LECTURE 2: INTEREST RATE RISK PART 1

1. INTEREST RATE RISK

- Interest Rate (IR) Risk has a balance sheet focus
  - 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?
  - 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
  - Central banks target short term rates via setting official rates
  - Interest rate changes and volatility increasingly transmitted from country to country due to increased globalization of financial markets
  - Statements by the US Fed chairman, Jerome Powell, can have dramatic effects on world interest rates

2. MEASURING INTEREST RATE RISK

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

2.1 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
- Extract from a Simple FI Balance Sheet
  - **Assets**
    - Overnight Loans 20
    - 3 mth treasury notes 30
    - 6 month investments 70
    - 1 year loans 90
    - 5 year fixed rate loans 40
    - 10 year govt. bonds 10
    - Total 260
  - **Liabilities**
    - Call deposits 30
    - 3 mth deposits 40
    - 6 mth deposits 85
    - 1 year deposits 70
    - 5 year deposits 30
    - 6 year deposits 5
    - Total 260
- What is the amount of the Interest Rate Risk of these positions?
- Rate sensitivity assets (RSA) and liabilities (RSL): assets and liabilities whose interest rates will be repriced (changed) over the planning horizon
- Repricing date: the date on which the interest rate changes
  - For example, 5-year variable-rate loans with interest rate adjusted every 6 months
- Repricing (funding) gap: RSA – RSL is the measure of IR risk exposure
  - Positive gap (RSA > RSL), exposed to the risk of interest rate decrease
  - Negative gap (RSA < RSL), exposed to the risk of interest rate increase

- Note: any discussion of RSA and RSL is relative to the planning horizon
- Examples:
    - Short-term loans
    - T-Notes (of various maturities)
    - Floating-rate long-term loans
- The question to ask is:
    - Will or can this asset have its interest rate changed within the planning horizon?
        - Yes? Rate-sensitive
        - No? Not rate-sensitive
    - For assets with maturity shorter than the planning horizon, what matters is the reinvestment rate – which should change with the market interest rate when reinvesting
- Examples:
    - Term deposits (of various maturities).
    - All roll-over credits, such as Bankers acceptances, certificates of deposits (CDs), commercial papers
- The question to ask is:
    - Will or can this liability have its interest rate changed within the planning horizon?
        - Yes? Rate-sensitive
        - No? Not rate-sensitive
    - For liabilities with maturity shorter than the planning horizon, what matters is the refinance rate – which should change with the market interest rate when refinancing
- Risk over one day using the data from the balance sheet shown above for one day
    - **Assets**
        - Overnight Loans 20
    - **Liabilities**
        - Call deposits 30
    - If the gap is -$10 million (liabilities exceed assets)
    - And if interest rates increase (+) by 1%
    - Then the annualised impact would be:
        - -$10million X + 0.01 = -$100,000
        - i.e. a reduction in income of $100,000pa
- Risk over one year using the data from the balance sheet
    - **Assets**
        - Overnight Loans 20
        - 3 mth treasury notes 30
        - 6 month investments 70
        - 1 year loans 90
    - **Liabilities**
        - Call deposits 30
        - 3 mth deposits 40
        - 6 mth deposits 85
        - 1 year deposits 70
    - We can assess the cumulative risk over one year
        - RSA = 20 + 30 + 70 + 90 = $210m
        - RSL = 30 + 40 + 85 + 70 = $225m
    - The gap is -$15 million (liabilities exceed assets)
    - And if interest rates increase (+) by 1%
    - Then the annualised impact would be:
        - -$15million X +0.01 = -$150,000
        - A reduction in income of $150,000pa
- Is this useful?
    - This at least tells us what would happen over a full year
        - But only for mismatches within the year
        - Assumes that the position is unaltered over the full period of the year
- Effect of interest rate change on FI's net interest income in a particular repricing bucket
    - $\Delta NII_i = (RSA_i - RSL_i)\Delta R_i = (GAP_i)\Delta R_i$
    - Where:
        - $\Delta NII_i =$ change in net interest income in the ith bucket

        - GAP_i = the dollar size of the gap between the book value of assets and liabilities in maturity bucket i
        - ΔR_i = the change in the level of interest rates impacting assets and liabilities in the ith bucket
- The Cumulative Gap (CGap): difference between all RSAs and RSLs with repricing date shorter than planning horizon
    - $\Delta NII_i = (CGAP_i)\Delta R_i$
- If changes in rates on RSAs and RSLs are not equal, then
    - $\Delta NII = (RSA \times \Delta R_{RSA}) - (RSL \times \Delta R_{RSL})$
- Further, the changes in interest rates may be different for assets or liabilities over different repricing buckets
    - Then you will need to calculate the change in net income for each individual bucket, and then sum them up
    - $\Delta NII = \sum[(RSA_i - RSL_i) \times \Delta R_i]$

WEAKNESSES OF THE REPRICING MODEL

- The Repricing model is useful to indicate how earnings will change as a result of interest rate changes, but:
- Market Value changes are not considered
    - Changes in interest rates affect not only earnings but also the value of assets and liabilities
    - The Repricing model ignores this affect
    - Only considers income and expense effects calculated based on the BV of RSAs and RSLs; it is only a partial measure
- Over-aggregation Effects
    - The "time buckets" that we use may be too broad
    - Thus, failing to capture the structure of assets and liabilities
- Off-balance sheet activities
    - These are generally not covered in the Repricing model, but may be exposed to IR risk

2.2 MATURITY MODEL

- The weaknesses in the Repricing Model led to a search for other alternatives:
    - Firstly, the Maturity Model
        - Considers the effect of interest rates on the value of the assets and liabilities which are subject to interest rate risk
- Key question: What is the value of an "asset"?
    - $Value\ of\ Asset_0 \equiv V_0\{CF_0, CF_1, CF_2, CF_3, \dots CF_T\}$
    - $NPV = PV(CF_0, CF_1, CF_2, \dots CF_T) = CF_0 + \frac{CF_1}{(1+r)} + \frac{CF_2}{(1+r)^2} + \cdots + \frac{CF_T}{(1+r)^T}$
- The Yield Curve or Term Structure of Interest Rates

	Call	**30 days**	**90 days**	**180days**	**2 years**	**3 years**	**5 years**	**10 years**
27/08/2020	0.25%	0.09%	0.09%	0.15%	0.25%	0.27%	0.44%	0.92%

- Key question: What is the value of a fixed income security?
    - $Value\ of\ a\ fixed\ income\ security \equiv V_0\{I_1, I_2, I_3, \dots, I_T + P_T\}$
    - $NPV = PV(I_1, I_2, \dots, I_T + P_T) = \frac{I_1}{(1+r)} + \frac{I_2}{(1+r)^2} + \cdots + \frac{I_T+P_T}{(1+r)^T}$
    - $PV_0(FI) = PV_0(Interests) + PV_0(Principal)$
    - $PV_0(FI) = \sum_{t=1}^{T} \frac{Interests}{(1+r)^t} + \frac{Principal_T}{(1+r)^T}$
    - $PV_0(FI) = Interests \times \frac{1}{r}\left[1 - \frac{1}{(1+r)^T}\right] + \frac{Principal_T}{(1+r)^T}$

MATURITY MODEL

- We can consider the effect of an interest rate change on a bond, as follows:
    - Buy a $100 bond today @10%, earning 10% (Par) annually for one year
    - $P = \frac{FV + C}{(1+i)^1}$
    - $P = \frac{100+10}{1.10} = \$100$
- If Rates change to 11% then the price is:
    - $P = \frac{110}{1.11} = \$99.10$
- $99.10 is market value and is also the new PV
    - Can also assess the change in price in terms of percentage change 0.90%

    - i.e., $\frac{\$0.90}{100} = 0.90\%$
- An interest rate change on a coupon bond would be as follows:
    - Buy a $100 bond today @10%, earning 10% (Par) annually for two years
        - $P = \frac{C}{(1+i)^1} + \frac{C+FV}{(1+i)^2}$
        - $P = \frac{10}{1.10} + \frac{110}{1.21}$
        - $P = \$9.09 + \$90.91 = \$100$
    - If Rates change to 11% then the price is:
        - $P = \frac{C}{(1+i)^1} + \frac{C+FV}{(1+i)^2}$
        - $P = \frac{10}{1.11} + \frac{110}{1.23}$
        - $P = \$9.01 + \$89.28 = \$98.29$
    - $98.29 is market value and is also the new PV
        - Can also assess the change in price as 1.71%
        - i.e., $\frac{\$1.71}{100} = 1.71\%$
- The Three Principles (Plus One) of Interest Rate price relationships
- A rise in interest rates
    - Leads to a fall in the market value of an asset
    - The longer the maturity of an asset the larger the fall in its market value
    - The rate of fall in market value of an asset diminishes the longer the maturity of the asset (convexity)
- A rise in interest rates will have the opposite effect 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)
- The Maturity Model calculates the structure of the portfolio as:
    - The weighted average maturity of assets or liabilities in the portfolio, where the weighted value is calculated on the basis of market values
    - This calculates the approximate average maturity of the portfolio
    - Rule 2 in the previous slide shows that the bigger the maturity gap for a given portfolio size, the larger the risk
    - Maturity model suggests matching MA and ML will reduce or eliminate interest rate risk
- Calculating Maturity Gap
    - $M_{GAP} = M_A - M_L$
- Where:
    - $M_A =$ Weighting of each Asset in the portfolio x Maturity of each asset
    - $M_L =$ Weighting of each liability in the portfolio x Maturity of each liability
- As noted above the model suggests that matching M_A and M_L will "immunise" the risk

PROBLEMS WITH THE MATURITY MODEL

- 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

SUMMARY

- Interest rate risk is an important source of market risk for FIs
- The repricing model provides a simple method to measure a FI's interest rate risk
- It focuses on the difference or gap between a FI's portfolio of RSA and RSL
- The repricing model is simple to use but has its weaknesses
- The maturity model provides an alternative
- More complete and accurate measures of a FI's interest rate risk exposure are duration and the duration gap (which we will cover next week)
- Maturity model provides information about changes in asset value than the repricing model
- Techniques that further assist in assessing the extent of interest rate risk that a bank is exposed to and to address some of the limitations that exist with the Repricing and Maturity models

        - Bitcoin an application of Blockchain technology
- Smart contracts are applications made possible by blockchains
    - Enforces a relationship with cryptographic code
        - Example: Ethereum and NEO
- Artificial intelligence (AI) and machine learning
    - AI is the application of computational tools to address tasks traditionally requiring human sophistication
    - Machine learning is a sub-category of AI, involving the design of an algorithm
- Internet-of-Things (IoT)
    - Encompasses everything connected to the internet, but is increasingly being used to define objects that "talk" to each other
        - E.g. Apple Watch and FitPay

AI AND MACHINE LEARNING APPLICATIONS

- Pattern recognising exercise – analyse data based on past patterns
- Assess credit quality, price and market insurance contracts, and automate client interaction
- Optimizing scarce capital with AI and machine learning techniques
- Back-testing models and analysing market impact of trading large positions
- Find signals for higher and uncorrelated returns and optimize trading execution (hedge funds, broker-dealers, other firms)
- Regulatory compliance, surveillance, data quality assessment, and fraud detection (public and private sector institutions)

CREDIT, DEPOSIT AND CAPITAL-RAISING SERVICES

- Crowdfunding is a way to raise money through the collective effort of family, friends, individual investors, and customers – bypasses traditional lending services
    - Example: KickStarter and GoFundMe
- Lending marketplaces make loans to consumers and small businesses
    - Example: LendingClub and SoFi
- Mobile banks and credit scoring
- Fintech lending vs. traditional commercial banking
- Peer-to-peer lending (P2P lending)
- Guaranteed return model – lending platform acts as pseudo bank
- Notary model – lending platform reaches out to communities where banks usually do not have a presence
- Features of fintech credit activity
- Pricing
    - Favourable pricing for the borrowers?
        - Mixed results (fintech borrowers vs. bank borrowers)
        - Large dispersion in interest rates (fintech retail borrowers vs. bank retail borrowers)
    - Better investment opportunity for the lenders?
        - Fintech lending vs. traditional bank deposits?
            → Data needs to be accumulated for a few more years to determine
        - Difficult to identify alternative investment opportunities
- User convenience
    - Ease of lending process
    - Ease of borrowing process
    - Speedy transaction & lower searching costs

INVESTMENT MANAGEMENT SERVICES

- Provide solutions for HFT, copy trading, e-trading and robo-advice
    - HFT accounted for little over half of daily trading volume in 2017
    - Copy trading allows millions of individuals trade FX on platforms
        - Trade360, FxPro, etc
    - Robo-advisors are online services that automatically perform many investment tasks done by a human financial advisor
        - Easier to trade and invest, yet may generate exposure of risks that investors are unaware of or don't understand

REGULATORY APPROACH TO FINTECH

- Fintech charters and other licenses
    - Regulators have lowered barriers in forms of virtual bank licenses, fintech charters, and e-money licenses
        - Regulatory sandbox – creates specific regulation for a specific service as a test case to see whether the regulation works so won't spill over to the rest of the system
- International regulations
    - Two significant changes to EU regulations
        - General Data Protection Regulation (GDPR)
        - Payment Services Directive 2 (PSD2)

SUMMARIES

- Fintech areas
    - **Payment service related** – seen significant development in the level of sophistication and convenience
    - Intermediation service related
    - Investment/Trading related
- Core banking activities relatively unaffected in advanced financial systems – fintech doesn't really replace banks
    - Fintech will ultimately have to use traditional banking and payment system
    - Banks embracing new technologies due to increased ease and convenience of use
- Regulatory attention for some services
    - Needs regulation for stability of system if inefficient running of fintech (is it important enough?)
    - Banks have been relatively unaffected hence may not warrant regulation
- Whilst fintech is popular, banks remain largely unaffected