Use of Derivatives in ALM

Derivatives

- **Derivative is a financial instrument or security whose payoffs depend on a more primitive or fundamental good.**
- **Financial derivative is a financial instrument whose payoffs depend on the financial instruments or security**
- **Types of derivative instruments: Futures, Forwards, Options and Swaps**

Forward Vs. Future

- **Forwards: A forward contract is a customized contract between two entities, where settlement takes place on a specific date in the future at today's pre-agreed price.**
- **Futures: A futures contract is an agreement between two parties to buy or sell an asset at a certain time in the future at a certain price. Futures contracts are special types of forward contracts in the sense that the former are standardized exchange-traded contracts**
- **Financial future contract is an Agreement Between a Buyer and a Seller Which Calls for the Delivery of a Particular Financial Asset at a Set Price at Some Future Date**

Futures Vs. Forwards Cont…

FORWARDS	FUTURES
Private contract between 2 parties	Exchange traded
Not standardized	Standard contract
Usually 1 specified delivery date	Range of delivery dates
Settled at maturity	Settled daily
Delivery or final cash settlement usually occurs	Contract usually closed out prior to maturity
Some credit risk	Virtually no credit risk

Buyers of Future Contract

- **A buyer of a futures contract is said to be *long futures***
- **Agrees to pay the underlying futures price or take delivery of the underlying asset**
- **Buyers gain when futures prices rise and lose when futures prices fall**

Seller of the Future Contract

- **A seller of a futures contract is said to be *short futures***
- **Agrees to receive the underlying futures price or to deliver the underlying asset**
- **Sellers gain when futures prices fall and lose when futures prices rise**

Relationship between Future Price and Spot Price

- **Basis is the relationship between the spot price and future price of the asset.**
- **Basis =Current Spot Price – Future Price**
- **Normal Market: Prices for more distant futures are higher than for nearby futures. Future Price > Spot Price**
- **Inverted Market: Distant Futures prices are lower than the prices for contracts nearer to the expiration. Future price < Spot Price**
- **When the future contract is at expiration, the future price and the spot price of asset must be same. Basis is zero. This behaviour of basis over time is known as convergence**

Options

- An option is a security that gives the holder the right to buy or sell, but not obligation a particular asset at a specified price, on or before, a specific date.
- Options are of two types - calls and puts. Calls give the buyer the right but not the obligation to buy a given quantity of the underlying asset, at a given price on or before a given future date. Puts give the buyer the right, but not the obligation to sell a given quantity of the underlying asset at a given price on or before a given date.
- A European option is one that can be exercised only at the exercise date, while an American option can be exercised at any time on or before the exercise date.

Options Cont…

Option Type	Buyers of Option (Long Position)	Writer of Option (Short Position)
Call	Right to Buy Asset	Obligation to Sell Asset
Put	Right to Sell Asset	Obligation to Buy Asset

Options Cont…

- **Every option has an option price, an exercise price, and an exercise date.**
- **The price paid by the buyer to the writer is referred to as the option premium**
  - **The exercise price or strike price is the price specified in the option contract at which the underlying asset can be purchased or sold.**
  - **The exercise date is the last day the holder can exercise.**

Concept of Moneyness

Condition	Call Option	Put Option
$S_0 > E$	In-the-Money	Out-of-the Money
$S_0 < E$	Out-of-the Money	In-the-Money
$S_0 = E$	At-the-Money	At-the-Money

Intrinsic Value and Time Value

- Option Premium = Intrinsic Value (Parity Value) + Time value (Premium over parity)
- Intrinsic value refers to the amount by which it is in-the-money
- Option which is out-of-the money has a zero intrinsic values
- For a call option which is in the money, the intrinsic value is the excess of stock price over the exercise price
- For a put option which is in the money, the intrinsic value is the excess of exercise price over the stock price

Example

Option	Exercise price	Stock price	Call Option price	Classification	Intrinsic value	Time Value
1	80	83.5	6.75	In-the-money	3.5	6.75-3.5
2	85	83.5	2.5	Out-of the money	0	2.5

Swap

- **Swaps are private agreements between two parties to exchange cash flows in the future according to a prearranged formula. They can be regarded as portfolios of forward contracts. The two commonly used swaps are :**
- ***Interest rate swaps*: These entail swapping only the interest related cash flows between the parties in the same currency.**
- ***Currency swaps*: These entail swapping both principal and interest between the parties, with the cash flows in one direction being in a different currency than those in the opposite direction.**

Use of Derivatives

- To hedge risks
- To speculate (take a view on the future direction of the market)
- To lock in an arbitrage profit
- To change the nature of a liability
- To change the nature of an investment without incurring the costs of selling one portfolio and buying another

What is Hedging?

- Managing risks by using one financial instrument ('hedging instrument') purposely to offset the variability in future value or cash flows of a recognized asset or liability, firm commitment, or future cash flows ('hedged item')
- Hedging is viewed as the purchasing insurance
- For hedging all the factors should match
  - Time span covered
  - Amount of the assets
  - Particular characteristics of the good

Long & Short Hedges (Hedging the dollar gap position)

- A long futures hedge is appropriate when you know you will purchase an asset in the future and want to lock in the price
- A short futures hedge is appropriate when you know you will sell an asset in the future & want to lock in the price
- A bank with a positive dollar gap would benefit on-balance-sheet from rising interest rates but would lose from falling interest rates. It would hedge this risk by taking a long or buy position in the financial futures market.
- If, conversely, the bank has a negative dollar gap it would take a short position in the futures market.

Long-Hedge in future

- A long hedge can be used to protect the bank against falling interest rates
- Long hedge applicable when interest rate falls; usually when a cash inflow is expected in the near future
- Positive dollar gap: RSA> RSL
- If interest rate falls then net interest margin will fall
- Strategy to be adopted: (i) Reduction of RSA, (ii) Long hedge by purchasing one or more T-Bill contracts for future delivery
- If interest rate falls then reduction in NIM would offset by the gain on the long-hedge in the future market
- If interest rate rises the gain in NIM would be offset by the loss on the futures transactions

Long Futures Hedge Process

- **Today – Contract is Purchased Through an Exchange**
- **Sometime in the Future – Contract is sold Through the Same Exchange**
- **Results – The Two Contracts are Cancelled by the Clearinghouse**
- **Gain or Loss is the Difference in the Price Purchase For (At the Beginning) and the Price Sold For (At the End)**

Short hedge in future

- **Negative dollar gap: RSA< RSL**
- **If interest rate increases then net interest margin will fall**
- **There will be gain in the short-hedge position, which will offset the loss in the spot market**
- **If interest falls then increased NIM would be offset by the loss on the future contracts**

Short Hedge in Futures : Example

- Consider securities portfolio of bank contains $10 million in 6%, 15 yr bonds
- Market yield increase from 6% to 6.5% →market value of bonds decreases from $10 million to $9,525,452.07
- Loss of $474,547.73 in cash market
- Loss offset by futures contract
- If the bank makes an offsetting sale and purchase of the same futures contract on a futures exchange, it has no obligation either to deliver or to take delivery of securities named in contracts

Short Futures Hedge Process

- **Today – Contract is Sold Through an Exchange**
- **Sometime in the Future – Contract is Purchased Through the Same Exchange**
- **Results – The Two Contracts Are Cancelled Out by the Futures Clearinghouse**
- **Gain or Loss is the Difference in the Price Purchased for (At the End) and Price Sold For (At the Beginning)**

Hedging with Futures Contracts

- **Typical interest rate hedging problems most banks face:**
  i. **Protecting the value of securities and fixed-rate loans from losses due to rising interest rates**
  ii. **Avoiding a rise in borrowing costs**
  iii. **Avoiding a fall in the interest returns expected from loans and securities holding**

Avoiding Higher Borrowing Costs and Declining Asset Values → **Use a Short Hedge: Sell Futures Contracts and then Purchase Similar Contracts Later**

Avoiding Lower Than Expected Yields from Loans and Securities → **Use a long Hedge: Buy Futures Contracts and then Sell Similar Contracts Later**

Futures to hedge Duration Gap

- **With a positive duration gap, a bank would experience a decline in the market value of equity if interest rates increased (because the market value of assets would fall more than the market value of liabilities). It could help this exposure by taking a short position in financial futures. With such a position, increases in interest rates would produce gains in the futures market position that could be used to offset the losses in the cash market position.**

- **In contrast, a bank with a negative duration gap would hedge with a long position in the futures market.**

- **Number of contracts to be bought or sold :**

  $[(V/F) \times (M_C / M_F)]\ b$

  V = value of cash flow to be hedged

  F = face value of futures contract

  M_C = maturity of anticipated cash assets

  M_F = maturity of futures contacts

  b = variability of cash market to futures market.

  ***Example*: A bank wishes to use 3-month futures to hedge a $48 million positive dollar gap over the next 6 months. (Assume the correlation coefficient of cash and futures positions as interest rates change is 1.0).**

  N = [(48/1) x (6/3)] 1 = 96 contracts.

Change in the Market Value of the Futures Contract

$$\frac{\text{Change in futures price}}{\text{Initial futures price}} = -\left[\begin{array}{c}\text{Duration of the}\\ \text{underlying security}\\ \text{named in the}\\ \text{futures contract}\end{array}\right] \times \left[\frac{\text{Change expected in interest rates}}{1 + \text{Original interest rate}}\right]$$

Change in the Market Value of the Futures Contract

$$\text{Positive or negative change in futures position value} = -\left[\begin{array}{c}\text{Duration of the underlying security named in the futures contract(s)}\end{array}\right] \times \left[\begin{array}{c}\text{Initial futures price}\end{array}\right] \times \left[\begin{array}{c}\text{Number of futures contracts}\end{array}\right] \times \left[\frac{\text{Change expected in interest rates}}{1 + \text{Original interest rate}}\right]$$

$$F_t - F_0 = -D \times F_0 \times N \times \frac{\Delta i}{(1+i)}$$

Number of Futures Contracts Needed

$$= \frac{(D_A - D_L * \frac{TL}{TA}) * TA}{D_F * \text{Price of the Futures Contract}}$$

Steps Involved in Hedging

Steps involved in hedging the interest-sensitivity position of a bank with respect to its dollar gap or duration gap:

1. **Determine the total interest rate risk either on or off the balance sheet**
2. **Select a futures contract: select contract most highly correlated with cash market instrument being hedged**
3. **Determine the number of contracts needed**
4. **Determine the maturity of the hedge**
5. **Place the hedge**
6. **Monitor the hedge**
7. **Lift the hedge**

Basis with a Short Hedge

- Banks fear increasing interest rate → change in cash market price $(C_t - C_0)$ will be negative
- Take short position in futures market to hedge the long position in cash market → gain of $(F_0 - F_t)$

$ Returns from a combined cash and futures position :

$$= (C_t - C_0) + (F_0 - F_t)$$

$$= (C_t - F_t) - (C_0 - F_0)$$

Dollar Return = Basis at termination of hedge – Basis at initiation of hedge

Basis with a Long Hedge

- Banks fear decreasing interest rate: create long hedge
- Take long position in futures market
- Loss (gain) in cash market = $(C_0 - C_t)$; gain (loss) in the futures market = $(F_t - F_0)$

$ Returns from a combined cash and futures position :

$$= (C_0 - C_t) + (F_t - F_0)$$

$$= (C_0 - F_0) - (C_t - F_t)$$

Dollar Return = Basis at initiation of hedge – Basis at termination of hedge

Realized Return from Combining Cash and Futures Market Trading

Return Earned in the Cash Market

+/- Profit or Loss from Futures Trading

- **Closing Basis Between Cash and Futures Market**

- **Opening Basis Between Cash and Futures Market**

Interest Rate Options

- **Interest rate option grants a holder of securities the right to either :**

  a. **Sell (put) those instruments with another investor at a pre-specified exercise price before the option expires**

  b. **Buy securities (call) from another investor at a pre-specified price before the option's expiration date**

Interest Rate Options

- **Put option writer must stand ready to accept delivery of securities from the option buyer if the option is exercised**
- **Call option writer must stand ready to sell the securities to the option buyer upon request**
- **The fee than an option buyer should pay to the option writer for this facility is known as *option premium***

Futures Versus Options

- Unlike futures, options do not obligate any party to deliver securities and require a smaller initial outlay
- The option buyer can
  1. Exercise the option
  2. Sell the option to another buyer
  3. Allow the option to expire
- Interest rate options are traded mostly over the counter markets where the exercise date and price can be tailored to the needs of the option buyer

Futures Options Market

- **A futures options contract is an option contract in which the deliverable is a futures contract, such as the Treasury bill futures contract. For standardized exchange traded interest rate option most activities happen using the *futures option market***
- **Buyer of call futures option has the right, but not the obligation, to take a long position in the futures market at the exercise (strike) price any time prior to expiration of the options contract**
- **Buyer of put futures option has the right, but not the obligation to take a short position in the future market at the exercise (strike) price anytime prior to expiration of option**

Principal Uses of Option Contracts

1. Protecting a security portfolio through the use of put options to insulate against falling security prices (rising interest rates)
2. Hedging against positive or negative gaps between interest-sensitive assets and interest- sensitive liabilities

Hedging Interest Rate and Futures Options Contract

- **Future price is highly correlated with the underlying cash price → futures on option can be used to hedge interest rate risk**
- **Example: Buyer of a T-bond future option at exchange is granted the right call or short position in a T-bond futures contract at the exercise price until option expires**
  - **i. If interest rate rise, put(sell) options are most likely to be exercised**
  - **ii. If interest rate falls, holders of call options will be more inclined to exercise their option**

Example:

- **Suppose that your bank has a commitment to make a fixed rate loan in three months at the existing rate. In order to hedge against the prospect of rising interest rates, the bank takes a position in the futures options markets. What position should it take? The relevant information is as follows: T-bill futures prices:89; Put option:90; Premium Rs.2500. What will be the net gain to the bank if T-bill futures prices fall to 85? Increase to 93?**

- **If T-bill futures prices fall to 85, the put option could be exercised at 90 for a gain of 5, or Rs. 50,000. After paying the premium, the net gain would be Rs. 47,500.**

- **If T-bill futures prices rise to 93, the put option would not be exercised. The loss would equal the premium paid for the option, or Rs. 2,500.**

Hedging Dollar Gap with Options

- **Suppose interest sensitive liabilities > interest sensitive assets ; bank has a negative dollar gap**
- **Without hedging: if interest rate increases, net interest income declines**
- **Long interest rate put option reduces the interest rate risk**

  ✓**If interest rate increases, bank earns profit on put option and could use it to reduce or eliminate the net interest income loss from negative dollar gap**

  ✓**If interest rates decrease, the bank would not exercise its put option, and benefit from an increasing net interest income (minus the put premium)**

Hedging Dollar Gap with Options Cont…

- **Conversely interest sensitive assets > interest sensitive liabilities ; bank has a positive dollar gap**
- **Banks buy interest rate call option hedge the interest rate risk**

  ✓**If interest rate fall, bank would lose on its cash or spot market portfolio, but gain from its options position would partially or completely offset that loss**

  ✓**If interest rate rise, the gain from net interest income would only be partially offset by option cost (premium)**

Hedging Dollar Gap with Futures Options Contract

- **When bank has negative dollar gap and is concerned about rising interest rates : buy a put option in T-bill future contracts**

  ✓**If interest rate increases and T-bill prices will fall, the gain in futures position could be exercised**

  ✓**If interest rate decreases, T-bill prices rise and T-bill futures contract is not exercised**

Hedging Dollar Gap with Futures Options Contract

- **When bank has positive dollar gap and concerned about falling interest rates : buy a call option in T-bill future contracts**
  - ✓**As interest rates fall, the call option would earn profits to offset declining net interest income**
  - ✓**If interest rate rises, the call option would not be exercised**

Interest Rate Swaps

- **A swap is an agreement to exchange cash flows at specified future times according to certain specified rules.**
- **Interest rate swap is a way to change a borrowing institution's exposure to interest rate fluctuations and achieve lower borrowing costs.**
- **Swap participants can convert from fixed to floating interest rates or from floating to fixed interest rates and more closely match the maturities of their liabilities to the maturities of their assets**

Interest Rate Swap Cont..

- A company agrees to pay cash flows equal to interest at a predetermined fixed rate on a notional principal and in return it receives the interest at a floating on same principal for same period of time
- Mostly, swaps are used to transform the nature of assets and liabilities

Example

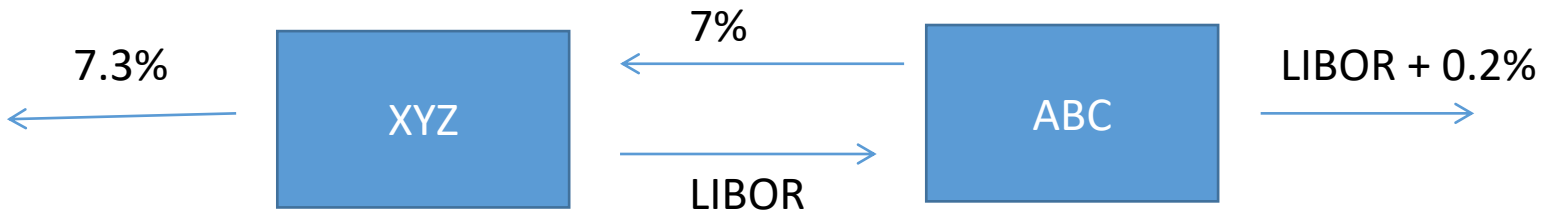
- Let there is a 3 year swap started on 15 March 2018 between the companies ABC and XYZ
- Company ABC agrees to pay an interest rate of 7 % per annum on a principal of Rs. 100 crore
- In return XYZ agrees to pay ABC 6-month LIBOR rate on the same principal
- ABC is the fixed player and XYZ is the floating rate player

Cash Flow to ABC

Date	Six Month LIBOR rate	Floating Rate Cash Flow (Received)	Fixed Cash Flow (Paid)	Net Cash Flow
March 15, 2018	6.0			
Sept 15, 2018	6.2	3	-3.5	-0.5
March 15, 1019	7.4	3.1	-3.5	-0.4
Sept, 15, 2019	7.5	3.7	-3.5	0.2
March 15, 1020	7.8	3.75	-3.5	0.25
Sept, 15, 2020	8.0	3.9	-3.5	0.40
March 15, 20		4.0	-3.5	0.50

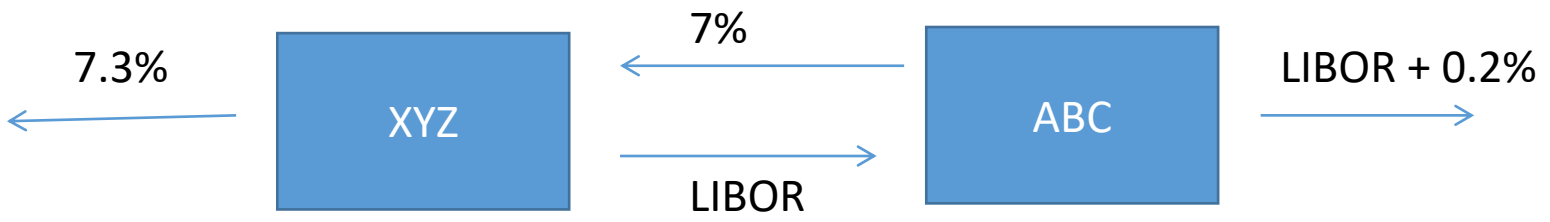
Using Swap to Transform a Liability

- For ABC this swap may be used to transform a floating rate loan into a fixed rate loan. How?
- Let ABC has borrowed Rs. 100 crore at LIBOR plus 20 basis point (from outside). After entering into swap the cash flows will be:
- It pays LIBOR plus 0.2% to the outside lender
- It receives LIBOR under the terms of swap
- It pays 7% under the terms of swap
- This arrangement makes the floating rate loan to fixed rate loan (7.2%)



Using Swap to Transform a Liability

- Let ABC has borrowed Rs. 100 crore at 7.3% (from outside). After entering into swap the cash flows will be:
- It pays 7.3% to the outside lender
- It pays LIBOR under the terms of swap
- It receives 7% under the terms of swap
- This arrangement makes the fixed rate loan to floating rate loan (LIBOR + 0.3%)



Using the swap to transform an asset (nature of an asset)

- Suppose Company X owns Rs.100 million in bonds that will provide 4.7% per annum over the next 3 years. Now company X enters into a swap, wants to switch its assets from fixed to floating rate.
- Investment income 4.7%
- Less: Paid under swap -5%
- Add: Received under swap +LIBOR
- Net income LIBOR-0.3%

Using the swap to transform an asset (nature of an asset) Con…

- Company Y is transforming an asset earning floating to fixed. Suppose Y has an investment Rs.100 million that yields LIBOR-0.20. After it has entered into the swap:
- Investment income LIBOR-0.20
- Less: Paid under swap - LIBOR
- Add: Received under swap + 5%
- Net Investment income 4.8%

The Comparative Advantage Argument

AAA Company and BBB Company wish to borrow Rs.10 million for 5 years

- AAA wants to borrow floating
- BBB wants to borrow fixed

	Fixed	*Floating*
AAA	4.0%	6-month LIBOR − 0.10%
BBB	5.2%	6-month LIBOR + 0.6%

The Comparative Advantage Argument

- BBB has a comparative advantage in floating market and AAA has a comparative advantage in fixed rate market.
- They can enter into a swap that AAA ends up with floating rate funds and BBB ends up with fixed rate funds.
- Suppose AAA agrees to pay interest at 6 month LIBOR on Rs.10 million and BBB agrees to pay 4.35% per annum on Rs.10 million.

Comparative Advantage Argument

	AAA	BBB
Loan payment	4%	LIBOR+0.6%
Add: Paid under swap	+ LIBOR	+ 4.35%
Less: Received under swap	-4.35%	-LIBOR
Net Payment (Before)	LIBOR-0.35% (LIBOR-0.10%) (0.25% gain)	4.95% (5.2%) (0.25% gain)

Comparative Advantage Argument

- The swap agreement appears to improve the position of both company.
- Total gain is: 0.25+0.25=0.50%
- If “a” is the difference between the interest rates in fixed market and if “b” is the difference between the interest rates in floating market.
- Total gain is; a-b
- a = 1.2% (5.2%-5%)
- b= 0.7% (LIBOR+0.6%-(LIBOR-0.1%))
- a-b = 1.2-0.7=0.5%

Criticism of the Comparative Advantage Argument

- The 4.0% and 5.2% rates available to AAACorp and BBBCorp in fixed rate markets are 5-year rates
- The LIBOR−0.1% and LIBOR+0.6% rates available in the floating rate market are six-month rates
- BBBCorp's fixed rate depends on the spread above LIBOR it borrows at in the future

Use of Swap

- **Firms with a negative GAP can reduce risk by making a fixed-rate interest payment in exchange for a floating-rate interest receipt**

- **Firms with a positive GAP take the opposite position, by making floating-interest payments in exchange for a fixed-rate receipt**

Currency Swaps

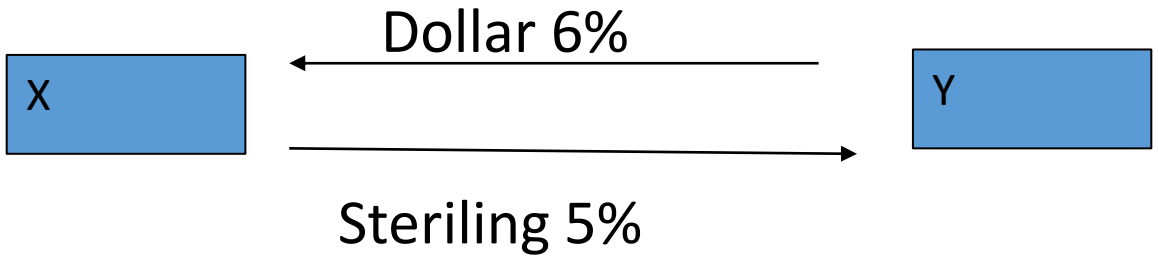
- Exchanging principal and interest payments in one currency for principal and interest payments in another currency.
- In an interest rate swap the principal is not exchanged
- In a currency swap the principal is usually exchanged at the beginning and the end of the swap's life

Fixed-for-fixed currency swap

- This involves exchanging principal and interest payments at a fixed rate in one currency for principal and interest payments at a fixed rate in another currency.
- Usually the principal amounts are chosen to be approximately equivalent using the exchange rate at the swap's initiation. When they are exchanged at the end of the life of the swap, their values may be quite different.

Example

- Consider a 5-year currency swap agreement between X and Y entered into on February 1, 2015. We suppose that X pays a fixed rate of interest of 5%in sterling and receives a fixed rate of interest of 6%in dollars from Y. Interest rate payments are made once a year and the principal amounts are $15 million and £10 million. This is termed a fixed-for-fixed currency swap because the interest rate in each currency is at a fixed rate.



Cash Flow to X

	Dollar cash flow (millions)	Sterling cash flow (millions)
February 1, 2015	-15.00	+10.00
February 1, 2016	+0.90	-0.50
February 1, 2017	+0.90	-0.50
February 1, 2018	+0.90	-0.50
February 1, 2019	+0.90	-0.50
February 1, 2020	+15.9	-10.50

Typical Uses of a Currency Swap

- Conversion from a liability in one currency to a liability in another currency

- Conversion from an investment in one currency to an investment in another currency

Use of a Currency Swap to Transform Liabilities and Assets

- A swap can be used to transform borrowings in one currency to borrowings in another. Suppose that X can issue $15 million of USdollar-denominated bonds at 6% interest. The swap has the effect of transforming this transaction into one where X has borrowed £10 million at 5% interest.
- The initial exchange of principal converts the proceeds of the bond issue from US dollars to sterling. The subsequent exchanges in the swap have the effect of swapping the interest and principal payments from dollars to sterling.
- The swap can also be used to transform the nature of assets. Suppose that X can invest £10 million in the UK to yield 5% per annum for the next 5 years, but feels that the US dollar will strengthen against sterling and prefers a US-dollar-denominated investment. The swap has the effect of transforming the UK investment into a $15 million investment in the US yielding 6%.

Comparative Advantage Arguments for Currency Swaps

General Electric wants to borrow 20 miilion AUD and Qantas wants to borrow 15 million USD (Exchange rate is $0.75 per AUD)

	USD	AUD
General Motors	5.0%	7.6%
Qantas	7.0%	8.0%

GE has a comparative advantage in USD and Qantas has a comparative advantage in AUD. So that GE borrows USD and Qantas borrows AUS then they enter into a currency swap to transform GE's loan into a AUD and Qantas loan into a USD.

Total gain to all parties: 2%-0.4% = 1.6%

Limitations of swap markets

- It is difficult to find counterparties wanting to take the opposite side of a specific transaction
- Swap agreements are difficult to alter and hard to terminate once they are initiated
- The counterparties are both exposed to default risk.