rate (or Futures Rate). It is the relationship between the two currencies. **INTEREST RATE PARITY** describes the **forward rate in terms of risk free rates and the current spot price**. This is telling us that if we apply the futures rate to the barrowings it must be equal to the amount of money I've earned in US dollars.

The forward rate is determined by supply & demand in the forward market. So at any particular time the relationship may not hold. If it doesn't and falls too far out of line, the profit should be arbitraged away. These things come from two different markets and arbitrage should keep them pretty close.

If the actual F0 is greater than or less than the solved for F0 there is an arbitrage opportunity. [This is a HW problem, it is in the text] If one is too big than barrow some, make a bigger return, if one is too small barrow from the other. If no arbitrage the relationship should hold (?).

Credit Derivatives

- Sources: The Lehman Brothers guide to exotic credit derivatives
- Credit derivatives are financial instruments that separate the impact of credit related events from the asset

There are so many forms of credit derivatives it is difficult to describe all of them. We can think of them as fitting into a few categories. *Why are they used …*

Hedging Credit Risk

- More FIs fail due to credit-risk exposures than to either interest-rate or FX (foreign exchange) exposures. Credit Risk is biggest threat that FIs face.
- In recent years, development of derivatives for hedging credit risk has accelerated. Three possible categories of CR include:

1. **CREDIT FORWARDS**
2. **CREDIT OPTIONS**
3. **CREDIT SWAPS**

Credit risks are being used for speculative purposes. So they represent a hedging and speculative opportunity.

Basic Structures

- Link a stream of payments based on the total return on an asset
  - The receiver of the stream takes on the credit risk
  - Example would be a total return swap
- Base the payoff on a specified credit event
  - The event could be a bond default, or a credit downgrade
  - Example would be a credit swap
- Payoff tied to credit spread
  - Example would be a credit spread put option

The categories of CR have these common elements.
Ex. you have a bond from a customer, if the customer defaults the CF stream is truncated and I receive 0. If the bond issuer runs into credit problems the bond may sell for 10 cents on the dollar. This would represent a change in cash flows stream.

For these reasons we need some way to link payments on these derivatives to some underlying actual cash flow stream from the asset. The receiver of the cash flow stream takes on the credit risk. In some sense we are saying, you pay me some agreed upon amount and I'll pay you something based on the underlying asset. That something is going to change based on credit worthiness. So the party buying this is taking on some of the credit risk.

The "seller" is selling some of his credit risk to an outside party for the purpose of diversification. Likewise the "seller" may decide to buy credit risk from another party which has risk in other sectors, again this is for the purpose of diversification. In effect if I buy the credit risk from a portfolio of different loans I am getting the benefit of diversification without actually lending to these other parties.

Credit derivatives allow me to get exposure to other types of barrowers without actually selling debt to them. A very powerful diversification tool.

So far we have some agreement to swap payments, exchange payments, to vary the payments in some way. The payoff of these derivatives involves some event such as bond default, credit downgrade. But we could also link the event to something really simple such as the spread between this bond and a 10 year treasury note widening. This makes the measurement very fluid. Payoff in some way must be tied to credit exposure aka credit spread. In the extreme the credit spread can be very large because the "thing" defaults. Or something more mild such as a credit downgrade from BBB to C. Credit Forward is a zero sum game, what one person losses the other person gains. It's not an option, it's a *forward contract*.

Credit Forwards

- **Credit forwards hedge against decline in credit quality of borrower**
  - Common buyers are insurance companies. Insurance companies are limited in who they can lend to or what bonds they can buy. Here they can buy the credit risk which they receive payment for as well as getting exposure to the lenders. Better diversification. It is a synthetic loan to a certain type of barrower without actually lending.
  - Common sellers are banks. They want to sell some of their credit risk because they may be too exposed to a certain area. Maybe one customer is accounting for too much of portfolio, they can sell some of this credit risk.
  - Specifies a credit spread on a benchmark bond issued by a borrower

EXAMPLE: BBB bond at time of origination may have 2% spread over US Treasury of same maturity.

The difference between the yield on this debt and the treasury security has liquidity issues as well. But the main component is going to be default risk.

When this thing was issued the market was saying "we need an additional 200 basis points of yield due to credit risk."

CS_F = agreed **forward credit spread** at **time contract written**. The 200 basis points in above example, investors need this premium. This is the negotiated item.

CS_T = actual **credit spread at maturity** settled upon for the forward contract.

Forward Contract, what payments are made? Two possibilities depending on the actual credit spread at time of maturity and the agreement made at time of purchase.

Credit Spread **at END**	Credit Spread **SELLER**	Credit Spread **BUYER**
$CS_T > CS_F$ (credit risk widens)	**Receives** $(CS_T - CS_F)MD(A)$	**Pays** $(CS_T - CS_F)MD(A)$
$CS_F > CS_T$ (credit risk narrows)	**Pays** $(CS_F - CS_T)MD(A)$	**Receives** $(CS_F - CS_T)MD(A)$

MD: modified duration of the notional value of the forward contract (notional /underlying debt).
A: Notional value (amount) of contract. So MD(A) is modified duration as a function of A, the notional value of contract. Buyer wants to take on additional credit risk, betting that credit risk narrows. Seller wants to hedge credit risk. There is no trading marketplace for these. The two parties in these contracts do not include the firm whose credit rating is under debate.

EXAMPLE:

- A bank has a loan outstanding for $10 million to a corporate customer with a modified duration of 5 years.
- To hedge its credit risk exposure the bank enters into a credit forward contract for $5 million
  - The yield on the customer's traded debt which has a duration of 10 years will be compared to a benchmark Treasury bond
- What is the gain on the credit forward contract if the credit spread between the benchmark Treasury bond and a borrowing firm's debt decreases by 25 basis points?

Solution

The gain would be:

modified duration * change in interest rates * value

$MD*\Delta R*\$5 \text{ million} = 10*0.0025*\$5 \text{ million} = \$125{,}000$

The bank loan is not traded. We use the customers traded debt as the benchmark, this values the credit forward contract.

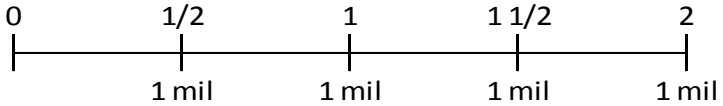
What is the gain on the credit forward contract? It is the credit spread between the benchmark treasury bond and the barrowing firms debt decreasing by 25 basis points.

Total Return Swap

- Suppose a bank's customer wishes to borrow money from the bank
  - Unfortunately the bank for diversification issues does not want to take on this additional asset (too exposed in that area however the customer is of value).
  - The bank enters into a **TOTAL RETURN SWAP**
    - The payments from the loan are paid to the total return receiver
    - The bank receives payments back from the receiver
    - When the swap expires, the receiver is obliged to make (or receive) payment for any decrease (or increase) in value of underlying asset

Two parties in this arrangement. The Total Return Receiver receives the cash flow from the debt. The bank receives payments back from the receiver (usually fixed payments).

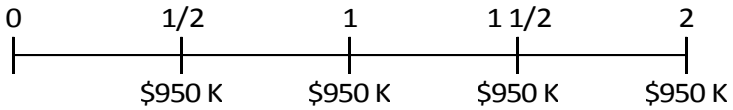
Swap: swapping fixed payments for the risky cash flows from my debt (which I am selling).



Original Agreement

Customer originally barrows $40 million.

Loan, has interest payments of $1 million every 6 months for 10 years. I entered into a total return swap and agreed with the receiver the following, he makes payments to me $950,000 each 6 month period for 2 years.



So the lender has exchanged a cash flow schedule of $1 million for a total of $4 million for 4 payments of $950,000! Does not seem to make sense!

Why is this an advantage? Suppose the customer goes bust after the first 2 payments and does not make the last two payments. The receiver does not receive the last two $1 million payments. But "he", the receiver (?), still has to pay the $950,000 payments.

Even better, if the custom goes bust he agrees to pay me what was owed all along.

More realistic: suppose what actually happens is the credit worthiness of this customer (who originally owed $40 million) declines so at the end of the two year period the loan is only worth $38 million on a $40 million loan because the value of the loan has declined because the credit risk of the customer has gone up. What will happen? At the end of the agreement "he" has to make an extra payment of $40 - $38 = $2 million to make good on any decline in the value of that loan.

Swapping out any cash flows or any change in value of that loan and receiving a fixed payment back. In essence this "thing" is only really as good as the credit worthiness of the total return receiver because I'm exchanging his credit for the customer I made a loan to. Ih he goes bust he cannot make the payments owed and the contract has no point.

In essence, this total return swap I'm exchanging the credit of my customer with the credit of the receiver of this total return swap.

If the customer goes under the total return receiver would owe $40 million to the bank.

The total return receiver is completely taking the place of the customer. In effect he is guaranteeing the customers payments. He takes all the risk. As if I have sold the loan to him without recourse.

If the credit worthiness of the customer goes up so that at the end the value is worth $42 million, then "I" owe $2 million to the total return receiver.

Customer originally barrows $40 million. Suppose their credit declines, this means the value of their loan goes down. Why? Because they are not as credit worthy. If I try to sell this loan it is worth less ($2 million less in this example, the loan would be worth 438 million). In this situation the total return receiver would have to make an additional payment of $2 million. If the credit worthiness had gone up so that the loan was actually worth $42 million, then "I" would have to make a $2 million payment to "him."

To decide credit worthiness you agree to use some benchmark, perhaps a bond rating agency, if the customer agrees to BBB you would look up BBB customers and see what their publicly traded debt was worth. Need an agreed benchmark on how to price.

Suppose the receiver is an insurance company. They may not have the ability to make a loan directly to a particular customer, may not have the relationship with the customer. bank makes the loan. good thing is bank keeps the relationship with the customer. The

customer has not idea this is going on, has no idea the payments have been swapped with someone else. Customer has no change in relationship with the bank.

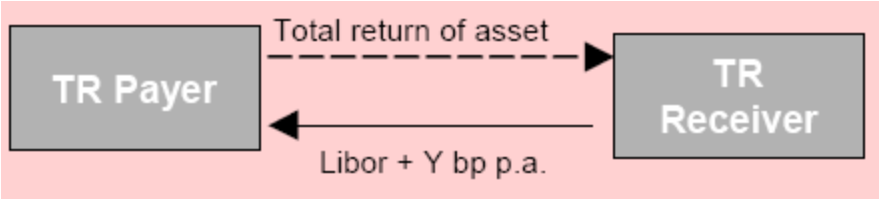
Called Total Return Swap because you are completely swapping all cash flows associated with that loan.

If it is a floating rate debt to begin with you may agree not just on a fixed payment of $950,000 each period but some benchmark LIBOR plus some premium. Because in this situation if it is a fixed rate note you are exposed to interest rate risk as well. may remove the interest rate risk by making payments back to the receiver. Many ways to negotiate these things.

In effect the Total Return Payer has removed any economic exposure to this barrower. This is a confidential risk transfer, selling the debt without lossing the rights to it. Typically the original bank retains the servicing rights, remains in control of that debt in a sense. No ownership rights change hands,, a contractual relationship between seller and receiver.

Total return comprises the sum of interest, fees, and any change-in-value payments with respect to the obligation

- The change-in-value payment is equal to any appreciation (positive) or depreciation (negative) in the market value of the obligation



- When entering into a TR Swap on an asset residing in its portfolio, the TR Payer has effectively removed all economic exposure to the underlying asset
- This risk transfer is effected with confidentiality and without the need for a cash sale
- Typically, the TR Payer retains the servicing and voting rights to the underlying asset
- The TR Receiver has exposure to the underlying asset without the initial outlay required to purchase it. They have taken on the risk of the loan without having to invest their own money.
  - The economics of a TR Swap resemble a synthetic secured financing of a purchase of the obligation provided by the TR Payer to the TR Receiver
- Applications of TR Swaps include making new asset classes accessible to investors for whom administrative complexity or lending group restrictions imposed by borrowers have traditionally presented barriers to entry
  - Insurance companies have made use of TR Swaps to access bank loan markets Insurance company becomes the RECEIVER. They are able to make loans in a purely synthetic way.

Types of Credit Derivatives

- Source: The RMA Journal, Nov 2001 v84 i3 p42 “Community Banker Guide to Credit Derivatives Part I: The Basics.” D.K. Malhotra, Francis Garritt, Philip Russel
- Credit default swap
  - Provides protection against credit losses associated with default on a specified reference asset

Credit Default Swaps Derivative

- Typical contract, the buyer of the contract (such as the bank with credit risk exposure) will make periodic payments or one up-front payment to the seller
- The seller promises to make payment contingent upon a defined credit event, such as a credit downgrading or default on debt

Protection against default against some specified reference asset.

Will make periodic payments or an upfront payment to the seller. The seller promises to make payment back contingent on a defined credit event such as a credit downgrading or default on a debt. Buying insurance in effect.

I'm a bank with exposure to a particular company or industry. I come up with an agreement with another party that I make an insurance payment or a stream of insurance payments, we come up with a payoff in the event of some event happening. For example, a third company (the subject of the proceedings) is downgraded from BB to BBB. In that event I receive $1 million. An insurance contract.

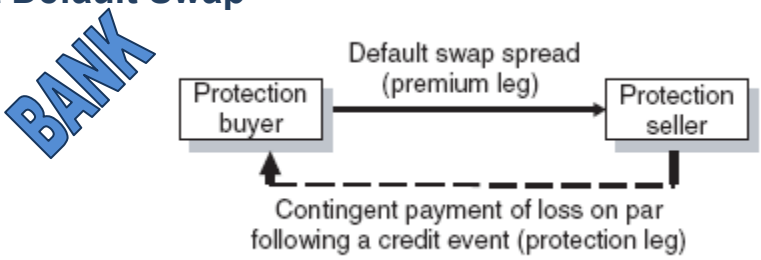
Credit Event

- Failure to meet payment obligations when due
- Bankruptcy
- Repudiation
  - The refusal, especially by public authorities, to acknowledge a contract or debt
- Material adverse restructuring of debt, extending term, restructure to lower coupon

These are commonly seen. Will see these credit default swaps on sovereign debt quite a bit. If a payment is not made, principle of interest, that will be defined as an event. bankruptcy is another. Refusal to acknowledge a contract or debt is another (usually by a sovereign government).

Define the event and get payment if that event happens.

Credit Default Swap



bank is the protection buyer, wants to reduce exposure. They, the bank, makes a premium payment. Can be upfront or overtime. Contingent payment based on the occurrence of some event, a protection payment is paid back to the buyer. Complete insurance policy.

EXAMPLE:

- Suppose a protection buyer purchases five-year protection on a company at a CDS (credit default swap) spread of 300bp
  - The face value of the protection is $10m
  - The protection buyer therefore makes quarterly payments approximately equal to

  $10m × 0.03 × 0.25 = $75,000 per year payments made on the contract

- After a short period the **reference entity** suffers a **credit event**
  - Assuming that the cheapest deliverable asset of the reference entity has a recovery price of $45 per $100 of face value, the payments are as follows (trading for 45% of face value)
  - The protection seller **compensates** the protection buyer for the loss on the face value of the asset received by the protection buyer and this is equal to $5.5m ($10m * [100-45]/100)

The value of the **reference asset** at the time of the credit event determines the amount to be paid (this had been negotiated). Common method of negotiation but just 1 of many ways.

- The protection buyer pays the accrued premium from the previous **premium payment** date to the time of the credit event
  - For example, if the credit event occurs after a month then the protection buyer pays approximately

  $10m × 300bp × 1/12 = $25,000 of **premium accrued**

Illustration of why something like this would be used.

EXAMPLE:

- Source: The RMA Journal, Dec 2001 v84 i4 p54(5) "Community Banker Guide to Credit Derivatives: Part II; Uses, Risks, and the Future. (Credit Derivatives)." D.K. Malhotra, Francis Garritt, Philip Russel
- ABC bank has a $525,000 loan to a church
  - Accepting some of the risk- $200,000-is acceptable to the bank, which also benefits from the positive relationship with an important part of its community
  - Accepting all the risk is questionable, particularly during a recessionary period
- A credit default swap is a customized contract that sells that risk to another bank, such as Barclays Capital Group, while keeping the relationship with the church
  - ABC bank no longer has to keep capital reserves for that loan and can make other loans and establish more relationships

Wants to make the loan to keep up it standing in the community but the bank can only afford to be exposed to $200,000. BCG receives premiums, guarantees some of the loan in case some event happens. The bank made the loan for $525,000 but immediately went into the marketplace and insured $325,000 of it. $200,000 remains as acceptable risk. But what would be the benchmark? How to calculate the loss? What is the event? However, since the risk has been passed on the potential exist to charge the church less interest.
Not making as much, not losing as much.

Types of Credit Derivatives (continued)

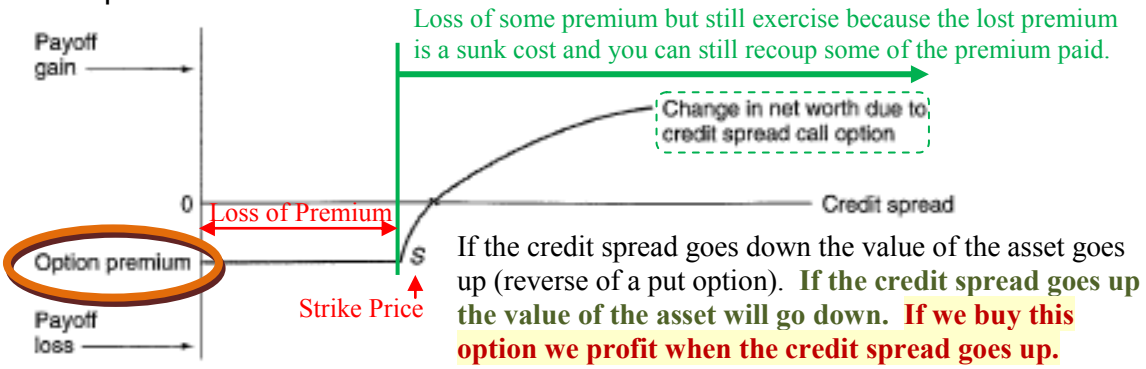
- **Credit-linked notes**
  - Credit-linked notes are an on-balance-sheet item and can be structured in a number of ways
  - Generally issued by a trust or a special-purpose entity to transfer the credit risk from a bank to the trust
  - Notes are then issued by the trust with the total return of the notes linked to the market value of a basket of debt securities
  - Issuers often use credit-linked notes as a way to adjust the credit risk profile of a loan portfolio to reduce regulatory capital
  - Investors find credit-linked notes attractive because they provide access to a pool of securities

Securitization, selling notes to a third party. Passing on the credit risk by setting up a special entity to accumulate debt and selling notes on the trust to other investments. We still control the loans but the credit risk has been passed on to the investors who take notes from this trust.

The following credit derivatives are auction based so there is a premium paid up front and the risk is hedged in one direction only. Benefit in one direction and simply lose the premium in the other direction.

Types of Credit Derivatives (continued)

- **CREDIT SPREAD OPTIONS (PUT VERSION)**
  - Gives the **buyer the right to sell the underlying asset at a pre specified credit spread**
    - The spread refers to the **difference** between yield on the **reference asset** and yield on the **risk-free security**
  - A credit spread option hedges the risk that the obligation credit spread will increase above a predetermined level
- The buyer of a credit spread option has the right, but not the obligation, to sell an obligation at a predetermined spread throughout the term of the contract
  - Buying an option allows the buyer to retain the upside potential
  - If the option is not exercised, the seller benefits to the extent of the premium received at the initiation of the contract



If the credit spread goes down the value of the asset goes up (reverse of a put option). **If the credit spread goes up the value of the asset will go down. If we buy this option we profit when the credit spread goes up.**

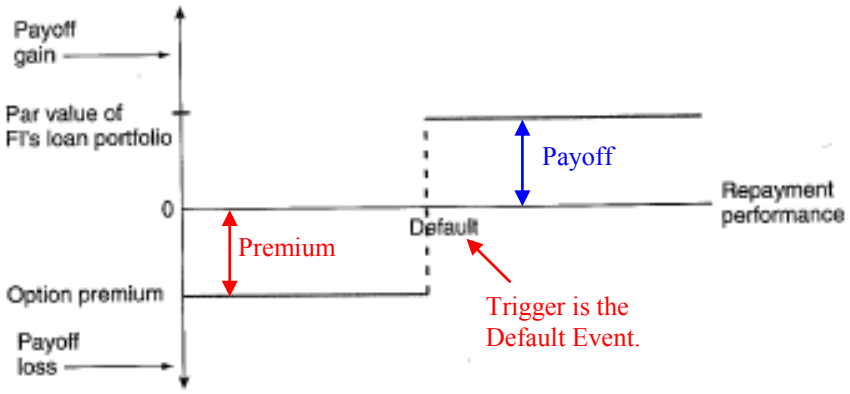
Idea being if the credit spread widens on this debt security the price of the asset will fall. Therefore if I buy this PUT option I am allowed to sell it at a predefined credit spread. I am protected in the event the credit worsens above the credit spread. Protected from the credit spread rising above some pre-determined level. The buyer has the right to sell at some pre-determined spread before the end of the contract. If the credit spread tightens I let the option expire worthless and lose the premium.

If the credit worthiness of the issuer improves, we see our asset increase in value and the option will expire worthless. If the credit spread widens (gets worst) we can cash in on the option and we are protected against the falling value of the original asset (?). If the spread goes down the value of the asset goes up (and visa-versa).

(Similar to a put option except with a PUT the credit spread is replaced with the stock price). **Credit spread is the underlying variable**. Not a linear relationship between yield to maturity and the value of the asset. As credit spread gets wider the gain will level off.

THE PROFIT IS WORTH THE VALUE OF THE UNDERLYING BOND VALUED AT THE SPREAD VALUE

DIGITAL DEFAULT OPTION



- An option that pays a **stated amount** in the event of a **loan default**

Get paid a lump sum if the trigger event happens. The size of the payment does not change in size. It is an all or nothing thing. In the above example the event is "default" presumably on a loan. If that happens owner of option is paid.

In the graph the part below zero is the premium paid. OTC contracts, can be negotiated but fairly standardized.

Credit Option Benefits to Sellers, What is the value of these things?

Source: The RMA Journal, Dec 2001 v84 i4 p54(5) "Community Banker…

- **A bank may** have reached its concentration limit (credit limit) within a certain industry (or a particular barrower) and may **need to diversify** into a different industry
  - Credit derivatives can **help banks diversify their portfolios** and gain access into the new industry
  - By underwriting the contract as a protection seller, banks can assume credit risk within a market without having to fund a loan and/or develop any loan origination capability
  - Allows a bank 9for instance) to readjust their risk, to take more risk in under-represented areas and to pass on risk where over-exposed. All of the above credit derivatives allow us to manage this risk, adjust exposure.

Risks

Source: The RMA Journal, Dec 2001 v84 i4 p54(5) "Community Banker…

- **COUNTERPARTY RISK**
  - Counterparty risk is the risk that a counterparty to a financial transaction will fail to perform according to the terms and conditions of the contract
    - Both the protection buyer and protection seller can incur counterparty risk
    - In a credit swap, the protection buyer has credit exposure to the protection seller, contingent on the performance of the reference entity
    - If the protection seller defaults, the buyer must find alternative protection and will be exposed to the replacement cost due to changes in credit spreads since the inception of the original swap

The point of credit risk derivatives is to reduce credit risk exposure. Here we enter into a contract so that if something bad happens you get paid off by this third party. But there is credit risk, not with the original person who barrowed but with the third party you've entered into this contract with. If it is an OTC contract you are exposed to credit risk with the third party. So not completely eliminated. If it is a contract with an exchange traded company it is the exchange which is behind the loan and you are safe from credit risk. This is called counterparty risk. Cannot eliminate, just hoping the third party is a better risk then the company you are loaning to.

With OTC contracts there is an incentive for the other party to default when you "win."

Background on SWAPS

- One of the largest derivative OTC markets that exist.
- Swaps are multi-period **extensions of forward contracts**
  - For example, rather than agreeing to exchange British pounds for U.S. dollars at an agreed-upon forward price at one single date (a single date would just be a forward contract), a foreign exchange swap would call for an exchange of currencies **on several future dates** such as every 6 months for 2 years.
  - The parties might exchange $1.6 million for £1 million in each of the next 5 years
  - This type of arrangement is an extension of a forward contract called a swap. **A series of forward contracts bundled together**.
- An **INTEREST RATE SWAP** is an arrangement whereby **one party exchanges one set of interest payments for another set of interest payments**. (large segment of market).
  - Ex: fixed-rate payments exchanged for floating-rate payments. A company which is not credit worthy (enough) may have to use such an arrangement. The company does not want the high exposure of floating rate payments so they barrow from investors to swap out their floating rate debt with fixed rate. The bank swaps their floating payments for fixed rate payments.
- Interest rate swap as succession of forwards (forward agreements)
  - **Swap BUYER agrees to pay fixed-rate**.
  - **Swap SELLER agrees to pay floating-rate**.

If I buy an interest rate swap I am agreeing to make fixed payments. If I sell a swap I am agreeing to make floating payments.

- The provisions of a swap include (generally what is in a swap contract):
  - The **NOTIONAL PRINCIPAL**: used to calculate what the interest payments actually are. This is the basis for the "what is LIBOR + 200bp" tied to, what the interest rate represents. This is why the swap market appears to be so big, but looking at the size of the swap market you are really seeing the notional amount of the swap contracts. This notional amount is not owed by anyone.
  - The **FIXED INTEREST RATE**: must be specified. Formula and type of index to determine the floating rate,
  - The **formula and type of index to determine the floating rate**: market benchmark to say what the floating rate is on each payment day. LIBOR is often used as the index to calculate the floating rate, "LIBOR + X bp."
  - The **FREQUENCY OF PAYMENTS**: annual, monthly, quarterly, …
  - The **LIFETIME** of the swap: how long until it dies.
- Amounts owed are typically netted out so that only the net payment is made; calculate what the fixed payment is, calculate what the floating

payment is, compare the two, the one that is greater is paid by the party owning that side of the contract to the party owning the other half of the contract.

- The market for swaps is facilitated by over-the-counter trading (some qusi-swap agreements on the CBOT)
  - Swaps are less standardized than any other type of derivative
- Swaps became popular in the early 1980s because of large fluctuations in interest rates, ways of making money off these interest rate fluctuations.
- A primary reason for the popularity of swaps is **market imperfections**
  - A lack of information about foreign institutions and convenience encourages individual depositors to place deposits locally

Investors will not necessarily have a good understanding of financial practices in other countries.

- Swaps are sometimes used for speculative purposes, bets on which way interest rates are going to move.
  - e.g., a firm could engage in a swap to benefit from rising interest rates even if its operations are not exposed to interest rate movements

Buying a bundle of forward contracts. Grew up out of interest rate derivatives, swapping fixed payments for floating rate payments. (Standard Vanilla Swap)

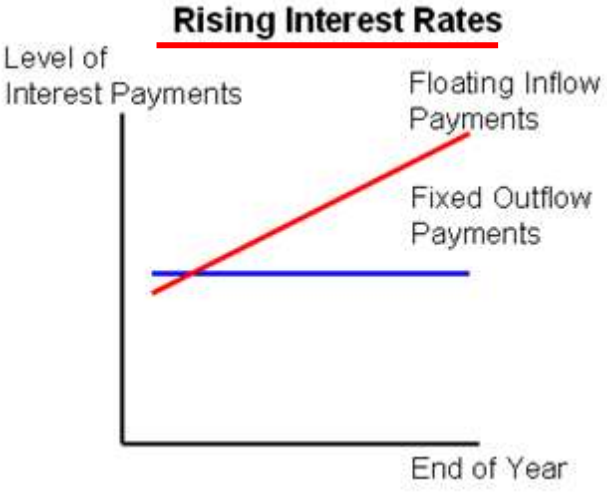
Why are Swaps Used?

- A corporation may find it easier to issue floating rate debt
  - But wishes to limit its exposure to interest movements, lock in a fixed rate so they …
  - Swaps outs its floating rate payments for fixed
- A bank has a balance sheet financed with floating rate deposits but invests in fixed rate mortgages. Bank has a problem with DURATION. Barrowing short term floating, investing long term fixed. Exposed if interest rates move. Can limit its exposure using swap contracts. (example below)

Types of Interest Rate Swaps

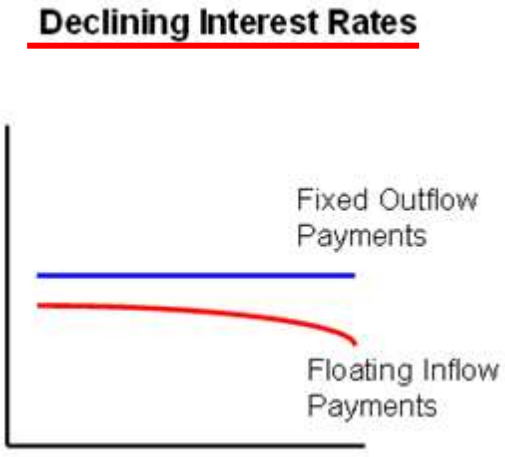
❑ PLAIN VANILLA SWAPS

* In a plain vanilla swap (**FIXED-FOR-FLOATING SWAP**), fixed-rate payments are periodically exchanged for floating-rate payments
* Consider two scenarios:
  - A consistent **rise** in market interest rates
  - A consistent **decline** in market interest rates



Red is floating payment and how it is changing over time wrt interest rates. Blue line is the fixed payment which does not change with interest rates.

In a rising interest rate situation the fixed payer is better off because he receives the floating rate payments, the difference (?) as they rise above the fixed rate payment values. The inflow from the floating rate payments are going to increase.



Declining interest rates help the seller of the swap, the floating rate payer.

(example next page)

Using A PLAIN VANILLA SWAP

- Bruny Bank has negotiated a plain vanilla swap in which it will exchange FIXED PAYMENTS OF 8 PERCENT for FLOATING PAYMENTS EQUAL TO LIBOR PLUS 1 PERCENT (= 100 BP) at the end of each of the next four years
  - Assume that the NOTIONAL PRINCIPAL IS $100 MILLION
  - scenario1: rising interest rates
  - scenario2: falling interest rates

Scenario 1 (RISING)	**Year**			
(benefit buyer, fixed payer)	**1**	**2**	**3**	**4**
LIBOR	7.0%	7.5%	8.5%	9.5%
Floating rate received	**8.0%**	**8.5%**	**9.5%**	**10.5%**
Fixed rate paid	**8.0%**	**8.0%**	**8.0%**	**8.0%**
Swap differential	**0.0%**	**0.5%**	**1.5%**	**2.5%**
Net dollar amount received	**$0**	**$500K**	**$1.5M**	**$2.5M**
Scenario 2 (FALLING)	**Year**			
(benefit seller, float payer)	**1**	**2**	**3**	**4**
LIBOR	6.5%	6.0%	5.0%	4.5%
Floating rate received	**7.5%**	**7.0%**	**6.0%**	**5.5%**
Fixed rate paid	**8.0%**	**8.0%**	**8.0%**	**8.0%**
Swap differential	**–0.5%**	**–1.0%**	**–2.0%**	**–2.5%**
Net dollar amount received	**–$500K**	**–$1M**	**–$2M**	**–$2.5M**

The floating rate received is 100 bp greater than LIBOR.
Swap Differential = Fixed - Floating

Year 2 Rising: Δ = .5% → $100,000,000 * .005 = $500,000 payment to swap buyer (Fixed Payer)

Year 1 Falling: Δ = -.5% → $100,000,000 * -.005 = -$500,000 payment to swap seller (Floating Rate Payer)

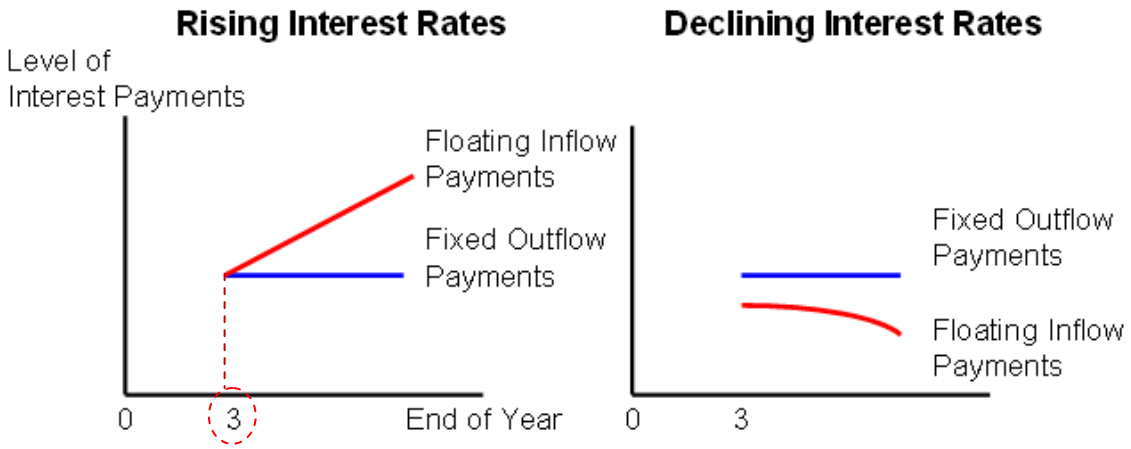
No premium up front but premiums are adjusted.

Types of Interest Rate Swaps (continued)

FORWARD SWAPS

- A forward swap involves an exchange of interest payments that **does not begin until a specified future point in time**
  - Useful for institutions that expect to be exposed to interest rate risk at a future point in time (reduce exposure to interest rates over the long term)
  - **The fixed rate on a forward swap may differ from the fixed rate on a swap beginning immediately**
    - Institutions may be able to negotiate a fixed rate today that is less than the expected fixed rate on a swap negotiated in the future

- A forward swap beginning in year 3:



Swap agreement which does not begin until some future point, delayed swap agreement. Say today you have negotiated fixed rate lending at 8%. This rate will certainly change in the future. If you try to negotiate one of these things with a forward element to it, the fixed rate is going to differ from the plain vanilla swap depending on which way the market feels the rates are going to move. You are locked in at the time of the agreement (but remember no funds are turned over).

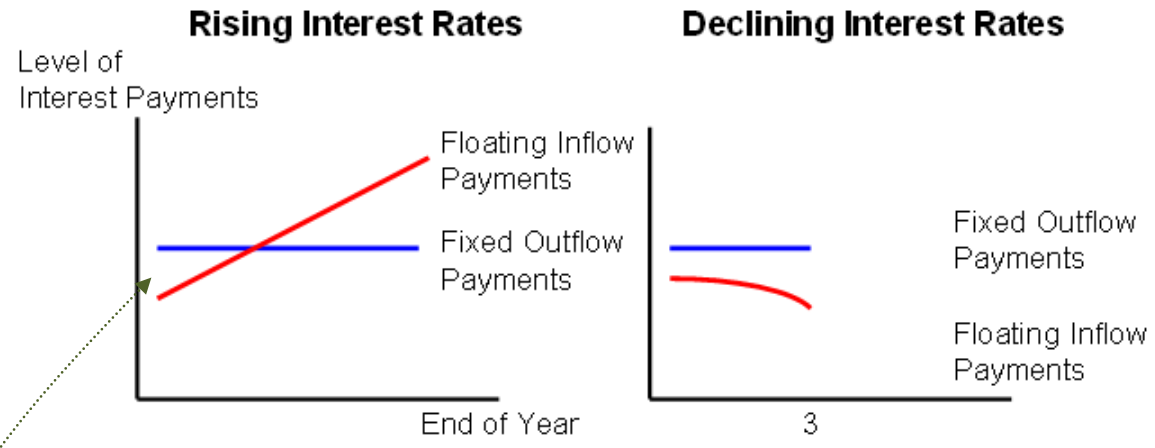
In this example the contract is deferred 2 years because with a plain vanilla swap the first payment is 1 year in the future (or whatever period is agreed to). Same situation but starting point is in the future.

Types of Interest Rate Swaps (continued)

CALLABLE SWAPS

- A callable swap provides the **party making the fixed payments** with the **right to terminate** the swap **prior to its maturity**
  - Allows the fixed-rate payer to avoid exchanging future interest payments if it desires
- The fixed-rate payer pays a premium in the form of a higher interest rate than without the call feature
- Callable swaps are an example of swaptions, a swap with an option attached.

❑ A callable swap terminated in year 3:



If the buyer of the swap (fixed payer) does not like the way things have developed (market interest rates have moved) he can terminate the swap agreement. Option to discontinue. The Fixed rate Payer pays a premium for this option in exchange for the greater flexibility. The premium is a higher interest rate than without the call feature. So the fixed rate for the swaption is higher than for that of a comparable plain vanilla swap.

Interest Rates Increasing: buyer of swap (fixed payer) is happy. Does not terminate.

Interest Rates Declining: at some point when the buyer believes there is no chance of the rates recovering, he will terminate the contract.

Swaptions: bundles of forward agreements with options on continuing.

Fixed rate will be higher than the equivalent fixed rate of a vanilla swap.

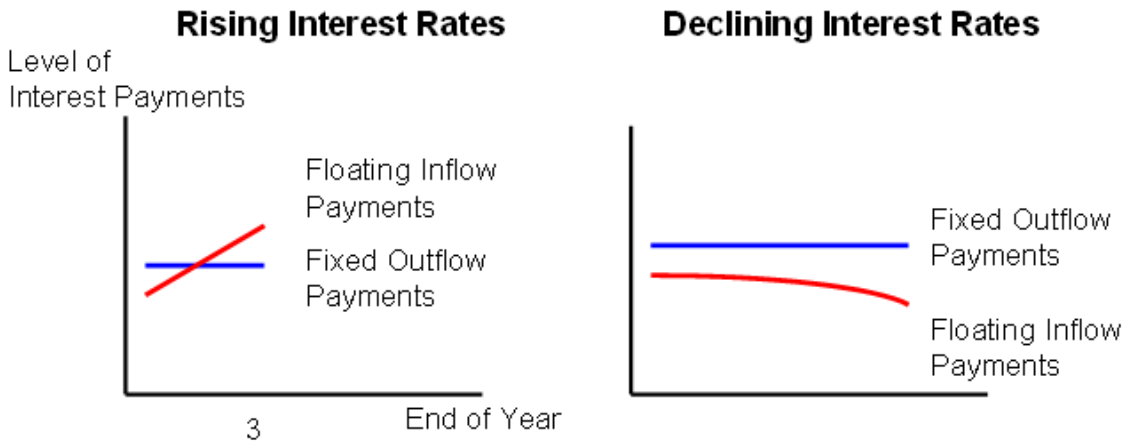
First payment made is in the future, will not know what the LIBOR rate will be.

Types of Interest Rate Swaps (continued)

PUTABLE SWAPS

* A putable swap provides the party making the **floating-rate payments** (SELLER) with a right to terminate the swap
  - The floating-rate payer pays a premium in the form of a higher floating rate

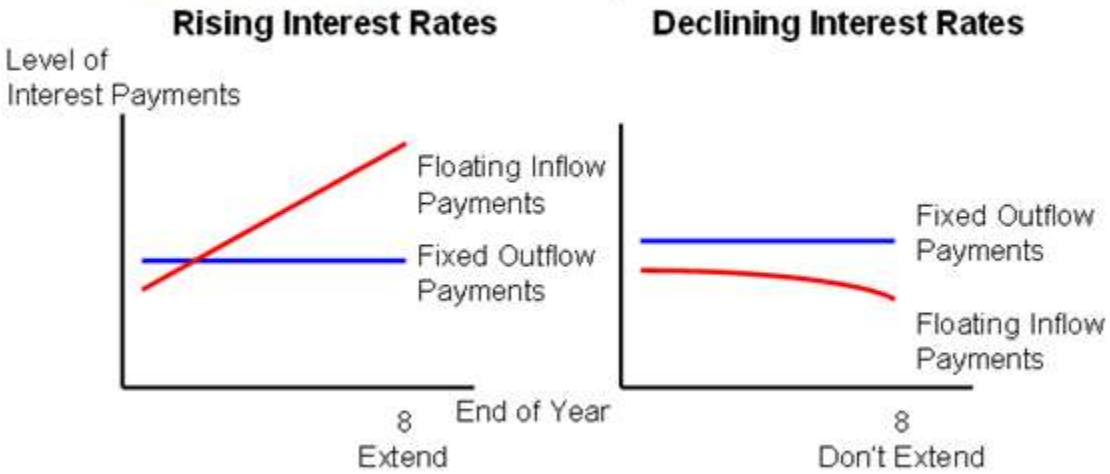
❑ A putable swap terminated in year 3:



EXTENDABLE SWAPS

* An extendable swap contains a feature that allows the **fixed-for-floating** party to **extend the swap period**, option at scheduled termination to keep the swap in place for an additional x years. Premium will likely be higher fixed rate.
* The terms of an extendable swap reflect a price paid for the extendibility feature

❑ An extandable swap after year 8:

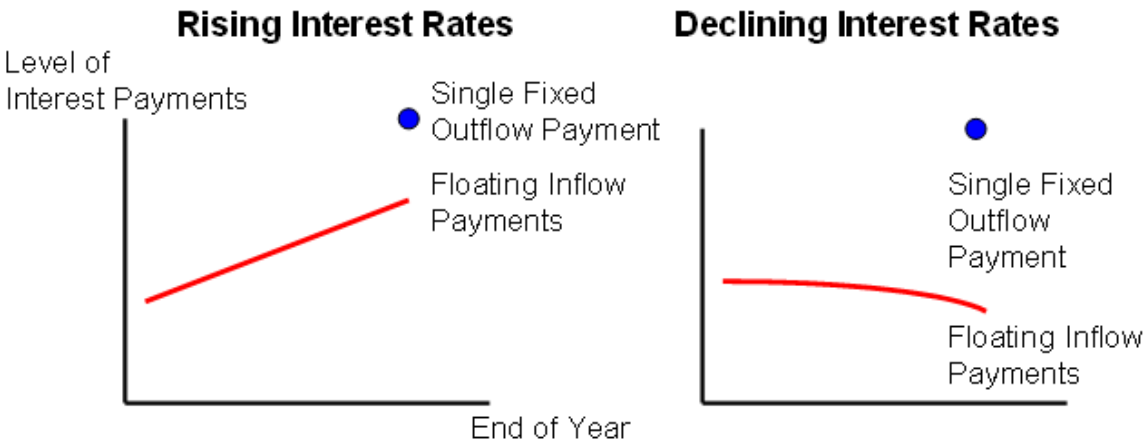


Types of Interest Rate Swaps (continued)

ZERO-COUPON-FOR-FLOATING SWAPS

- In a zero-coupon-for-floating swap:
  - The **fixed-rate payer** makes a **single payment** at the maturity date
  - The **floating-rate payer** makes **periodic payments** throughout the swap period
- An institution that expects interest rates to increase would prefer to be the fixed-rate payer
- An institution that expects interest rates to decline would prefer to be the floating-rate payer

❑ A zero-coupon-for-floating swap:



Fixed Payer (buyer) makes one lump sum payment at end of contract (thus the coupon name). Floating rate payer still makes the floating rate payments.

If I expect interest rates to increase I want to be the fixed payer and make a lump sum payment at the end. This allows me to let the increasing rtaes work onmy money before giving it up.

If I believe interest rates are going to decline I want to sell this contract (be the floating rate payer) because I will profit from the difference between fixed rate and falling floating rate.

● The blue dot in graphics is the lump sum.

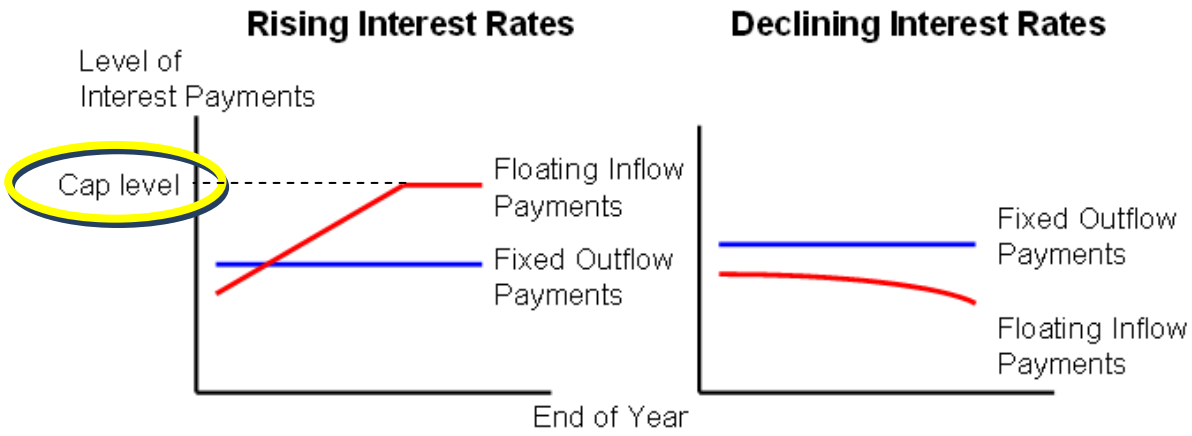
This type of contract may help make duration calculations easier.

Types of Interest Rate Swaps (continued)

RATE-CAPPED SWAPS

- A rate-capped swap involves the exchange of fixed-rate payments for floating-rate **payments that are capped**
- The floating-rate payer pays an up-front fee for this feature
- The fixed-rate payer may allow the cap if it believes interest rates will not exceed the cap and receives the up-front fee

❑ A rate-capped swap:



The floating rate payer is able to cap his exposure. Fixed rate payer does not believe interest rates will exceed cap. Receives a premium up front to cap the floating rate payments.

Generally these things (meaning all the above swaps) are used by banks to hedge their balance sheets.

Types of Interest Rate Swaps

EQUITY SWAPS

- An equity swap involves the **exchange of interest payments linked to the degree of change in a stock index**
- Appropriate for portfolio managers of insurance companies or pension funds that are managing stocks and bonds, they have fixed payments. They may use these mechanisms to protect their asset portfolios and ensure they can make their fixed payments under their contracts in the future.

Instead of having interest payments linked to LIBOR you have interest payments linked to the S&P500 or some other stock index.

RISKS of Interest Rate Swaps

- **Basis risk** is the risk that the interest rate of the index used for an interest rate swap **will not move perfectly in tandem** with the floating-rate instruments of the parties involved in the swap (imperfect correlation)
- **Default risk** is the risk that a firm involved in the swap will not meet its payment obligations (these are OTC)
  - Usually not pronounced because the non-defaulting party will discontinue its payments
  - When you are in the money the other party is out of the money and therefore more likely to default.

Currency Swaps

FIXED-FIXED CURRENCY SWAPS

- Suppose a US based company opens a division in England
  - Financed with bonds with a face value of $1 billion
- The business has mismatched assets and liabilities
  - The project in England financed with US debt (makes profit in BP£ but is financed with US debt). Exposed to currency risk.
- Could reduce this exposure by initially financing the expansion with BP£ denominated debt. Debt and income in pounds.
  - This may be difficult to do, medium sized company in US may have difficulty issuing bonds in UK.

- Alternatively, the company could swap its $ debt payments for fixed BP£ payments.
  - The fixed-fixed refers to the original debt agreements
  - Contrast with fixed-floating currency swaps
  - All of the risk comes from variable exchange rates.

Synthesized Barrowing

Someone has a US debt and someone else has a UK debt. The two agree to swap their fixed interest payments. One fixed interest payment is in dollars, one is in pounds. It's called Fixed-Fixed because the amounts are locked but if exchange rates move one party will profit and the other will lose.

Fixed-Fixed refers to the original debt agreements. No variable element.

Fixed-Floating currency swaps, one party makes fixed payments and receives back floating payments in another currency. Foreign exchange risk and interest rate risk in the same contract.

Interest Rate Caps, Floors, and Collars

INTEREST RATE CAPS

- An interest rate cap generates payments to the buyer of the cap in periods when a specified interest rate index exceeds a specified ceiling (cap) interest rate (an option on interest rates) (Gives coverage if interest rates go too high)
  - Payments are based on the amount by which the interest rate exceeds the ceiling, person I bought the cap from makes the payment to me.
- Typical purchasers are institutions that are adversely affected by rising interest rates
- Buying a cap means buying a call option or a succession of call options on interest rates
- The seller of an interest rate cap received an up-front fee (premium) and is obligated to provide period payments at certain dates if the interest rate is above the agreed upon cap level
- Commercial banks and securities firms serve as dealers and/or brokers for interest rate caps

Bungee Bank purchases a three-year cap for a fee of 3 percent of **notional principal** valued at $50 million, with an interest rate ceiling of 10 percent. The agreement specified LIBOR to be used to represent the prevailing market interest rate. LIBOR is currently 8 percent and is expected to increase by 1 percent in each of the next three years. Fill in the table below. If interest rates go above 10% then the seller of the cap has to make payments back.

Cap level is 10%	**End of Year**			
Rates are rising	**0**	**1**	**2**	**3**
LIBOR		9.0%	10.0%	11.0%
Interest rate ceiling		10.0%	10.0%	10.0%
LIBOR's percent above ceiling		0%	0%	1.0%
Payments received		$0	$0	$500,000
Fee paid	$ 1.5 million			

As long as the interest rate at each of the anniversary dates is below the ceiling no payments are made (unlike a swap). The $500,000 payment is 1% of the $50 million notional principle.

Fee Paid calculation: 3% * $50 mil (notional amount) = $1.5 mil
This fee is the equivalent of a premium.

INTEREST RATE FLOORS

- An interest rate floor offers payments when a specified **interest rate index falls below a specified floor rate**
  - Payments are based on the **amount by which the interest rate falls below** the floors rate
- Interest rate floors can be used to **hedge against lower interest rates**
- **BUYING A FLOOR** means buying a **PUT OPTION** or series of puts on interest rates
  - Sellers of interest rate floors receive an up-front fee (premium) and are obligated to provide periodic payments as needed if the option is in the money
- Commercial banks and securities firms serve as dealers and/or brokers for interest rate floors

EXAMPLE: Purage Bank purchases a **three-year floor** for a fee of **3 percent** of **notional principal valued at $50 million**, with an interest rate floor of 8 percent. The agreement specified LIBOR to be used to represent the prevailing market interest rate. LIBOR is currently 6 percent and is expected to increase by 1 percent in each of the next three years. Fill in the table below.

3 year floor, 3% fee LIBOR is 6%	**End of Year**			
Rates are rising	**0**	**1**	**2**	**3**
LIBOR		7.0%	8.0%	9.0%
Interest rate floor		**8.0%**	**8.0%**	**8.0%**
LIBOR's percent below floor		**1%** =7% - 6%	**0%**	**0%**
Payments received		**$500,000** =1% * 50 mil	**$0**	**$0**
Fee paid	**$1,500,000** =3% * $50mil			

This example is in-the-money to start, floor is at 8% and LIBOR is already below that floor.

Fee Paid calculation: 3% * $50 mil (notional amount) = $1.5 mil
This fee is the equivalent of a premium.

INTEREST RATE COLLARS

- An interest rate collar involves the **purchase of an interest rate cap** and the simultaneous **sale of an interest rate floor**
  - The fee received from selling the floor can be used to pay the fee for purchasing the cap
- Institutions wishing to hedge against rising interest rates purchase collars
  - If interest rates rise as expected and remain above the floor, the institution will not have to make payments

Buy the cap for protection against rising interest rates, sell the floor to someone who wants protection against falling interest rates.

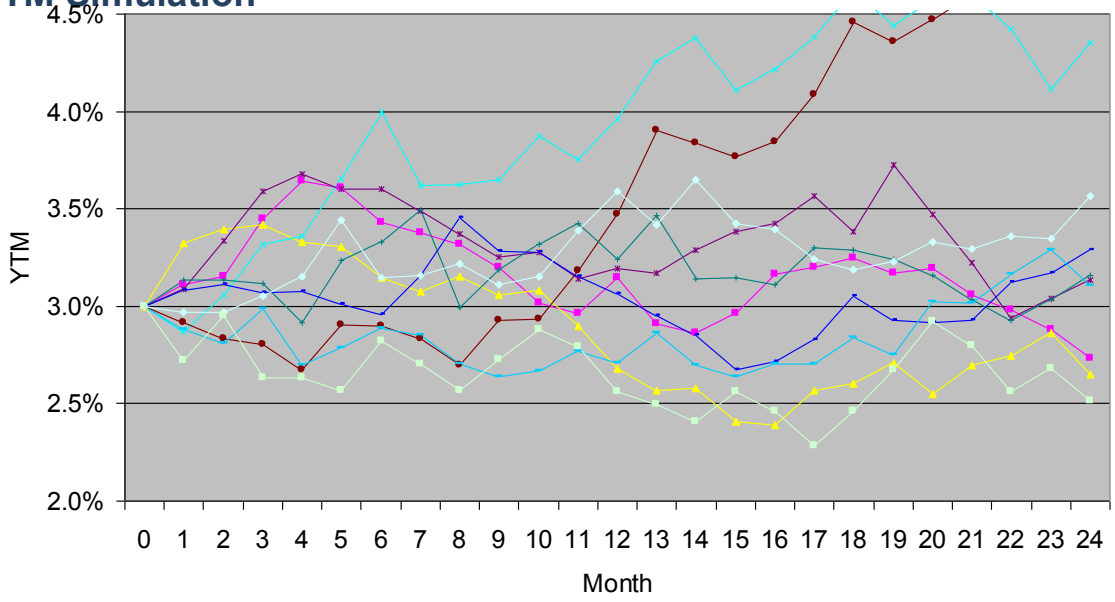
When you buy the cap you pay an up front fee
When you sell the floor you receive an up front fee
So the collar finances the protection on the up side by giving away some of the benefit on the downside.

Example: banks are usually more profitable as interest rates fall, therefore a bank may use a collar to protect itself against rising interest rates but that cap can be expensive so it sells a floor. Gives away some of the benefits from its operations on the downside, but receives a fee for this and uses that fee to pay for the cap.

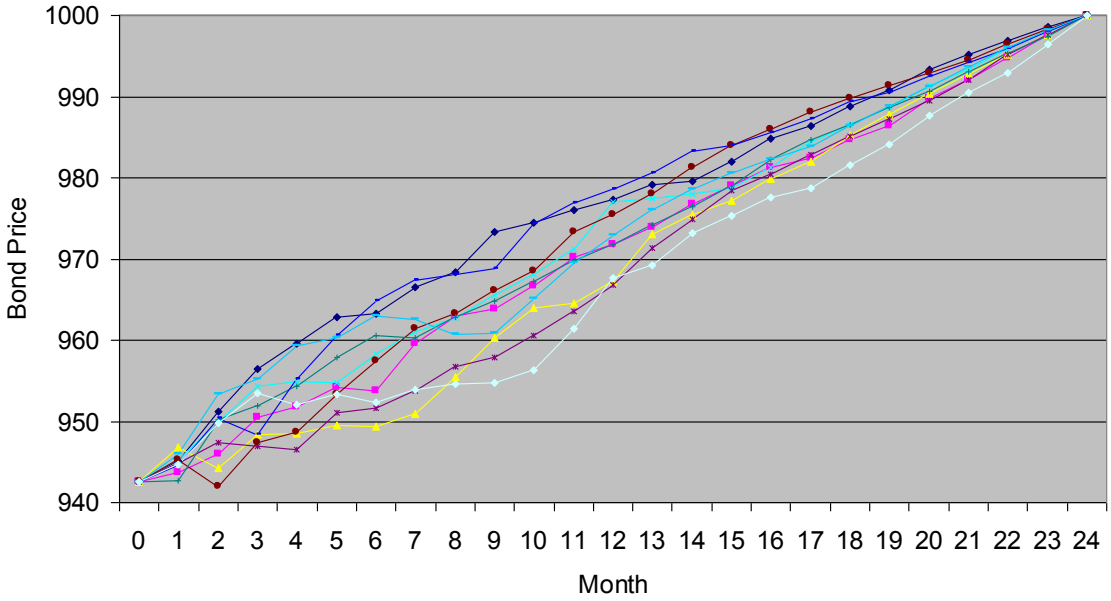
Hedging Bonds

- Weaknesses of Black-Scholes model.
  - Assumes short-term interest rate constant
  - Assumes constant variance of returns on underlying asset.
  - Behavior of bond prices between issuance and maturity
    - Pull-to-par

YTM Simulation



Bond Price Simulation



- Notice that the volatility of prices is not constant
- And that prices converge to the face value at maturity
  - An application of Black-Scholes will not be available
- We have to price a put option on this bond using alternative methods
  - Risk-neutral approach
  - Simulation techniques

Actual Bond Options

- Most pure bond options trade over-the-counter
  - Open interest on CBOE relatively small
- Preferred method of hedging is an option on an interest rate futures contract
  - Combines best features of futures contracts with asymmetric payoff features of options

Other Derivatives

- Weather Derivatives
  - Until recently, insurance has been the main tool used by companies' for protection against unexpected weather conditions
  - Insurance provides protection only against catastrophic damage
  - Insurance does nothing to protect against the reduced demand that businesses experience as a result of weather that is warmer or colder than expected

Weather Derivatives

- **CME Weather Products** are temperature-based index futures and options that are geared to **seasonal and monthly weather** in **18 U.S., nine European and two Asia-Pacific cities**
- The trade is **settled in cash** based on the final monthly or seasonal index value determined for each contract by Earth Satellite (EarthSat) Corporation, they accumulate the value of "heat" in these cities, rain fall basis also exist.

Traditionally companies have used insurance to protect against unexpected events. But these products cannot protect against such things as reduced demand if the weather turns bad. Another example would be Wal-Mart claiming they have not met their earnings projections due to such-and-such weather conditions in this or that region of the country.

Payments are based on actual versus predicted movements in weather temperatures (actual versus predicted).

Heating Degree Day

- Weather contracts for the winter months in U.S. and European cities are classified according to an index of **Heating Degree Day (HDD)** values
- An HDD value represents **the number of degrees the day's average temperature is lower than 65°**
  - For example, an average daily temperature of 40° would generate a daily HDD value of 25 (65 – 40 = 25 degrees below the average of 65)
  - **If the temperature exceeded 65°, the value of the HDD would be zero**, since theoretically, there would be no need for heating

Cooling Degree Day

- The contracts for U.S. cities in the summer months are geared to an index of Cooling Degree Day (CDD) values, days in which energy is used for air conditioning
- CDD values are calculated according to the **number of degrees an average daily temperature exceeds 65°**
  - For example, an average daily temperature of 80° would generate a daily CDD value of 15 (80 – 65 = 15 deg above average)
  - If the temperature were lower than 65°, the value of the CDD would be zero

Measuring Monthly Index Values

- **Monthly HDD or CDD** index values are the **sum of each daily HDD or CDD value** recorded during a given month or season
  - For example, if there were 10 HDD daily values recorded in November 2008 in Chicago, the November 2008 HDD index would be the sum of the 10 daily values

The Period HDD or CDD values are just the sum of the HDD and/or CDD values over the period.

EXAMPLE

- If the HDD values were 25, 15, 20, 25, 18, 22, 20, 19, 21 and 23 the monthly HDD index value would be **208** (deviation from 65 degrees)
- The value of a CME Weather futures contract is determined by **multiplying the monthly HDD or CDD value by $20**
  - Using the example above, the CME November Weather contract would settle at $4160 (**$20 x 208 = $4160**)

So this contract had every HDD translate to $20 (per degree).

Example of Use of Weather Derivatives

- A home improvement company knows that cool weather in spring means customers will not get started on spring and summer projects, and that this will have a negative effect on profitability
  - To hedge against the potential risk of a cool spring, the chain can sell (go short) CME CDD futures
  - They could sell at a CDD level of 400, for example, which might be close to the average in that area
  - If the weather is indeed cool and the CDD level only reaches 300, they could buy back their CDD contracts at 300, and make a profit of $2,000 per contract (100 index points x $20 per point = $2,000)
  - The profit on the weather futures could help offset the losses due to reduced sales

Selling "at the money" meaning they are selling the contract right at where the temperature historically should be. They want to benefit if the temperature moves away from the historical average.