Week 3 – Interest Rate Risk

Interest Rate Risk

- Interest Rate (IR) Risk has a balance sheet focus
  o As we saw last week it arises from one of the core functions of FI's in intermediating the flow of funds within the economy
- The risk incurred by an FI when the maturity of its assets and liabilities are mismatched
- Why is this the case?
  o To illustrate we consider two simple cases:
- Assets longer than Liabilities – Creates Refinancing Risk
- Liabilities longer than Assets – Creates Reinvestment Risk
- The Magnitude of the Problem
  o Central banks target short term rates via setting official rates
  o Interest rate changes and volatility increasingly transmitted from country to country due to increased globalization of financial markets
  o Statements by the US Fed chairman, Jerome Powell, can have dramatic effects on world interest rates

Measuring Interest Rate Risk

- Risk has two factors that we need to assess in order to arrive at a measure of risk:
  o The Possibility or probability of a risk event and
  o The extent of loss incurred if the risk event occurs

Repricing Model

- The risk arises from the mismatch of the maturity of assets and liabilities, so the extent of the risk can be assessed by reference to the difference or "gap" between them
  - This is referred to as the "Repricing Gap"
- One consequence of the changes in interest rates is on an FI's net income (Earnings)
  - So, we need to focus on those assets generating interest incomes which varies with the market interest rate
  - Similarly, we need to consider those liabilities paying interest expenses which varies with the market interest rate

Let: ΔNII_i = change in net interest income (NII) in maturity bucket i,

GAP_i = dollar size of the gap between the book value of rate-sensitive assets and rate-sensitive liabilities in maturity bucket i,

ΔR_i = change in interest-rate levels impacting assets and liabilities in the i^{th} bucket.

$$\Delta NII_i = (GAP_i) \times \Delta R_i$$

$$\Delta NII_i = (RSA_i - RSL_i) \times \Delta R_i$$

$$\Delta NII_i = (RSA_i \times \Delta R_{RSA}) - (RSL_i \times \Delta R_{RSL})$$

⇨ As NII = Interest income – Interest expense = (Assets x r_{assets}) – (Liabilities x $r_{liabilities}$),

$$NII_{new} = NII_{original} + \Delta NII_i$$

Rate sensitivity = gap ratio = $\frac{\text{Cumulative gap}}{\text{Total assets}}$ (not in formula sheet)

- **Maturity Model** continued … a rise in interest rates:
  - Leads to a fall in the market value of a FI's asset and liability portfolios
  - The longer the maturity of a FI's asset and liability portfolio, the larger the fall in its market value
  - The rate of fall in market value of a FI's asset and liability portfolio diminishes the longer the maturity of the asset (convexity)
  - A rise in interest rates will have the opposite affect in market values for liabilities
  - The absolute value will fall if interest rates increase, but since liabilities are an obligation (i.e. they have a "negative" value) then this will result in a lower obligation or a smaller negative value (which is a gain).
  - **Problems:** Does not account for the degree of leverage, Does not account for the timing of cashflows, Assumes symmetric change in interest rates across different maturities

Week 5 – Liquidity Risk

Causes of Liquidity Risk

Liquidity risk arises for two reasons: a liability-side reason and an asset-side reason.

Liability Side

- The **liability-side** reason occurs when an FI's liability holders, such as depositors, seek to cash in their financial claims immediately
  - The FI needs to borrow additional funds or sell assets to meet the withdrawal.
  – The most liquid asset is cash.
  – However, FIs tend to minimise their holdings of cash reserves as assets because those reserves pay no interest.
  – While most assets can be turned into cash eventually, for some assets, this can be done only at a high cost when the asset must be liquidated immediately.
  (• The price the asset holder must accept is far less than it would receive with a longer horizon over which to negotiate a sale. • Thus, some assets may be liquidated only at low fire-sale prices.)

Asset Side

- The second cause of liquidity risk is asset-side liquidity risk, such as the ability to fund the exercise of off-balance-sheet loan commitments.
  – When a borrower draws on its loan commitment, the FI must fund the loan on the balance sheet immediately.
  – This creates a demand for liquidity.
  – An FI can meet such a liquidity need by running down its cash assets, selling off other liquid assets, or borrowing additional funds

Liquidity Risk at Depository Institutions

Liability-side Liquidity Risk

- A DI's balance sheet typically has a large amount of short-term liabilities, such as **demand deposits** and other transaction accounts, which fund relatively long-term assets.
- A depository institution knows that normally only a small proportion of its deposits will be withdrawn on any given day
  - Most **demand deposits act as core deposits** on a day-to-day basis, providing a relatively stable or long-term source of savings and time deposit funds for the DI
  - A DI manager can predict the probability distribution of net deposit drains (the difference between deposit withdrawals and deposit additions) on any given banking day.
- A DI can manage a drain on deposits in two major ways: **purchased liquidity management** and/or **stored liquidity management**

Purchased Liquidity Management

- A DI manager who purchases liquidity turns to the markets for purchased funds, such as the federal funds market and/or the repurchase agreement markets, which are interbank markets for short-term loans.
  – However, this can be expensive for the DI since it is paying market rates for funds in the wholesale money market to offset net drains on low-interest-bearing deposits.
  – Further, since most of these funds are not covered by deposit insurance, their availability may be limited should the depository institution incur insolvency difficulties.

- With the liquidity crunch experienced during the financial crisis, wholesale funds were hard to obtain.

Stored Liquidity Management

- The FI could liquidate some of its assets, utilising its stored liquidity
- When the DI uses its cash as the liquidity adjustment mechanism, both sides of its balance sheet contract

Asset-side Liquidity Risk

Just as deposit drains can cause a DI liquidity problems, so can loan requests and the exercise by borrowers of their loan commitments and other credit lines.

Panel A: Balance Sheet Immediately Before and After Exercise

(a) Before Exercise				(b) After Exercise			
Cash	12	Deposits	100	Cash	12	Deposits	100
Other assets	138	Borrowed funds	20	Other assets	143	Borrowed funds	20
		Other liabilities	5			Other liabilities	5
		Equity	25			Equity	25
	150		150		155		150

Panel B: Adjusting the Balance Sheet to a Loan Commitment Exercise

(a) Purchased Liquidity Management				(b) Stored Liquidity Management			
Cash	12	Deposits	100	Cash	7	Deposits	100
Other assets	143	Borrowed funds	25	Other assets	143	Borrowed funds	20
		Other liabilities	5			Other liabilities	5
		Equity	25			Equity	25
	155		155		150		150

Measuring a DI's Liquidity Risk Expsosure

1. Financing Gap - difference between a DI's average loans and average (core) deposits

Financing gap = Average loans - Average deposits

(If this financing gap is positive, the DI must fund it by using its cash and liquid assets and/or borrowing funds)

Financing gap = - Liquid assets + Borrowed funds

Financing gap + Liquid assets = Financing requirement (borrowed funds)

The level of core deposits and loans as well as the amount of liquid assets determines the DI's borrowing fund needs.

Assets		Liabilities and Equity	
Loans	$25	Core deposits	$20
Liquid assets	5	Financing requirement (borrowed funds)	10
Other assets	5	Equity	5
Total	35	Total	35
		Financing gap	5

2. Liquidity Index

This index measures the potential losses an FI could suffer from a fire-sale disposal of assets.

During the financial crisis, many DIs struggled to maintain adequate liquidity

The two new liquidity ratios to be maintained by DIs are the:

– liquidity coverage ratio - aims to ensure that a DI maintains an adequate level of high-quality liquid assets (HQLA) that can be converted into cash to meet liquidity needs for a 30-day time horizon under an 'acute liquidity stress scenario' specified by supervisors

– net stable funding ratio - takes a longer-term look at liquidity on a DI's balance sheet. Basically, stable funding is sought for all illiquid assets and securities held where stable funding is defined as equity and liability financing expected to be reliable sources of funds over a one-year time horizon

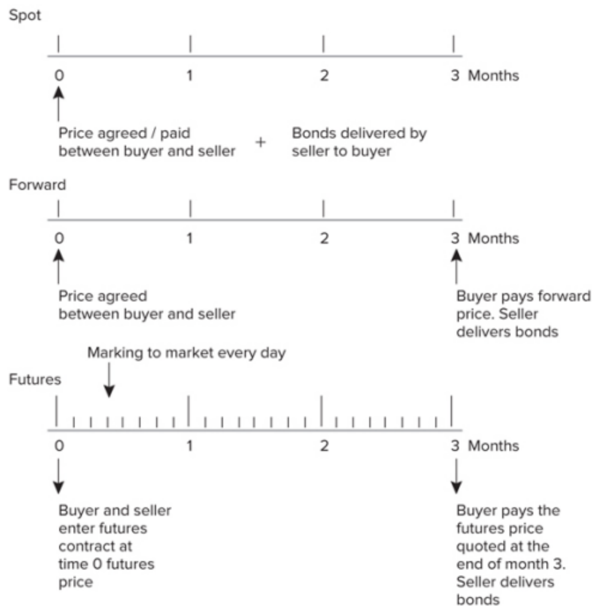
Week 9 – Derivative Contracts

Spot contract - an agreement between a buyer and a seller at time 0 when the seller of the asset agrees to deliver it immediately and the buyer of the asset agrees to pay for that asset immediately

Forward Contract - a contractual agreement between a buyer and a seller at time 0 to exchange a prespecified asset for cash at a later date at a price set at time 0.

Futures contract is arranged through an organised exchange.

- A futures contract is very similar to a forward contract.
- However, there are differences:
  – The price in a futures contract is **marked to market** daily.
  – Futures contracts are standardised.
  – The exchange itself guarantees the performance of the futures contract.
  – Delivery of the underlying asset seldom occurs for futures contracts.



– Consider an example of a **naive hedge** (the hedge of a cash asset on a direct dollar-for-dollar basis with a forward or futures contract).
  – Suppose an FI manager holds a 20-year, $1 million face value bond.
  – At time 0, these bonds are valued by the market at $97 per $100 face value, or $970,000 in total.
  – Interest rates are expected to rise by 2% from 8% to 10% over the next three months.
  – The manager has calculated the bonds' duration to be exactly 9 years.
  – The manager can predict a change in bond value (ΔP), from the duration equation:

$$\Delta P = -D \times P \times \frac{\Delta R}{1+R} = -9 \times \$970,000 \times \frac{0.02}{1.08} = -\$161,667$$

- The FI manager expects to incur a capital loss on the bond portfolio of $161,667, or as a drop in price from $97 per $100 face value to $80.833 per $100 face value.
  - The manager may hedge this position by selling $1 million face value of 20-year bonds for forward delivery in three months' time.
  - Suppose at time 0 the manager can find a buyer willing to pay $97 for every $100 of 20-year bonds delivered in three months' time.
- Now consider what happens if the forecast of a 2% rise in interest rates proves to be true.
- The on-balance-sheet loss of $161,667 is exactly offset by the off-balance-sheet gain of $161,667 from selling the forward contract.
  - The FI's net interest-rate exposure is zero; it has **immunised** its assets against interest-rate risk.

– Even though some hedging of interest-rate risk takes place using forward contracts, most FIs hedge interest-rate risk using futures contracts.

- Micro-hedging – An FI is micro-hedging when it employs a futures or a forward contract to hedge a particular asset or liability risk.
- Macro-hedging – Macro-hedging occurs when an FI manager wishes to use futures or other derivative securities to hedge the entire balance sheet duration gap.

Routine Hedging vs Selective Hedging

- **Routine hedging** occurs when an FI reduces its interest-rate risk exposure to the lowest possible level.
- Rather than a fully hedged position, most FIs choose to bear some interest-rate risk because of their comparative advantage as FIs. One possibility is that an FI may choose to **hedge selectively** its portfolio. For example, an FI manager may generate expectations regarding future interest rates before deciding on a futures position.

- **Macro-hedging with futures**
  - A measure of the change in an FI's net worth for a change in interest rates is:

$$\Delta E = -[D_A - kD_L] \times A \times \frac{\Delta R}{(1+R)}$$

  - **The risk-minimising futures position**
    - The sensitivity of the price of a futures contract depends on the duration of the deliverable bond underlying the contract, or:

$$\Delta F = -D_F \times F \times \frac{\Delta R}{(1+R)}$$

– where

ΔF = Change in dollar value of futures contracts

F = Dollar value of the initial futures contracts

D_F = Duration of the bond to be delivered against the futures contracts

- We can decompose the initial dollar value position in futures contracts, *F*, into its two component parts:

$$F = N_F \times P_F$$

  – The dollar value of the outstanding futures position depends on the number of contracts bought or sold (N_F) and the price of each contract (P_F).

  – N_F is positive when the futures contracts are bought and is assigned a negative value when contracts are sold.

- Futures contracts are homogeneous in size.
  - Futures exchanges sell T-bond futures in minimum units of $100,000 of face value.
  - T-bill futures are sold in larger minimum units: one T-bill future equals $1,000,000.
- The quote for each contract is the price per $100 of face value for delivering the underlying bond.
- A short position in the futures contract will produce a profit when interest rates rise.
- The change in net worth for an FI when rates rise is equal to:

$$\Delta E = -(D_A - kD_L) \times A \times \Delta R / (1 + R)$$

- The gain off-balance-sheet from buying futures is equal to:

$$\Delta F = -D_F \times (N_F \times P_F) \times \Delta R / (1 + R)$$

- Fully hedging can be defined as buying or selling futures so that:

$$\Delta F + \Delta E = 0$$

  – Substituting in the appropriate expressions and solving for N_F:

$$N_F = -(D_A - kD_L) \times A / (D_F \times P_F)$$

– Let *br* reflect the relative sensitivity of rates underlying the bond in the futures market relative to interest rates on assets and liabilities in the spot market.
  - That is, $br = [\Delta R_F/(1 + R_F)]/[\Delta R/(1 + R)]$.
  - Then the number of futures contracts to buy or sell is:

$$N_F = -(D_A - kD_L) \times A / (D_F \times P_F \times br)$$

Derivatives are subject to three levels of institutional regulation.

– Regulators of derivatives specify ‘permissible activities’ that institutions may engage in.

– Institutions engaging in those activities are subjected to supervisory oversight.

– Regulators attempt to judge the overall integrity of each institution engaging in derivative activities by assessing the capital adequacy of the institutions.

Swap markets - Although similar in many ways, swaps are different from other derivative securities.

- A swap can be viewed as a portfolio of forward contracts with different maturity dates.
- Transactions costs are highest for the option, next for the swap, and finally for the forward.
- Swaps have a longer maturity and provide an opportunity for FIs to hedge longer-term positions at lower cost

Duration Gap

+ve duration gap: if interest rates rise, assets will lose more value than liabilities, thus reducing the value of the firm's equity. If interest rates fall, assets will gain more value than liabilities, thus increasing the value of the firm's equity.

e.g. The bank has a positive duration gap; that is $DA – kDL > 0$.

The bank loses net worth on its balance sheet if rates rise, so it should hedge the value of its net worth by taking a short position in (i.e., selling) an appropriate number of futures contracts.

-ve Duration Gap: If interest rates rise, liabilities will lose more value than assets, thus increasing the value of the firm's equity.