2026

FALCON NOTES
FRM PART I

Financial Markets and Products

BOOK 3

Falcon Edufin

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TABLE OF CONTENTS

*Section 3 and section 4 are adv-1 and basic-1. The second part of these section is covered in Book 4. It is recommended to prepare 1 and 2 part of each of these sections together.

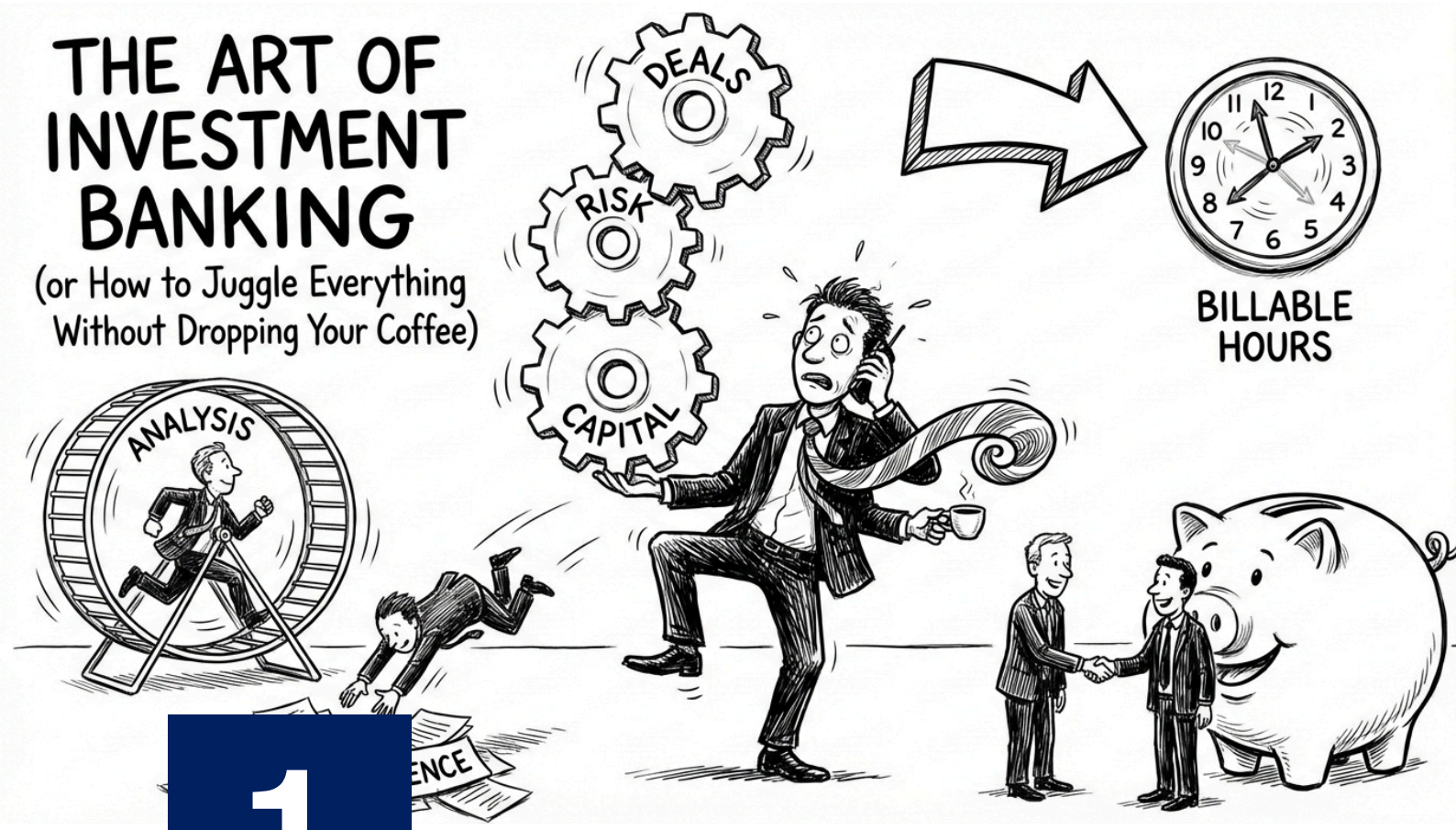
TABLE OF CONTENTS

SEction 5 Fixed income adv - 1

**Section 5 is adv-1. The second part of this section is covered in Book 4. It is recommended to prepare 1 and 2 part of this sections together.*

Table of Contents

1 Banks



1 Banks

Scope of this reading

Understand and differentiate between the major risks faced by banks—credit, market, liquidity, and operational risks—and how these risks arise in banking operations. Know the Basel Committee regulations for regulatory capital and their underlying motivations, and be able to distinguish between regulatory capital and economic capital.

Grasp how deposit insurance creates moral hazard problems in the banking system. Understand the various investment banking financing arrangements including private placement, public offering, best efforts, firm commitment, and Dutch auction approaches.

Recognize the potential conflicts of interest when commercial banking, securities services, and investment banking divisions operate within the same institution, along with recommended solutions to these problems. Finally, distinguish between the banking book and trading book, and evaluate the originate-to-distribute model with its benefits and drawbacks.

1.1 Introduction

The banking activities can be subdivided into commercial banking and investment banking.

Commercial Banking: It involves traditional activities such as receiving deposits and making loans. Commercial banking can be further divided into retail or wholesale banking.

- **Retail banking** is banking for private individuals and small businesses. Value of loan and deposit is lower compared to wholesale banking.
- **Wholesale banking** entails transactions with large corporations and generally involves larger amounts of deposits and loans, resulting in lower administrative costs. The difference between the interest rate on deposits and the interest rate levied on loans is lower in wholesale banking than in traditional banking.

Investment banking: investment banking is a combination of consultancy services and financing services. Investment banking involves activities such as

- Raising debt or equity for businesses.
- Advisory services to corporations on mergers and acquisitions, as well as financial decisions.
- Trading debt equity and other securities as a broker dealer.

1.2 The Risks in Banking

Investment bank and commercial bank both face 3 major risks. In the following section we'll see what these risks are and also how banks regulate to survive from these risks.

1.2.a Market Risk

Banks engage in investment and trading activities, exposing them to a variety of market variables (also called as risk factors). Market risk refers to the risk posed by a bank's exposure to market factors such as the foreign exchange rate, interest rate, and equities prices fluctuating. The trading volume in the financial markets determines the value and impact of market factors. Various events, such as the 2016 Brexit vote and the 2008 financial crisis, have an impact on the value of market variables. The principal source of a bank's exposure to changes in the value of market risk variables is trading activity. Banks are now prohibited from engaging in proprietary trading in the United States. Banks, on the other hand, offer a wide choice of products to corporate clients and institutional investors, with valuations based on market variables. The bank's market risk exposure is a result of the services offered to these clients.

Banks strive to keep their exposure to market risk factors to a minimum, but totally eliminating those risk elements is impossible. As a result, banks are always exposed to some market risk.

1.2.b Credit Risk

The failure of the opposing party to pay is referred to as credit risk. Credit risk comes from two key sources for banks. Commercial banks engage in lending activities, and one source of credit risk is the likelihood that borrowers will default on their obligations. Investment banks are involved in derivative transactions, which exposes them to both market risk and credit risk at the same time. When a derivative transaction has a positive exposure to the bank, the bank faces credit risk due to the probability that the counterparty to the transaction would default. Losses

are frequently incurred when a borrower defaults on payments, and the extent of the loss increases if the borrower declares bankruptcy. The amount of damage is determined by whether the assets have been put up as collateral and how the bank's claims compare to those of other creditors.

Expected losses are the losses incurred as a result of the borrower's default, which are computed using the probability, explained in book 4. As soon as a transaction is initiated, banks account for the expected loss. According to IFRS 9, banks must estimate expected losses on their loan portfolio and disclose outstanding principle on their balance sheet net of expected losses. The credit value adjustment is used to calculate the amount of expected loss in a derivative transaction (CVA). In the FRM Part 2 curriculum, the calculation of CVA is discussed in detail.

1.2.c Operational Risk

The most basic definition of operational risk is any risk that is not derived from the market or credit risk. Operational risk is defined as the risk of loss stemming from insufficient or failing internal processes, people, and systems, or external events, according to bank regulators. Market and credit risk are easier to quantify than operational risk. Operational risk is divided into seven categories by the regulators:

- **Internal Fraud**: Misappropriation by rogue traders or cash embezzlement by some employee.
- **External Fraud**: Cyber-attacks, bank robberies, etc
- Employment practices and workplace safety: Various types of claims made on bank from employees including worker compensation claims or employee discrimination claims etc.
- **Clients, products, and business practices:** Indulging in unlawful or prohibited activities like money laundering.
- **Damage to physical assets:** Terrorism, earthquake, floods etc
- **Business disruptions and system failure:** Hardware or software failures, utility outages, etc.
- **Execution, delivery, and process management**: Insufficient legal documentation, database errors etc.

In comparison to market risk or credit risk, operational risk is a significant problem for banks. Between 2008 and 2017, banks in North America and Europe were fined over USD 300 billion for operational risk violations. Cyber risk, legal risk, and compliance risk are key sources of operational risk in banking.

1.3 Banking Regulations

Protecting depositors as well as maintaining the confidence and stability in the financial system is very crucial. Hence banks are subjected to some regulations which are outlined below

1.3.a Capital

Banks must keep enough capital for the risk they are taking. There are **2 types of capital equity capital and debt capital** which can you be used as a buffer to safeguard depositors funds. The most important capital is equity capital. Banks must maintain enough equity capital to cover potential losses and remain solvent because losses reduce equity capital. Debt capital is subordinate to the assets held by the depositors and hence, offers protection for depositors in case of losses because debt capital will be used to absorb the losses after equity capital is exhausted. Equity capital is also referred as going concern capital because it absorbs losses when

the bank is going concern. Meaning if the losses increase beyond equity capital, then bank solvency is at risk. The great capital is considered as gone concern capital because it only starts to absorb losses once the equity has exhausted and bank has failed. Capital can be categorised into two, regulatory capital and economic capital.

- **Regulatory capital:** Regulatory capital is the minimum requirement of capital bank must keep from the regulatory perspective.
- **Economic capital**: It is capital maintained by bank based on banks own estimate of unexpected losses. the main objective of economic capital is to maintain high credit rating.

At all times banks must keep minimum of regulatory capital i.e., if regulatory capital is more than economic capital, then bank must keep capital equal to regulatory capital. Economic capital is apportioned to business units so that business units can be compared using return on capital allocation metric.

The amount of capital which should be maintained depends on the size of possible losses. assume that the bank maintains equity capital which can absorb unexpected losses 99% of the time which means 1% of the time bank won't be able to absorb these losses. This also means there is 1% chance that bank will become insolvent which is unacceptable.

1.3.b Basel Committee of Banking Supervision

Established in 1974, the Basel Committee for banking supervision provides a forum where the bank regulators from various countries exchange ideas. Basel I came in 1988, is international agreement that Required regulators in all signatory countries to calculate capital requirement in same standardised manner. prior to Basel one every country had their own regulations for capital requirement. In the initial phase Basel 1 provided capital requirements designed to cover credit risk arising from defaults on loans and derivative contracts. In 1998, Basel I was amended to commit the capital requirements for both market and credit risk. This amendment is known as the market risk commitment of 1998.

In 1999, Basel II was implemented to revise the procedure for calculation of Credit risk capital and introduction of capital requirement for operational risk. With Basel II, the total capital requirement was then the sum of amounts for credit risk, market risk and operational risk. Basel II.5 was the outcome of 2007-2008 crisis, which revised market risk capital calculation rules, because regulators felt the existing rules for marketplace capital calculation, we're inadequate.

The latest set of regulations is called Basel III, which proposes increase in equity capital. It is expected to be implemented fully by 2027. Meanwhile market risk capital rules are revised again with The Fundamental Review Of Trading Book, which is to be implemented by 2022.

1.3.c Standardized Model vs Internal Model

Banks use models to calculate their capital. The regulators provide standardised models that have common rules for capital calculation. Banks can also design their own internal models for capital calculation. Basel I introduced a standardised model for credit risk. After the Market Risk Amendments, banks had the option of using a standardised model or an internal model for market risk, as long as they met the requirements and got approval from national regulators. Basel II allowed internal models for both credit risk and operational risk. However, regulators later restricted the use of internal models for capital calculation because they believed that banks were manipulating them to lower their capital requirements. After the amendments, banks must use a standardised model for operational risk. For credit risk and market risk, banks can use both a standardised model and an internal model, but with some conditions. The internal models cannot

reduce the total capital requirement below a certain percentage of the standardised model capital. This percentage will be 72.5% by 2027.

Required capital = max (IMC, 0.725 X SMC)

1.3.d Trading Book Vs Banking Book

That reading book consist of asset and liability that are held for trade. The banking book consists of assets and liabilities that are expected to be held to maturity. The differentiation between the trading book and banking book is very crucial for the regulatory capital calculation. Items listed in the trading book are subject to market risk capital calculations whereas the items in the banking book are subject to credit risk capital calculations. Previously there was ambiguity as to whether the transaction it's for trading book or the banking book. Banks used to take the advantage of this ambiguity in order to lower the capital requirement.

The Fundamental Review Of The Training Book attempts to clarify whether an instrument should be in the banking book or the trading book. The bank has a desk for trading specific instrument, that instrument will be considered to be part of trading book else it will be part of banking book.

1.3.e Liquidity Ratios

Liquidity risk became a concern for regulators as well as banks post 2007 2008 crisis. Banks fund long term loans assets with the short-term liability (like short term certificates), because short term liabilities offers lower funding costs. This creates asset liability mismatch. The goal here is to issue short term commercial papers to find long term assets and keep renewing these short-term commercial papers till the maturity of long-term assets. The risk with the strategies comes when bank is unable to renew these short-term liabilities. This happens when market lose confidence in the bank and results into the measuring commercial papers cannot be replaced. This results into bank defaulting on its debts and go bankrupt. This problem can be avoided if the assets and liability have same maturity. In 2008 crisis liquidity problems played key role.

As a result of the liquidity problems encountered during the crisis, Basel Committee developed 2 liquidity ratios to which banks are required to adhere.

- **The Liquidity Coverage Ratio:** Ensures that banks have sufficient sources of funding to survive a 30-day period of acute stress.
- **Net Stable Funding Ratio:** is a requirement that limits the size of mismatch between the maturity of assets and the maturity of liabilities.

1.4 Deposit Insurance

The deposit insurance provides certain protection to depositors against the losses arising from the bank failure. In the US amount is currently $2,50,000. the insurance premium is to be paid by banks. in some jurisdictions the insurance premium is fixed per year for a dollar on deposits and in other jurisdictions premium is set based on the assessment of banks risk.

Deposit insurance may result into moral hazard. Moral hazard is when the insured party is willing to take more risk because the position is insured which increases the risk attached in the insurance contract. In case of Deposit Insurance, banks might take part into risky loans just because the deposits are insured. Without a Deposit Insurance depositors might withdraw their deposits if bank takes part in risky loans. There are two ways to discourage the moral hazard issue of banks-

- Risk based Deposit Insurance reduce the moral hazard to some extent.

- Regulations that ensure that banks required capital increases with the risk it takes.

1.5 Investment banking Financing arrangements

The underwriting is the key role performed by investment banks. Underwriting is the process of raising funds of companies in the form of debt, equity, or some complex form of securities. Following are the steps summarizing underwriting process –

- Step 1: Company will approach investment bank to discuss the plan to issue security. Plan must be agreed upon to proceed further.
- Step 2: Securities are originated accompanied by documentation specifying the rights of investors who purchase securities.
- Step3: A prospectus is issued detailing the companies past performance, future prospectus, risks involved, outstanding lawsuit, etc.
- Step 4: Road show by senior management to appeal investors to purchase securities.
- Step 5: Price is agreed upon between company and investment bank at which securities will be issued.

There are two types of offerings.

- **Private placement**: In which institutional investors are approached to purchase securities. In private placement bank receives fixed fees.
- **Public offering**: Where securities are offered to general public as well. In case of general public offering fees received by bank depends on the commitment of bank. There are two options available with companies' firm commitment (also called as bought out deal) and best efforts.

The way public offering is handled by bank, firm commitment or best efforts decides the fees earned and risk born by investment bank. In this section we will discuss both the ways of public offering.

- **Best efforts:** In the best-efforts bank will do their best to sell the securities for the agreed price. For the public offering to be successful, company should be able to get certain amount of subscription. However, in the best effort method bank offers no guarantee on this subscription of shares. In this method bank receives fixed fees for every security sold in the market say $1 for every security sold. This is less risky for bank compared to firm commitment.
- **Firm commitment:** In firm commitment bank guarantees that the securities will be sold for an agreed upon price. in this case bank buys the security at agreed upon price with the hope to sell security at higher rate in the market. The difference between the agreed upon price and sell price of security is profit for bank. Firm commitment helps companies in ensuring the success of their public issue. However, it raises risk for a bank if it fails to sell securities at higher price in the market.

The choice of alternative given above is made by bank based on their own estimates. It can be based on different probable outcomes of the public issue at given price.

1.5.a IPOs

And IPO is the initial public offering that is the first time offering of the company share to the public. Prior to this IPO shares are held by companies' founders or other investors who provided early stage funding. The shares sold in the IPO can be mixture of existing shares add new shares. Because the company shares are not yet publicly traded it is difficult for the investment bank to

assess the share price after IPO. To ensure the success of IPO, investment bank sets the offering price below its best estimate to make it more lucrative. It is often difficult for small investors to buy IPOs.

1.5.b Dutch Auction

Investment banks have expertise in deciding the price of issue in IPO. However, issuer companies might want to market to decide the price of IPO. Dutch auction can be used for this purpose.

Dutch auction process:

- **Step 1:** Investors are invited to submit bids indicating how many shares they would be willing to buy and at what price.
- **Step 2**: Bidders are sorted from the highest to lowest offered price.
- **Step 3**: Search for the price at which issue under consideration (all the stocks) can be sold.

An advantage of the Dutch auction is that the price decided in the process is the one that balances demand and supply in the market which makes, pre-IPO price and post IPO price the same.

One of the famous Dutch auction was Google with one change, Google reserved the right to change the number of shares offered and the percentage of the requested amount allocated to each bidder.

Illustration

Falcon Inc offers 100,000 shares to bidders in Dutch Auction process. Following table provides the top 5 bids (from share price) with number of shares offered and allocation made to the bidders.

Bidders	Price offered in $ value	No of shares offered	Cumulative shares	Shares offered	Price of offering
Abhishek	$100	15000	15000	15000	$84
Rohan	$96	10000	25000	10000	$84
Shree	$90	25000	50000	25000	$84
Priyanka	$86	30000	80000	30000	$84
Akash	$84	40000	120000	20000	$84
Arpit	$80	20000	140000	0	0
Nikhil	$75	35000	175000	0	0

Please note: Final price is the maximum price at which all the shares can be sold. In this case the maximum price at which all shares can be sold is $84. Hence all the successful bidders have to pay $84. Other bidders don't get any shares in this process.

1.5.c Advisory Services

Advisory services involve decisions regarding mergers and acquisition, divestment, and restructuring including advising companies that are subject to takeover. In order to advice the company who wish to take over the other company, investment bank need to value company and assess any potential synergies. It also needs to estimate the type of offer which can be made, like cash offer, share to share offer or combination offer. In the cash offer, acquisitions risk is born by acquiring company and in case of share to share offer it is born by both the companies. Investment bank must also consider the best way to approach the acquiring company.

Investment bank also advises the company which is likely to be taken over by the other company. Company might need to take the measures which may be unfavourable to company but are important to avoid takeover. This is known **as poison pills**.

- Granting the key employees attractive stock options that can be exercised in the event of takeover.

- Adding a provision in charter (similar to article of association used in India) making it impossible to fire management, directors in case of takeover.
- Issuing preferred shares which can be converted into regular shares in the takeover.
- Allowing existing shareholders to purchase shares at a discounted price.
- Changing the voting structure so that management has sufficient votes to block the takeover.
- Adding a provision that allows remaining shareholders to sell shares to the new owner at a higher premium in the event of a successful takeover.

Poisson pills are illegal in many countries but are permitted in the US. This must be approved by the majority shareholders.

1.5.d Trading

Investment banks also participate in trading activity, however, limitations are put on speculative trading after the 2008 financial crisis. In the US, the Dodd-Frank act prevents US banks from participating in proprietary trading. Proprietary trading is activity of trading on own account to profits instead of trading for client to earn trading commission. Banks also act as market maker by quoting bid and ask on wide variety of products.

Banks also offer broking service to retail clients. Broking service is taking order from client and executing these orders in exchange. Broking can be full broking (i.e. including advisory services).

1.6 Conflict of interest

Banks have possible conflicts of interest due to the nature of investment banking services. Following is the list of possible potential conflicts of interest for investment banks.

- **When handling new equity issue:** When banks have trouble finding investors for shares in a customer's new equity offering, they may ask the bank's broker to urge the client to buy the securities.
- **When advising the client about the possible acquisition:** Suppose the bank is advising the client about the possible acquisition of the target company, who is also a client of the bank from say commercial banking services. The bank might try to gain confidential information from the commercial division in order to gain on the acquisition.
- **When soliciting the new business from the company:** To please the prospective client, bank might ask broking division of the bank to buy shares of these prospective client to please them.
- **When having large loan outstanding to client:** Assume, banks commercial division has loan outstanding to the client, Bank might suggest client to replace the loan with a bond issue managed by investment banking division. This debt replacement can be done with the investor who not aware of the riskiness of this loan.

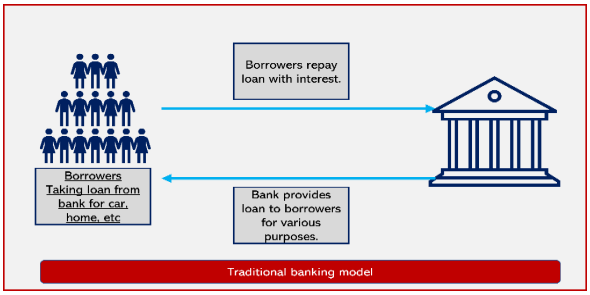
Chinese walls: Chinese walls are the rules within the bank which prevents the internal transfer of information between the various divisions. Chinese wall helps banks in avoiding the big fines from Government, lawsuits, and banks reputation which might arise due to conflict of interest.

Due to this conflict of interest, US government have separated investment banking from commercial banking services. Under the Glass -Steagall Act of 1993, Commercial banks were not allowed to handle IPOs and other investment banking activity. However, commercial banks could assist with Treasury bond and municipal bond issue and handle private placements. Similarly,

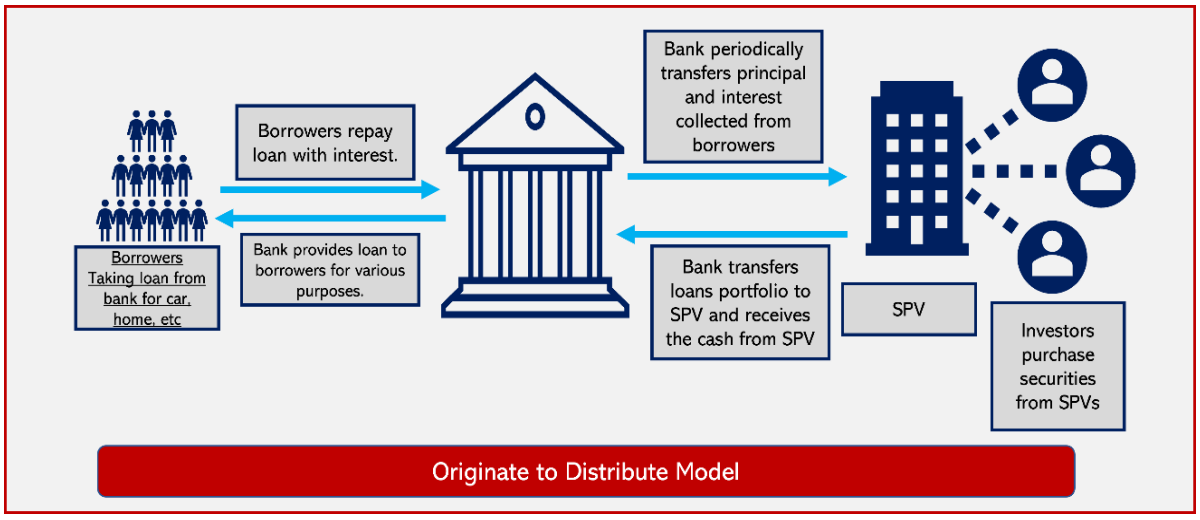
restrictions are imposed on investment banking activity, by prohibiting the acceptance of deposits and making commercial loans.

1.7 The originate to distribute model

In the traditional model of banking, banks take deposits from the depositors and use this fund to provide loans. Banks' profit is the difference in interest paid to depositors and interest earned from borrowers.



The main difference between this model and the traditional one is that it follows an originate to distribute approach. In this model, banks take deposits and use them to fund loans, but then they transfer these various loans in a package to a separate entity called a Special Purpose Vehicle (SPV). The SPV pays the banks for the ownership of these loan portfolios. In the traditional model, the banks keep the interest income, but in the originate to distribute model, this interest income goes to the investors of the SPV. After the banks sell the loan portfolio to the SPV, they can use the money to make new loans. This cycle can continue indefinitely.



Originate to distribute model is considered as source of financial crisis in 2008. Because, loan ownership is transferred to SPV, banks had no incentive in being careful while providing loans. At some points, banks become careless in checking the creditworthiness of borrowers. Which finally became the cause of 2008 financial crisis. (We will discuss this topic of financial crisis in more elaborate manner in Book 1 Foundations of Risk Management and in FRM Part II).

Originate to distribute model existed in US for very long time. To facilitate and promote this, US Government has sponsored the creation of three entities

- GNMA (Ginnie Mae) Government National Mortgage Association
- FNMA (Fannie Mae) Federal National Mortgage Association
- FHLMC (Freddie Mac) Federal Home Laon Mortgage Corporation

These agencies buy mortgage portfolio from banks and package the cash flows into securities and sell it to investors. Agencies also provides guarantee to these investors, hence investors are not subject to credit risk. However, investors are subject to prepayment risk.

Since the 1990s, banks used the originate to distribute model for a variety of loans without the support of these Govt agencies.

Securitization process: The process of converting the loans into securities which are then bought by investors is called as securitization. This removes loans from the banks balance sheet. Tranches are created from the loan portfolio. Tranches can have different credit risks. Tranches are of three types,

- **Senior tranches**: Major portion of tranches(70%) with low credit risk and low return(5%).
- **Mezzanine tranches**: Less portion of tranches(25%) with medium credit risk and medium return(7%).
- **Equity tranches**: Least portion of trances (5%) with very high credit risk and very high return(12%).

Tranches	Portion	Credit Risk	Return
Senior	Major (70%)	Low Risk	Low (5%)
Mezzanine	Less (25%)	Medium Risk	Medium (7%)
Equity	Least (5%)	Very High Risk	Very High (12%)

Prepayment risk is the risk of borrowers repaying loans earlier than due time. This reduces the earning on tranches. Repayment is made to senior first, then to mezzanine tranche and to equity trances. This arrangement ensures senior trance and mezzanine tranche get their promised returns. Lastly, equity bears the burden of any default on payment. To compensate for this risk, equity tranche gets higher return.

2 Insurance Companies and Pension Plans

2 Insurance Companies and Pension Plan

Scope of this reading

Understand the key features of various categories of insurance companies and identify the specific risks they face in their operations. Learn how to use mortality tables to calculate premium payments for policyholders. Distinguish between mortality risk and longevity risk, and describe effective hedging strategies for each. Understand the structure of pension funds by differentiating between defined benefit plans and defined contribution plans and their key differences.

Master the calculation and interpretation of key performance ratios for property-casualty insurers: loss ratio, expense ratio, combined ratio, and operating ratio. Recognize the moral hazard and adverse selection risks facing insurance companies, provide examples of each, and describe methods to overcome these problems. Finally, evaluate the capital requirements and capital adequacy considerations for insurance companies.

2.1 Introduction

Insurance covers specific unforeseeable events. The policyholder is the company or person insured. In most cases, the policyholder must pay recurring premiums. Unfavourable events are unlikely to occur in a year, so the insurance company incurs no costs. If one of the listed events occurs, the insurance company will usually pay the policyholder a large sum to cover the losses.

Most insurance contracts are either life or property and casualty. For the life insurance policy, the policyholder must pay premiums monthly or annually. Upon death, beneficiaries receive a lump sum payment in lieu of premiums. A property and casualty policy reimburses the policyholder for losses caused by accidents, fires, thefts, and other insured events. Renewal is usually done annually. While life insurance rates rarely change, property and casualty rates do.

There are parallels between pension plans and life insurance contracts. In an employer-sponsored pension plan, both the employee and the employer typically contribute regularly. The contributions fund a lifetime pension for the employee after retirement. After describing life insurance companies' activities, we discuss pensions.

2.2 Life Insurance

2.2.a Whole Life Insurance

Whole life insurance covers the policyholder for their entire lives. The policyholder pays monthly or annually until death. The policy's face value is then paid to the named beneficiary. This signifies that the insurance company will pay the policyholder, and the only question is when. In whole insurance, both the premium payment and the face value of the policy remain constant throughout the time.

2.2.b Term Life Insurance

Term insurance is a type of life insurance that lasts for a set number of years. If the policyholder lives to the end of the policy's term, no payment is made; however, if the policyholder dies during this time, a lump sum payment is given to the policyholder's nominee. The policyholder must pay the annual premium until the policy expires. If he does not make the payment, his insurance will be cancelled. We will go over how to calculate insurance premiums at breakeven in the next section. The insurance firm makes no profit and no loss at a breakeven premium. As a result, the company sets its profit % on the break-even premium. Know how to compute the breakeven premium for exam purposes. GARP may also ask about the premium charged by the insurer and the profit percentage that will be offered. To calculate the premium, add the percentage profit to the breakeven premium.

Exact age	Male			Female		
	Death probability	Number of lives	Life expectancy	Death probability	Number of lives	Life expectancy
0	0.006081	100,000	76.23	0.005046	100,000	81.28
1	0.000425	99,392	75.69	0.000349	99,495	80.69
2	0.00026	99,350	74.73	0.000212	99,461	79.72
3	0.000194	99,324	73.75	0.000166	99,440	78.74

4	0.000154	99,305	72.76	0.000137	99,423	77.75
5	0.000142	99,289	71.77	0.000122	99,409	76.76
6	0.000135	99,275	70.78	0.000111	99,397	75.77
7	0.000127	99,262	69.79	0.000103	99,386	74.78
8	0.000117	99,249	68.8	0.000098	99,376	73.79
9	0.000104	99,238	67.81	0.000095	99,366	72.79
10	0.000097	99,227	66.81	0.000096	99,357	71.8
11	0.000106	99,218	65.82	0.000102	99,347	70.81
12	0.000145	99,207	64.83	0.000116	99,337	69.81
13	0.00022	99,193	63.84	0.000139	99,326	68.82
14	0.000324	99,171	62.85	0.00017	99,312	67.83
15	0.000437	99,139	61.87	0.000204	99,295	66.84
16	0.000552	99,096	60.9	0.00024	99,275	65.86
17	0.000676	99,041	59.93	0.000278	99,251	64.87
18	0.000806	98,974	58.97	0.000319	99,223	63.89
19	0.000939	98,894	58.02	0.00036	99,192	62.91
20	0.001079	98,801	57.07	0.000405	99,156	61.93
21	0.001215	98,695	56.13	0.000451	99,116	60.96
22	0.001327	98,575	55.2	0.000491	99,071	59.99
23	0.001406	98,444	54.27	0.000523	99,022	59.02
24	0.001461	98,306	53.35	0.00055	98,971	58.05
25	0.001508	98,162	52.43	0.000575	98,916	57.08
26	0.001559	98,014	51.51	0.000605	98,859	56.11
27	0.001612	97,861	50.58	0.000642	98,800	55.14
28	0.001671	97,703	49.67	0.000691	98,736	54.18
29	0.001734	97,540	48.75	0.000749	98,668	53.22
30	0.001798	97,371	47.83	0.000811	98,594	52.26

Source: https://www.ssa.gov/oact/STATS/table4c6.html#fn1

Information provided in table: The table is three sections, 1) Exact Age 2) Male Deaths section and 3) Female Death table. Each section Male and female is subdivided into three sections.

Death probability: The probability of a person dying within a year is calculated using death probability. For example, the death probability of a 27-year-old male is 0.001671, which indicates the chance of dying within a year is 0.00167.

Number of lives: It all begins with a total of 100000 survivors being born alive. Only 99,392 children survived until they reached the age of one. Similarly, only 97,861 males lived to be 27 years old. The number of lives saved is used to assess the likelihood of living to that age. Total survival / 100,000 equals the probability of survival. The probability of survival at age 27 is 97861 / 100000 = 0.97861. As a result, there is a 97.861% chance that a new born will live to be 27 years old. Please note that the age of 27 represents the total number of years lived.

Life Expectancy in years: The estimated number of years (or more) that a person will live is known as life expectancy.

We'll use a modified version of this table that only includes the male section and mortality rate from 30 to 50 years old (check the following table).

Exact age	Male			
	Death Probability	Survival Probability	Number of Lives	Life Expectancy
0	0.006081	1	100,000	76.23
1	0.000425	0.99392	99,392	75.69
2	0.00026	0.9935	99,350	74.73
3	0.000194	0.99324	99,324	73.75
4	0.000154	0.99305	99,305	72.76
30	0.001798	0.97371	97,371	47.83
31	0.00186	0.97196	97,196	46.92
32	0.001926	0.97015	97,015	46
33	0.001994	0.96828	96,828	45.09
34	0.002067	0.96635	96,635	44.18
35	0.002147	0.96435	96,435	43.27
36	0.002233	0.96228	96,228	42.36
37	0.002318	0.96013	96,013	41.46
38	0.002399	0.95791	95,791	40.55
39	0.002483	0.95561	95,561	39.65
40	0.002581	0.95324	95,324	38.75
41	0.002697	0.95078	95,078	37.84
42	0.002828	0.94821	94,821	36.95
43	0.002976	0.94553	94,553	36.05
44	0.003145	0.94272	94,272	35.16
45	0.003339	0.93975	93,975	34.26
46	0.003566	0.93661	93,661	33.38
47	0.003831	0.93327	93,327	32.5
48	0.004142	0.9297	92,970	31.62
49	0.004498	0.92585	92,585	30.75
50	0.004888	0.92168	92,168	29.88

Policy Premium calculation for term insurance

The insurance company's estimated payoff to the insured determines the policy premium. Assume you have a $100,000 term insurance coverage two-year term. The first step in calculating the premium is to determine the insurance company's estimated pay-out.

Death probability and survival probability: Above table provides the death probability within one year and survival probability till the age given in the first column. Assume a person aged 42 whose probability of death within one year is 0.002828. To calculate the probability of person dying in the next year instead of current year we need the probability of person surviving this year and dying next year.

P(Dying next year) = P (surviving current year) X P(death within a year after one year)

P(Dying next year for male age 42) = P(1-0.002828) x 0.002976 = 0.002967

We can also arrive at this value by using the probability of survival column but that's lengthy step. Hence we will stick to simpler ones.

Expected Payoff: The term insurance policy business works on the principle of collecting payments in small size to pay big lumpsum amount to nominee of policy holder. Assume 10,000 insurance policy holders paid premium of $1000 each (per year) to get a policy with the insured sum of $100,000. The total sum collected by an insurance company is $10,000,000 (1000X10,000). Assume, 90 policy holder died in this year, hence insurance company is liable to make $9,000,000 payment to nominee of policy holder. Insurance company will still save $100,000. However, if 11 policy holders dies then company makes loss of $100,000. Hence, knowing the expected number of deaths is very crucial for insurance business.

The probability of death within a year in this case is 0.01 (assuming total death 100 / total policy holders 10,000). Assuming sum insured is $100,000, expected payoff for insurance company is P (death within a year) X Sum insured X total policy holders = 0.01 X 100,000 X 10,000 = $10,000,000.

The expected payoff per policy holder can be calculated as P(death within a year) X Sum insured = $1000. Hence company should collect a breakeven premium equal to $1000, which will result into no profit no loss situation if deaths does not exceed the expected value. To earn profit company will add some profit percentage say 15%, hence insurance premium should be 1000+15% = $1150. We will ignore taxes for sake of ease of calculation.

Consider a 35-year male from the above mortality table whose probability of death within one year is 0.002147. The expected payoff for this policyholder assuming the sum insured equal to $200,000 is equal to $429.

Premium calculation

Illustration: Assume a term insurance policy with two-year term with a sum insured equal to $200,000 for male aged 35. Calculate the breakeven premium assuming death is expected in mid-year and interest rate equal to 5% semi-annual. (Premium is paid in the start of the year).

First Step: Calculation of expected payoff.

Expected payoff in first year
= probability of death within one year X Sum insured
= 0.002147 X 200,000 = $429.4

Expected payoff in second year
= Probability of death in next year X Sum insured
= (1-0.002147) X 0.002233 X 200000
= $445.64

PV of expected payoff is calculated assuming death is in the mid-year. Hence first year's payoff is at 6 months and second-year payoff is at 18 months. The interest rate of 5% semi-annual for discounting is given in the illustration.

PV of expected payoff = $429.4 / 1.025 + 445.64 / (1.025)^3$ =832.74

Premium calculation:
Premium is expected to be collected twice first in the start of the first year and second in the start of second year only if policyholder survives for the first year. Let's assume premium is equal to P. Expected premium collection is equal to

=P + (P(survival for first year) X P) / Discounting for one year
=p + (0.997853XP) / $(1.025)^2$
= 1.94977 x P
Breakeven premium for two year term policy

1.94977 X P = 832.75
P = $427.10
Exam shortcut: Second trick is breakeven premium is above 0.5 X PV of expected payoff.

2.2.c Endowment Life Insurance

Endowment life insurance is a type of term life insurance in which the policyholder is guaranteed a payout at the contract's specified maturity date. If the policyholder dies during the policy's term, the payout occurs upon his or her death. Otherwise, it occurs at the policy's expiration date. Occasionally, the payout is made when the policyholder is diagnosed with a critical illness. When an insurance company issues a with-profits endowment life insurance policy, it declares bonuses based on the performance of its investments. These add-ons boost the final payout (assuming that the policyholder lives until the end of the life of the policy). In a unit-linked endowment policy, the policyholder selects a fund and the payout is contingent on the fund's performance.

2.2.d Group Life Insurance

Companies often purchase group life insurance for their employees. Premiums may be paid entirely by the company or in part by the company and its employees. Individuals are usually required to undergo medical tests when applying for life insurance, but these tests are usually waived in the case of group life insurance. This is due to the fact that the insurance company is aware that it will be taking some risks that are both better and worse than average.

2.2.e Annuity Contracts

Most life insurance companies also offer annuity contracts. Unlike life insurance which converts regular payments into a lump sum, annuities convert a lump sum into regular payments. An annuity contract typically pays for the rest of the policyholder's life. In some cases, the annuity begins when the insurance company receives a lump sum. In the case of deferred annuities, payments start years later.

Government taxes, like life insurance, can be a factor in annuity purchases. The insurance company is investing funds on behalf of the policyholder, tax is normally only due when the annuity is received. However, if the policyholder invested the funds themselves, annual tax would be due. This arrangement has two benefits: Due to the fact that taxes are deferred, many policyholders have low marginal tax rates when the annuity is received, and investment can grow tax-free.

The accumulation value of an annuity contract refers to the growth of the policyholder's funds. There are usually penalties for early withdrawals. The accumulation value of some annuity contracts is guaranteed to never decline. The contract may be structured so that the accumulation value tracks the S&P 500 with a return cap of 0% and a return cap of 7%.

In the UK, some deferred annuity contracts guarantee a minimum future annuity payment. For example, an insurer may offer a ten-year annuity that pays at least 8% of the accumulated value. But if interest rates fall and life expectancy rises, the guarantee can be very costly. Equitable Life, a huge UK life insurance company founded in 1762 with 1.5 million policyholders, failed because of its generous guarantees.

2.3 Longevity and Mortality Risk

Longevity risk is the likelihood of living longer than expected. This is due to improvements in medical science, nutrition, and other factors.

Mortality risk, on the other hand, is the opposite of longevity risk. War, epidemics, and other factors may cause people to die sooner than expected. An insurance company's life insurance business should welcome the possibility of people living longer than expected. As a result, whole life premiums will be paid for longer periods and payout will be (on average) delayed. The mortality risk is more concerning because it may result in earlier payout with insufficient premiums collected.

An insurer's annuity business is exposed differently than its life insurance business. People who live longer than expected receive their annuity for longer, making the contract more costly for the insurer. If they die earlier than expected, the insurance company saves money.

Longevity derivatives are the instruments to hedge the longevity risk. Payoff of these derivatives depends on the prespecified mortality rate and actual mortality rate.

Payoff = (Prespecified Fixed Mortality Rate – Realized Mortality Rate) X Principal

Similarly forward contracts or special type of bonds can also be used.

2.4 Property and Causality insurance (P&C)

Property insurance as the name suggests is insurance to cover damages to physical assets, is used to get protection against damage to property from fire, theft, flooding, and other loss generating events. Casualty insurance on the other hand provides the coverage for liabilities arising due to injury or damages caused to others due to insured party. Example: Third party insurance on car or two wheelers, which provides the insurance against the claim made by third party to whom injury or damages caused by insurer. Both property and causality insurance can be provided under the single insurance policy.

P&C insurance is renewed yearly. Insurance company can increase the premium to on the policy if insurance company is taking more risk on the policy. Say, for car insurance, insurance company finds more theft are occurring in particular city then premium will be increased on car insurance sold in that city.

P&C insurance company faces two main types of risk

- **Risk of average pay-out when the outcome of policy claim is independent:** Insurance company can reasonably predict the average claims on a particular policy based on the historical data. Assume, car accident insurance policy where company can estimate the total claims, but each claim of car accident is independent of each other. This independence in claims is very important and reduces the possibility of claims beyond the estimates.
- **Catastrophe risk:** This risk mainly relates to insurance policy which is linked with some natural disaster. If company sells home insurance policy which protects the insurer against the loss from earthquake. In this case, if earthquake hits the locality, company will get claims from multiple policy holders at the same time. This is due to dependent event because earthquake affects multiple houses at the same time.

Risk Type	Description	Example
Higher Average pay-out	Risk when the outcome of policy claim is independent. Company can predict average claims based on historical data.	Car accident insurance policy where each claim is independent of each other.
Catastrophe risk	Risk mainly relates to insurance policy linked with natural disaster. Company may get claims from multiple policy holders at the same time.	Home insurance policy protecting against loss from earthquake. Earthquake affects multiple houses at the same time.

2.4.a CAT Bonds

Catastrophe risk can result in sudden high payoff for insurance company. Hence, company prefers to reinsure catastrophe risk to another insurance company. Insurance companies can also use CAT bonds to hedge catastrophe risk.

Mechanism of CAT Bonds:

Insurance company issues the CAT bond which is at the higher interest rate than normal bond. CAT bonds are issued with predefined claim payout range. If pay-outs for the insurance company due to catastrophic risk exceeds this range, payout exceeding this range is made from the interest and sometimes principle of the bond. Assume, a insurance company issued CAT bond of $10M which covers claims in the range of $20M to $30M. The principle and interest is safe as long as claim payoff for the company is below $20M. If claim payoff exceeds $20M then, the interest or principle is used to make the payment of these claims. Bond investors are not liable to compensate the claim payoffs beyond $30M.

CAT bonds offer better diversification of risk compared to reinsurance. Because, in case of any catastrophe, all the insurance companies face this risk due to exposure to similar events. On the other hand, CAT bonds are uncorrelated to catastrophe.

2.5 Ratio for P&C business

Loss ratio: Is the key ratio for P&C insurance business. This is the ratio of total pay-outs to premiums. Loss ratio of 85% means, 85% of the premiums collected by company are used to pay claims. The remaining 15% is used to cover expenses and profits.

Expense Ratio: Is the ratio of total expenses to premiums collected. Say 5% is the expense ratio. If company collected $100M in premium, then total expenses incurred by company amounts to $5M.

Combined Ratio: Is the sum total of loss ratio and expense ratio. In this case combined ratio is 90% (85% + 5 %). Combined ratio can also be calculated after dividend. Assuming the dividend rate of 2%, then combined ratio post dividend is 92%.

Operating Ratio: Operating ratio is the combined ratio after adjusting for investment income of the company. Assume company earned 3% investment income, then operating ratio of the company is 92% - 3% = 89%.

2.6 Health Insurance

Health insurance provides the coverage against the health care cost for specific illness. The key difference is the increase in premium based on circumstances which mainly relates to illness of policy holder or nominee. If the policy holder develops the unexpected health conditions after the policy is issued, then premium may be increased by the insurance company.

2.7 Moral hazard Vs Adverse selection

Moral hazard is the risk that the policyholder's behaviour will change due to the insurance. In previous reading, we discussed deposit insurance moral hazard. We noted that banks may be tempted to take riskier strategies when depositors are insured by the government. Example: Shop owner owning insurance might be careless in maintaining security in the shop to avoid theft etc. Moral hazard is not the concern in life insurance business because it is highly unlikely that someone will jump off the cliff to get life insurance money.

To reduce the moral hazard insurance companies, take certain measures like deductibles (like part of the loss is born by the policyholder), co-insurance, and limit on the claim amount.

Adverse selection occurs when only high-risk policyholders buy insurance. If an insurance company offers the same car insurance rates to everyone, those with bad driving records will find it more appealing. Before quoting a premium, insurance companies should know as much as possible about the risks they are taking on and update the risk assessments as new information comes in.

2.8 Regulations

In Chapter 1, we learned that the Basel Committee sets global banking regulations. However, there are no global regulatory requirements for insurers. In the European Union, however, a new regulatory framework known as Solvency II went into effect in 2016.

Solvency II specifies an MCR (minimum capital requirement) and an SCR (Solvency capital requirement). If capital falls below the SCR, an insurer must devise a plan to raise it above the SCR. If it falls below the MCR level, the insurer may be unable to accept new business and existing policies may be transferred. The MCR is typically 25%-45% of the SCR. There are both standardised and internal model-based approaches to determining capital requirements. There are capital charges for:

- Investment risk (this relates to the asset side of the balance sheet),
- Underwriting risk (this relates to the liabilities side of the balance sheet), and
- Operational risk.

Property-casualty underwriting often has greater capital requirements than life insurance underwriting. This is because the catastrophic risks of the former are bigger than the longevity/mortality risks of the latter.

2.8.a Capital Requirement

In the previous reading we discussed about Basel regulation which is global regulation for banks. However, no such globally applicable regulation exist for insurance companies. However, in EU, regulatory framework Solvency II is applicable for all insurance companies. Solvency II specifies minimum capital requirement MCR and Solvency capital requirement SCR.

If capital < SCR – insurance company is required to formulate a plan to restore capital above SCR level.

If capital < MCR – Insurance company may be prevented from accepting any new business, however, company can make claim settlements for existing policies. MCR is generally set within the rage of 25% to 45% of SCR.

Similar to Basel, Solvency II provides the internal model and standardized model for capital requirement calculation.

2.8.b Risks faced by insurance company

Insurance company is required to maintain capital to cover following risks

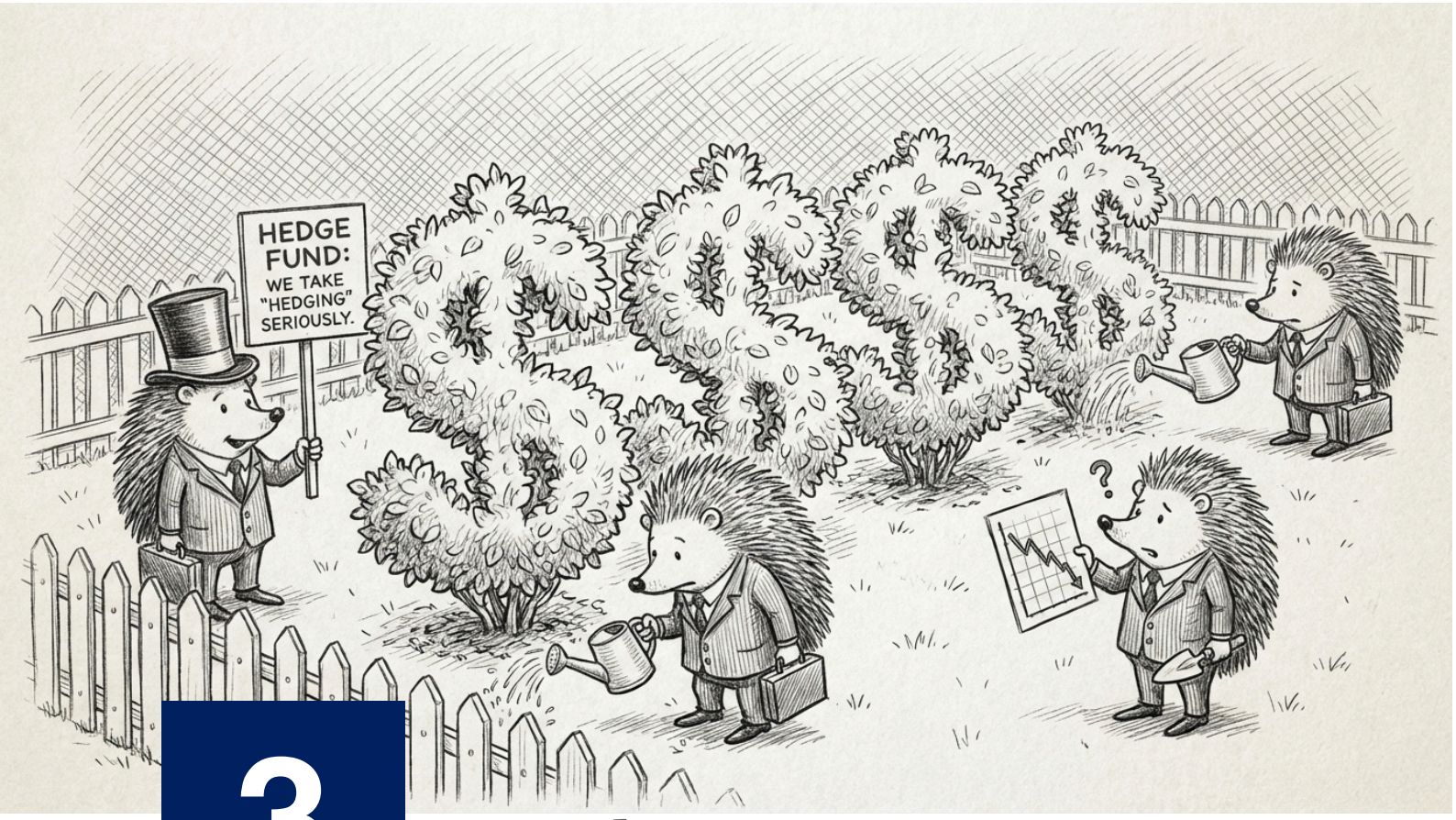
- Investment risk: Risk relating to investments made by the insurance company. This can be further divided into
  - Credit Risk
  - Market Risk
- Underwriting Risk: Risk arising due to underwritten policies.
- Operational Risk: Risk of fraud or internal operations of the company.

2.8.c Guarantee System for the policyholder

In the US, insurance is governed by state law rather than federal law. The NAIC is a national platform for insurance regulators to exchange ideas. For example, it gives national statistics on insurance company loss ratios. However, insurance regulations vary by state, and a large US insurer may have to deal with 50 separate regulators.

The US policyholder guarantee system is distinct from the bank depositor guarantee system. As explained in Chapter 1, bank premiums go into a fund managed by the Federal Deposit Insurance Corporation (FDIC) to compensate depositors. The feds have topped up the fund as needed. *However, there is no permanent fund to protect policyholders. And insolvencies are managed by state. When one insurance company fails, others are compelled to contribute to a fund, and claims are limited, and settlements are delayed.*

3 Fund management



3 Fund Management

Scope of this reading

Differentiate among open-end mutual funds, closed-end mutual funds, and exchange-traded funds (ETFs), understanding their structural differences. Learn to calculate the net asset value (NAV) of an open-end mutual fund and identify potential undesirable trading behaviours that can occur at mutual funds. Explain the key differences between hedge funds and mutual funds in terms of structure, regulation, and investor access. Calculate the return on a hedge fund investment and understand the incentive fee structure, including hurdle rate, high watermark, and clawback provisions. Describe various hedge fund strategies—long/short equity, dedicated short, distressed securities, merger arbitrage, convertible arbitrage, fixed income arbitrage, emerging markets, global macro, and managed futures—and identify the specific risks associated with each strategy. Finally, describe the characteristics of mutual fund and hedge fund performance measurement and explain how measurement biases such as survivorship bias, backfill bias, and selection bias affect performance evaluation.

3.1 Introduction

Investors and companies hire fund managers. Client funds are pooled, and fund managers make decisions based on declared investment goals and risk appetites. This method has numerous benefits.

- Clients may not have the same level of investment expertise as fund managers.
- Large deals have lower transaction costs (as a percentage of the amount transacted) than small trades.
- Small investors may find it difficult to diversify their portfolios, but a large fund with billions of dollars should have little trouble doing so.

In this chapter, we consider mutual funds, exchange-traded funds (ETFs), and hedge funds. Mutual funds cater to individual investors, whereas hedge funds generally have high minimum investment thresholds that limit participation to wealthy individuals and institutions. Hedge funds are subject to less regulation than mutual funds or ETFs and are free to follow a wide range of trading strategies.

3.2 Mutual Funds

Mutual funds (or unit trusts in some countries) have long been a favourite of small investors. Mutual fund assets have grown significantly. Mutual fund assets grew from USD 0.5 billion in 1940 to USD 19 trillion in 2017.

Open-end and closed-end mutual funds exist. Open-end funds dominate, accounting for approximately 98 percent of mutual fund assets in the US.

3.2.a Open-ended Mutual Fund

In open ended mutual funds investors can invest in the fund and retire from fund at any point in time. In simple terms, when investors buy or sell number of shares, the size of fund expands or contracts because shares are directly bought or sold to the fund. Open ended funds can be offered by asset manages or asset management division within the banks.

NAV (Net Asset Value)

The native set value is the total value of the assets of the fund divided by total number of shares in the fund. It is valued(NAV) at 4:00 PM each day. All the traits of shares in mutual fund are at NAV. The time of placing the order is irrelevant and hence order is placed at 4PM only at the NAV. There are no tax advantages associated with the investments in the mutual fund in US. The investors will pay taxes based on the type of capital gain.

Open ended funds can be categorized as follows:

Money Market Funds: Money market funds invest in short-term fixed-income securities (e.g., commercial paper). Money market funds are a popular alternative to bank savings accounts. Clients can sometimes write checks on their funds. Despite the lack of deposit insurance, money market funds typically outperform bank deposits. Money market funds in the US a kept at USD 1 NAV. The gain on every day is returned to the investors. If there is a negative return which is very unusual it is called as breaking the buck.

- **Bond Funds**: Bond mutual funds invest in long-term fixed-income assets

- **Equity Funds:** Equity funds invest in equity shares and are considered very risky. Peter most popular type of mutual funds which can be subdivided into actively managed funds and the index funds.
    - **Actively managed funds:** Fund manager uses his skills to achieve the funds goals. Girls can be like earning the highest dividend income.
    - **Index funds:** It is an attempt to track a specific index such as S&P 500. It can be done by simply purchasing stocks in the proportion of index.
- **Hybrid Funds:** Combination of above category of funds.

To cover the expenses incurred in management funds, fees is charged on the yearly basis. Expense ratio is the ratio of management fees to value of the asset being managed. In addition to management fees investors sometimes are also required to pay front end load and backend load, which is fees to enter the mutual fund or exit the mutual fund, respectively.

3.2.b Close Ended Mutual Fund

Closed-end funds have a fixed number of shares. A closed-end fund is a regular firm that invests in other companies. Buying a closed-end fund is like buying any other stock. Price adjustments balance supply (sellers) and demand (buyers) (investors wanting to buy shares).

Unlike open-end funds, closed-end fund shares are often traded at a discount to NAV. For example, a closed-end fund's share price may be USD 100 whereas the NAV is USD 102. In theory, an arbitrageur could benefit by buying all of the closed-end fund's shares at market value and then selling the fund's assets. The reason for this price mismatch can be attributed to management fees.

3.2.c Exchange Traded Funds

ETFs are mutual funds that are traded on an exchange. An exchange-traded fund (ETF) is a hybrid of open-ended and closed-ended mutual funds. When an institutional investor deposits a block of shares with the ETF in return for shares in the ETF, the ETF is created. ETFs are traded in the same way that ordinary stocks are. Investors should deposit a block of shares in an ETF with the same composition as the ETF's current assets. Because ETFs are redeemed in the form of shares, they do not trade at a discount and do not require liquid assets to fulfil redemption.

3.3 Undesirable trading behaviour at Mutual funds

Late Trading: Since all open-end mutual fund trades occur at 4 p.m., trading instructions must be received by a broker before then. For administrative reasons, the mutual fund may not receive such trades until well after 4 p.m. If the market moves after 4 p.m., a trader may call their broker to cancel or reschedule a trade. Some US brokers have been known to accept orders after 4 p.m. Late trading is prohibited by the SEC. Several prosecutions have resulted in substantial fines and job losses.

Market Timing: In open-end mutual fund, not all assets trade actively. As a result, the NAV prices may be obsolete (i.e., not reflecting recent information). Due to time zone differences, prices of securities traded on foreign exchanges may be stale. Assume it is now 3:45 p.m. and markets have risen in recent hours. Due to old pricing, the mutual fund's shares are presumably worth slightly more than the NAV, making the 4 p.m. NAV attractive. Similarly, selling at the 4 p.m. NAV is appealing if market prices are declining. Market timing trades are allowed, but they must be huge to be profitable. If the mutual fund accepts trades, the fund's size will fluctuate. This may result in fees for all investors if the fund must hold extra capital to cover redemptions. Regulators may be worried if market timers are given special trading powers.

Front Running: A trader for a mutual fund (or any other type of fund) may be tempted to trade on his or her personal account just before executing the fund's trade. For example, before a fund buys 1 million shares of a stock, the trader may acquire 10,000 for his own account. The trader might also alert favoured customers or other fund staff about impending price changes, allowing them to trade ahead of time. Fund managers cannot front run (also known as tailgating).

Directed Brokerage: A mutual fund and a brokerage firm have an informal partnership. A mutual fund will employ a brokerage house to trade if the brokerage firm recommends the mutual fund to its clients. Regulators oppose it.

3.4 NAV calculation

Net asset value NAV is very important factor for mutual fund specially in open ended funds because this is actual price to enter or exit the fund. NAV is calculated as net asset of the funds divided by total outstanding shares.

$$NAV = \frac{Total\ assets\ (including\ cash) - Total\ Liabilities}{Total\ outstanding\ shares}$$

Consider an open-ended fund with current outstanding shares of 1,000,000. Fund is currently holding $10M of equity and $5M of bonds. Funds owe $0.5M as a management fees. The NAV of the fund is calculated as follows

$$NAV = \frac{10M+5M-0.5M}{1M} = \$14.5$$

3.5 Hedge Funds

Alternative investments like hedge funds are less regulated than mutual funds and ETFs. Unlike mutual funds and ETFs, hedge funds typically only accept substantial investments from affluent individuals or institutions. Other differences exist.

The following are examples.

- Investors can redeem mutual fund or ETF shares at any time. A lock-up period may exist in a hedge fund. Year-long detentions are typical.
- A mutual fund or ETF's NAV must be calculated and reported daily. The NAVs of hedge funds are not required to be disclosed as regularly.
- Mutual fund and ETF strategies must be for its competitiveness and/or value offer, hedge funds often follow proprietary strategies. They reveal some facts to describe their value offer, but not all. They are also not bound by one strategy.
- Leverage restrictions may apply to mutual funds and ETFs. A hedge fund's borrowing limit is set by banks.
- Hedge funds charge both an incentive and management fee. Hedge fund fees are typically 2 plus 20%. This means that investors pay 2% of their investment value annually plus 20% of the earnings (if these net profits are positive).

Many hedge funds use long-short strategies, hence the term hedge fund. This approach involves holding long holdings in high-return equities and selling positions in low-return stocks. However, some hedge fund methods include little or no hedging.

3.5.a Incentive fees calculation

Here, we'll assume that the assets are valued at the beginning of each year, and that management fees are deducted from those values before calculating the incentive fee. Assume fees structure of 2 plus 20% where, 20% is incentive on return produced and 2% is management fees. Fees can be calculated as

0.2 X max(Return X Asset Value – 0.02 X asset Value, 0)

This formula has the similar payoff structure as call option payoff. If fund positive produces return after adjusting for management fees, manager would also encash profits equal to 20%. If fund performs poorly, manager would still get away with management fees. This creates upside potential for manager without any downside risk. Investors are concerned about this one sided profit structure for managements. To provide investors some relief hedge funds can provide terms such as

- **Hurdle rate:** Incentive fees is only payable if the return is above some benchmark.
- **High watermark:** Incentive fees will only apply if cumulative profits for an investor are positive. Assume hedge fund manager produced loss of $5M in previous year. Incentive fees will only apply if manager produces profits in the subsequent year which is first compensated for prior losses.
- **Clawback clause:** Some portion of incentive can be used to compensate future losses.

Incentive structure despite all these measures, gives motivation to managers to take more risk. Assume manager takes safer strategies to produce low returns to avoid risk, it will reduce the incentive payoff for managers. However if manager opts for risky strategies then payoff is higher if funds perform accordingly. However, if funds perform poorly and high watermark or clawback clause will kick in. But manager can escape these by closing the existing funds and starting new one.

3.6 Types of Hedge Fund

Hedge funds follow many different trading strategies. Here we discuss a few of the more common ones.

Long-Short Equity

Originally, hedge funds were long-short funds that bought undervalued equities and sold overvalued ones. For a long-short fund to perform well, the manager must be able to predict winners and losers independently of the market as long as:

- The value of the shares shorted equals the value of those bought, and
- Both the long and short portfolios have the same sensitivity to market movements.

The typical long-short approach has several variations. If the hedge fund management believes the market will rise rather than fall, the long position may outperform the short position. In the other case, the manager may opt for a longer short.

Dedicated Short

There are as many overvalued shares as undervalued shares at any given time. A dedicated short fund only picks expensive stocks. Hedge funds utilising specific short strategies hunt for companies having problems the market hasn't noticed. They are not, however, hedged against market performance. Not surprisingly, focused short strategies underperform during bull markets.

Distressed Debt

Some hedge funds trade distressed debt. They use their bankruptcy knowledge to locate circumstances where they can take a large debt position and gain from reorganisation offers.

Merger Arbitrage

When a business declares its intention to buy another, the deal is usually questionable. The target company's stock price normally rises, but not to the promised price. A merger arbitrage hedge fund may assume that there is an 80% chance of success and that the acquisition price will be greater than current. Buying the target's stock may be a solid investment. With a share-for-share exchange offer, the hedge fund might buy the target firm's stock and sell it to the acquiring business in a ratio that mirrors the present offer.

Merger arbitrage does not involve trading on non-public information (which is illegal). It involves estimating the likelihood of a merger's success and the final price (or exchange ratio in the event of a share-for-share merger).

Convertible Arbitrage

Convertible bonds are issued by companies and can be exchanged into a certain number of shares at a later date. Hedge funds that value convertible bonds utilise complex models. They protect the company's share price, credit spreads, and interest rate risks. The approach can be beneficial if the market price converges to the hedge fund's model price.

Fixed Income Arbitrage

Some traded bonds are likely to be expensive compared to similar bonds, while others are likely to be cheap. In a fixed-income arbitrage strategy, a hedge fund manager buys inexpensive bonds and sells pricey ones. They usually utilise a lot of leverage to justify the tactic.

Emerging Markets

Emerging market hedge funds try to obtain information on obscure equity securities in developing nations. They buy (sell) securities in the local markets when they think they are undervalued. Use American Depositary Receipts (ADRs), which are backed by foreign firm shares and traded on an American exchange. Any disparity between ADR and local prices can lead to arbitrage.

Global Macro

Global macro hedge funds make trades based on macroeconomic data. They look for market disequilibrium using models based on exchange rates, interest rates, balance of payments, and inflation rates. The Quantum Fund, run by George Soros, made $1 billion in 1992 by wagering the British pound was overvalued. But not all global macro trades are successful, and economies might remain in disequilibrium for a long time.

Managed Futures

Managed futures techniques try to forecast future commodity prices and take profitable bets if they are correct. In addition, trading rules are frequently back-tested to evaluate how well they would have done if utilised in the past. But there is a risk. Back-testing does not distinguish between market-savvy tactics and those that were lucky (and thus not necessarily bound to be successful in the future).

3.7 Fund Research

Researching the hedge fund and mutual fund have their own complexities.

3.7.a Mutual Fund Research

"Is it worth employing a professional to invest my money?" asks an investor. It's not evident that the answer is yes. While certain mutual funds and hedge funds have delivered exceptional returns to investors, the fine print always states, "Past performance is no guarantee of future outcomes."

Jensen observed that actively managed mutual funds underperform the market. Not a surprise. Every investors return (before expenses) is the market return. A systematic underperformance by other investors would mean that mutual funds and ETFs have outperformed.

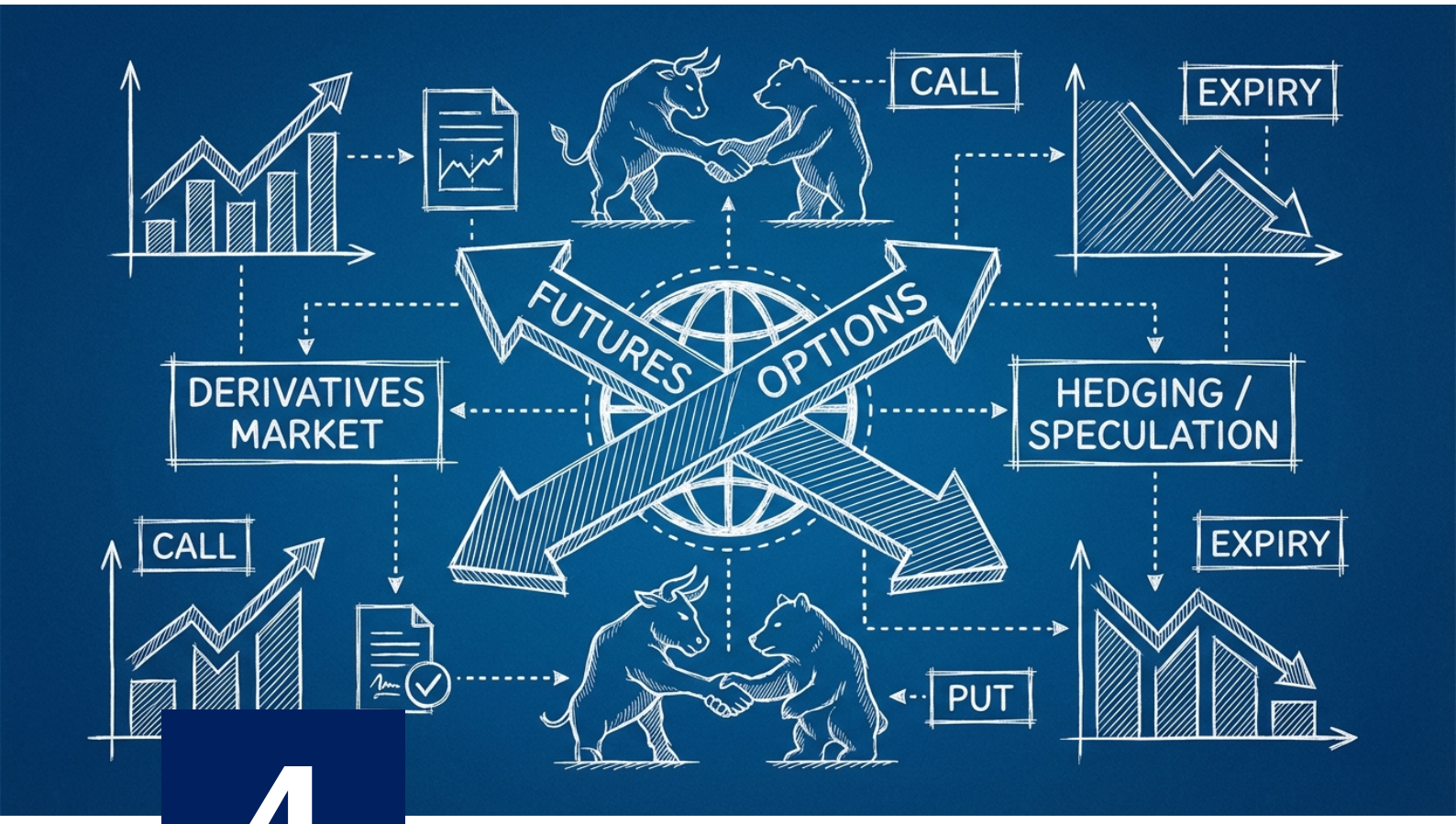
Jensen evaluated the likelihood that a mutual fund that has outperformed the market for several years will do so again the following year. This is called testing persistence. A year later, just 50% of mutual funds that outperformed the market did so again. Jensen's analysis (supported by other academics using more recent data) implies that there can't be many mutual funds that continuously outperform the market.

3.7.b Hedge Fund Research

Upward bias: Hedge fund performance is not as straightforward to analyse as mutual fund performance. The involvement of hedge funds is voluntary and not all of them reveal their results. In reality, funds that lose money (or close) may be less willing to publish returns. This would lead to an increase in average reported returns.

Hedge funds use more advanced techniques than mutual funds, and some have made investors very wealthy (we mentioned the outstanding success of Jim Simons and Renaissance Technologies earlier). But others have flopped. Hedge funds can show high returns for a few years before losing a big amount of their assets (e.g., Long Term Capital Management and Amaranth).

4 Introduction to Derivatives



4 Introduction to Derivatives

Scope of this reading

This chapter introduces derivatives by defining their structure, features, and uses, and distinguishing between linear and nonlinear instruments. It compares over-the-counter and exchange-traded markets, highlighting their respective advantages and limitations. The chapter differentiates forwards, futures, and options, and develops payoff calculations for these contracts. It analyzes the roles of hedgers, speculators, and arbitrageurs, and evaluates hedging, speculative, and arbitrage strategies using forwards, futures, and options. Finally, it discusses key risks associated with derivative usage, including market, credit, liquidity, and operational risks.

4.1 Key terms

Financial instruments: Financial instrument is the legal contract between the two parties which has monetary value. These instruments can be in physical (document form) or virtual (electronic form). Generally, it can be traded between the parties for some monetary value. Examples of financial instrument: Cheque, shares, forwards, futures, options, bonds etc. Assume, you own 1000 shares of Apple Inc currently prices at $160. This gives you ownership in Apple inc. worth 1000 shares. These shares can be transferred to another party in exchange for cash.

Derivatives: Derivatives are the financial instruments which derive its value from underlying. We will discuss number of derivatives in FRM curriculum in details. Following is the list of derivatives discussed in FRM curriculum.

- Forwards
- Futures
- Options
- Swaps
- FRA

Underlying: A word underlying when used in the context of derivatives can represent any stocks, commodity (metals, crude oil and even spices), weather (rain or temperature), event (economic crisis, cricket match) and some other derivatives. Assume option derivative on any stock. Price of this derivative is variable and depends on the price of underlying stock. In case of derivative on weather(rain), price of such derivative might depend upon number of days raining in specific region.

Other miscellaneous definitions:

- Bilateral contract: contract between two parties where terms are mutually agreed upon.
- Payoff: Amount paid at the time of settlement of contract.
- Spot price: Price of the asset to buy or sell immediately in spot market.

4.2 Forwards and futures

Forward contract is an agreement between two parties to buy or sell an underlying at a certain future data for a fixed price. A forward contract is traded bilaterally over the counter market. Long forward is the position taken by party willing to buy an asset in future date and short position is the position of party willing to sell an asset to a long position holder on same terms like month of delivery, quality, and quantity.

Consider, a farmer Mr. John who grows corn which is due for harvesting in the June. Today is 1st of January and price of corn is $7 per bushel. The farmer is looking to sell it at profit but afraid of price decline in June, when crop is harvested and ready for sale. At the other end of town there is a popcorn manufacturer Mr. Pop, who needs corn for popcorn production in June. Mr. Pop is afraid of price increase in corn which will affect his raw material procurement cost and will affect his profitability. To save themselves from any unnecessary price fluctuation, they both decided to enter into a contract where, Mr. John agrees to sale 5000 bushels of corn at $7.25 / bushels to Mr. Pop in the month of June. This contract fixes the buy price for Mr. Pop and sale price for Mr. John, which will save both the parties form any unwanted price fluctuation. This is called as the forward contract which is legally binding on both the parties. Hence, irrespective of the market price in the month of June, both the parties must trade corn at locked price of $7.25 / bushels.

- **Long forward:** Mr. Pop owns a long forward position when he agrees to buy the underlying (corn) at specific time in the future. Long forward is concerned about price increases, so he locks in his purchase price. This price increase protection comes at the cost of a missed opportunity to profit from a price decrease in the underlying, assuming there was one at the time of purchase. Long forward profits on price increases because, without a forward contract, he could have purchased corn at a higher price than the forward price, and loses on price decreases because, without a forward contract, he could have purchased corn at a lower price than the forward price.
- **Short forward:** Mr. John is in a short forward position because he has agreed to sell the underlying at specific time in the future. Short forward is concerned about a price drop and hence wants to lock in a selling price. This price protection comes at the cost of a missed opportunity to profit from a price increase in the underlying, if there is one at the time of purchase, which could result in more profit. Short forward loses on price increases because he could have sold corn at a much higher rate without the forward contract, but benefits on price decreases because he had to sell corn at a much lower price than the locked price in the absence of the forward contract.
- **Inception date and settlement date:** The date at which agreement is made is called as inception date of forward contract. The date at which goods are transferred by short forward and cash is paid by long forward is the settlement date.

The forward contract can be settled in two ways. One way to settle the contract is by delivery, which is transfer of goods by short and cash payment by long. Another method of settlement is settlement in cash, where winning party gets differential amount (actual price and settlement price) from losing party. Following table summarizes the settlement in cash.

	LONG FORWARD (MR. POP)	SHORT FORWARD (MR. JOHN)
AT THE TIME (JANUARY) OF INCEPTION OF CONTRACT	Long agrees to buy 5000 bushels of corn at $7.25/ bushel.	Short agrees to sell 5000 bushels of corn at $7.25 /bushel
AT THE TIME OF SETTLEMENT (JUNE)		
CASE 1: ACTUAL MARKET PRICE OF CORN IS $7.25 / BUSHEL	No loss or gain for long forward hence no payment required.	No loss or gain for short forward hence no payment required.
CASE 2: ACTUAL MARKET PRICE OF CORN IS $8.50	Long forward gains on price increase by $8.50 - $7.25 = $1.25 / bushel. Total cash received by long forward from short forward is 1.25 X 5000 = $6250	Short forward loses on price increase by same amount of $1.25/bushel. Total cash paid by short forward to long forward is $6250.
CASE 3: ACTUAL MARKET PRICE OF CORN IS $6.50	Long forward loses on price decrease by $7.25 - $6.50 = $0.75 / bushel. Total cash paid by long forward to short forward is $0.75 X 5000 = $3750	Short forward gains on price decrease by same amount of $0.75 / bushel. Total cash received by short forward from long forward is $3750.

Intuition behind cash payment: Let's consider situation from Case 2. Long forward agreed to buy corn at $7.25 / bushel. If the market price increases to $8.50 at the time of settlement, long can purchase corn for $8.50 from the market and receive cash $1.25 from short forward as a compensation for additional cost of $1.25 ($8.50 - $7.25) incurred by long. Hence, final cost of corn bushel for long forward is same as forward contract price $7.25 (Paid $8.50 for corn purchase – Received $1.25 from short as a gain on position). From the shorts perspective, short forward can sell corn into the market at $8.50 but net sell value for short forward will be $7.25

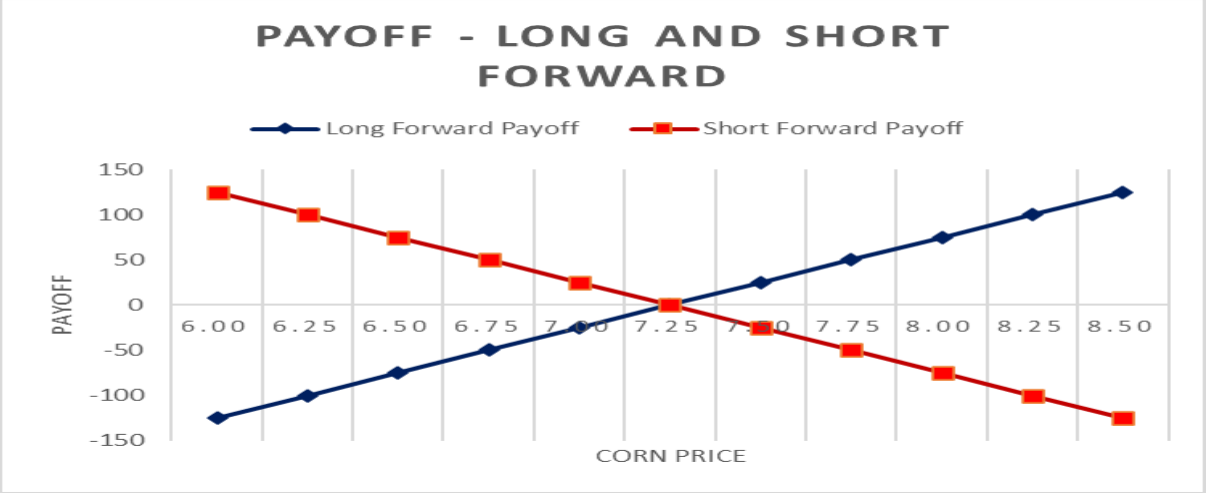
only (Received $8.50 on sale of corn bushel - $1.25 paid to long) which is same as forward contract price.

Payoffs from forward contract

The payoff is the amount transferred by losing party to winning party in cash settlement of derivative. Forward contract offers linear payoff. We already know, long forward gain on price increase and lose on price decreases and reverse is true for short forward. The amount of payoff depends upon the difference between market price (St) of underlying at the time of settlement and forward price(F). Following illustration provides the payoff structure for long and short forward.

Illustration: Extending the above example of farmer and popcorn maker, assume both the parties enter into forward contract for total of 100 bushels. We will assume different settlement prices (market price of underlying on settlement date) and see how payoff structure is generated. Please note: Payoff value will be exactly opposite for long and short position holder. For long payoff is St – F and for short payoff is F – St.

	Long forward		Short Forward	
Settlement prices $ per bushel	Payoff per bushel	Payoff per contract (100 lot size)	Payoff per bushel	Payoff per contract (100 lot size)
6.00	-1.25	-125	1.25	125
6.25	-1.00	-100	1.00	100
6.50	-0.75	-75	0.75	75
6.75	-0.50	-50	0.50	50
7.00	-0.25	-25	0.25	25
7.25	0.00	0	0.00	0
7.50	0.25	25	-0.25	-25
7.75	0.50	50	-0.50	-50
8.00	0.75	75	-0.75	-75
8.25	1.00	100	-1.00	-100
8.50	1.25	125	-1.25	-125



4.2.a Futures contract

Futures are standardized version of forward contract traded on exchange. Unlike forward contract, which is traded on OTC market, futures are traded on exchange. The payoff structure of forward and futures contract is same. Exchange specifies certain standardization in features of the contract. The main advantage of trading in exchange is that the credit risk is very low for exchange traded derivative because exchange acts as counterparty for each both the parties with the help of CCP mechanism (which we will discuss in next reading). The futures trade on a wide range of underlying compared to forward contract. We will discuss more on futures contract in later chapter.

4.3 Options

An option gives the buyer the right but not the obligation to buy or sell an underling at agreed price. Option buyer is said to be long on option. Seller of the option also known as writer of option has an obligation (but no right) to buy or sell underlying. An option can be thought of as the privilege offered to buyer of option by seller of option. There are two types of options.

- **Call option:** The buyer of a call option has the **right to purchase** an underlying at a specific price. When the buyer of the call option exercises his right, the writer of the call option is obligated to sell an underlying to the buyer of the option.
- **Put option:** The buyer of a put option has the **right to sell** an underlying at a specific price. When the buyer of the put option exercises his right, the writer of the put option is obligated to purchase an underlying from the buyer of the option.

Properties of option: In the next scenario, we will just discuss the long position in option for the sake of brevity. The attributes of option are detailed in the table below. For this example, we'll use Apple Inc's stock as the underlying, which is currently trading at $150.

	Call Option	Put Option
Strike price (X)	Price at which call holder(long) agrees to buy Apple Inc stock at a price say $155.	Price at which put holder agrees to sell Apple Inc stock at a price say $ 165.
Underlying (S)	Underlying is the asset or derivative which is bought if price of underlying is above strike price. Apple Inc stock is underlying.	Underlying is the asset or derivative which is sold if the price of underlying is below the strike price.
Expiration date	The date at which right can be exercised.	- **Same** -
Premium	Call premium is (denoted by P) the amount paid by the buyer of the option to purchase right to buy from writer of the option.	Put premium (denoted by P) is the amount paid by the buyer of the option to purchase the right to sell from the buyer.

Illustration(continued): Assume you take long position in call on Apple Inc (S) with strike price of $155 by paying premium of $5. You take second position, long put on Apple Inc with strike price of $165. At the expiration date we will assume 3 different scenarios to understand how option works and intuition behind it.

Price at expiration	Long call at $155	Long put at $165
Case 1: $150	Call option gave right to buy S at expiration date. It makes sense exercise this right only if the right at	Put option gave right to sell at expiration date. It makes sense exercise this right only if the right at

	which you can buy is less than the market price. In market S is trading at $150 and you have right to buy it at $155, hence there is no sense in exercising this right. Please note long position gives right and no obligation, hence long will only exercise right if it benefits him.	which you can sell is more than market price of S. In market S is trading at $150 and you have right to sell it at $155. You will exercise this right and seller of option has obligation to buy S from you at $155. The payoff on option exercise is $165 - $150 = $15 per option. (payoff is explained below)
Case 2: $160	Market price of the S is more than the strike price. Hence option is exercised, and payoff is equal to $5 i.e. (155 – 160)	Marker price of S is less than the strike price and hence option can be exercised, and payoff is equal to $5 (165-160)
Case 3: $170	Market price of the S is less more than the strike price and hence option is exercised, and payoff is $15 (170-155)	Market price of the S is more than the strike price, it would make more sense to sell s directly in the market instead of exercising right to sell. Payoff is zero.

Payoff Vs profit

Recall our discussion from forwards where we discussed cash settlement of forward instead of settlement by delivery. Same logic is extended here for the calculation of payoff. Payoff is the amount transferred by seller / writer of the option to buyer of the option if option is exercised. Let's take the example of Case 3 for long call. You have right to buy S at $155, when market price of S is $170. First option is to take delivery of S and make the payment of $155. But options are rarely settled by delivery. Options are mostly settled by cash settlement. In this case you can buy S from market at $170 and take the difference of $170 - $155 = $15 from the writer of the call. At the end final cost for you is still the same $155 ($170 buy price - $15 cash received from Seller of option). It is fine if you don't want to buy any stock and just enjoy the $15 received from the option seller.

If we think from the perspective of long put option in case 1, you have right to sell stock at $165 when market price is $150. You can ask seller of the option to simply pay the difference of $165 – $150 = $15 and sell S in the market at $150. Total sale value in this case is equal to $150 + $15 received from seller of option. This makes you sale price equal to strike price.

We can also think from the perspective of short seller. For exam purpose, simply remember the payoff of short is opposite of long. Assume above case 1 for put option. Seller of put has obligation to buy S from you at $165 irrespective of market price. When the market price is $150, his landed cost of buying S should be $165. If option is settled in cash, seller will pay you $15 and he will buy S from the market. His landed cost is still the same as agreed price (strike price) of $165 ($150 paid to buy S from market + $15 Paid to you in cash).

Profit in option: Unlike forward or futures, to buyer of the option needs to pay premium to option seller to get this right. Profit of option is payoff – premium of option. Assume buyer received payoff of $15 and premium paid is $5, then profit is equal to $10 (15-5).

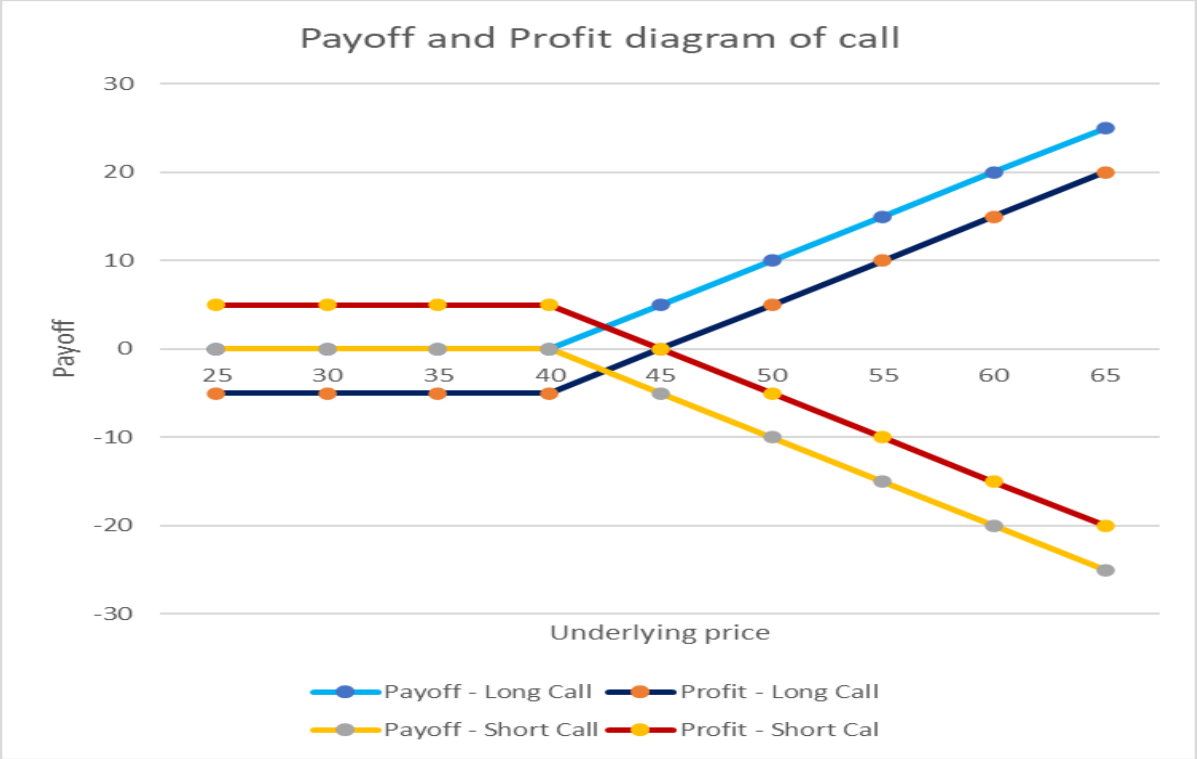
Key points to note:

- Buyer of call or put pays premium which is the earning source of seller of option.
- At maturity of option buyer receives payoff if option is exercised and no payoff if option lapses (not exercised), which is paid by seller of option.

Following illustration provides the different scenarios for payoff and profit for call and put.

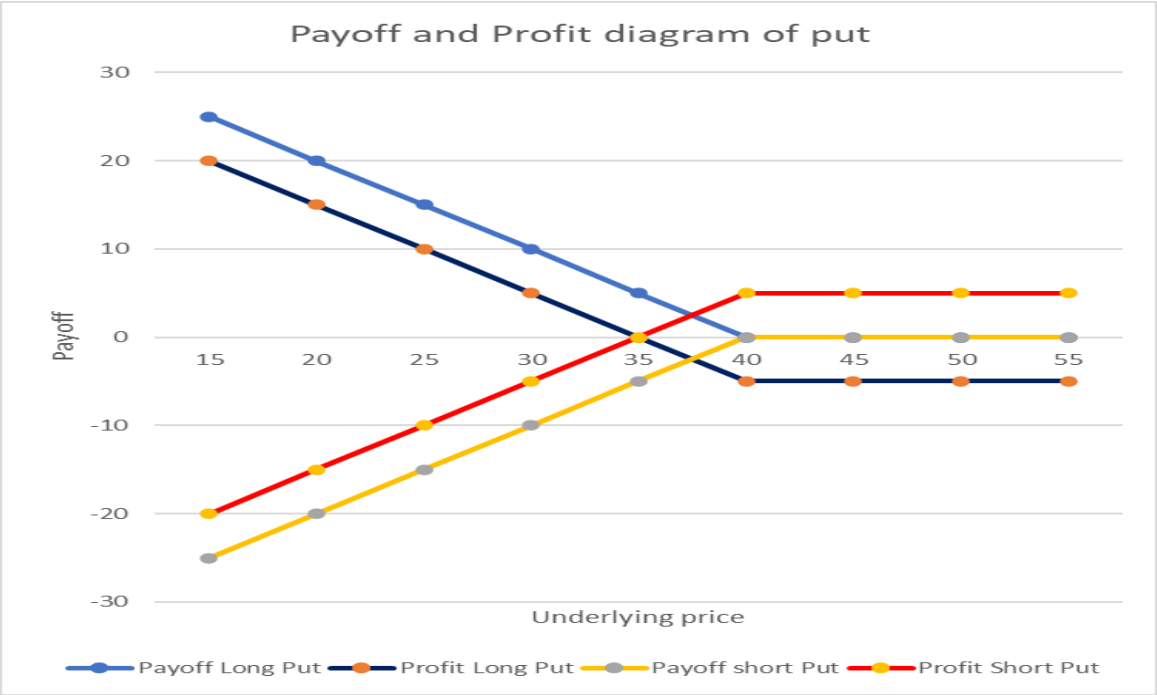
Illustration: Mr. John buys a call option at strike price of $40 by paying premium of $5 to Mr. Don who is seller of the option. Find the payoff and profit for both long call and short call position holder.

	Long call - Mr John				Short call - Mr Don			
Price at option expiration	Premium paid	Option status	Payoff	Profit (Payoff - Premium	Premium received	Option status	Payoff	Profit (Payoff - Premium
25	5	Laps	0	-5	5	Laps	0	5
30	5	Laps	0	-5	5	Laps	0	5
35	5	Laps	0	-5	5	Laps	0	5
40	5	Laps	0	-5	5	Laps	0	5
45	5	Exercised	5	0	5	Exercised	-5	0
50	5	Exercised	10	5	5	Exercised	-10	-5
55	5	Exercised	15	10	5	Exercised	-15	-10
60	5	Exercised	20	15	5	Exercised	-20	-15
65	5	Exercised	25	20	5	Exercised	-25	-20



Extending the above example for put option by keeping everything same except for option type (put instead of call). Following is the payoff and profit table and diagram.

	Long put - Mr John				Short put - Mr Don			
Price at option expiration	Premium paid	Option status	Payoff	Profit (Payoff - Premium	Premium received	Option status	Payoff	Profit (Payoff - Premium
15	5	Exercise	25	20	5	Exercise	-25	-20
20	5	Exercise	20	15	5	Exercise	-20	-15
25	5	Exercise	15	10	5	Exercise	-15	-10
30	5	Exercise	10	5	5	Exercise	-10	-5
35	5	Exercise	5	0	5	Exercise	-5	0
40	5	Laps	0	-5	5	Laps	0	5
45	5	Laps	0	-5	5	Laps	0	5
50	5	Laps	0	-5	5	Laps	0	5
55	5	Laps	0	-5	5	Laps	0	5



Points to note:

- Payoff of long call option is Ct = max (0,S-X), where, s is underlying price at maturity and x is strike price. Payoff of short call is simply -ve Ct
- Payoff of long put option is Pt = max(0,X-S). Payoff of short put is simply -ve Pt.
- Virtually long call holder has possibility of unlimited gains and hence resulting into unlimited loss for short call. Whereas loss for long call holder is limited to premium paid and hence gain for short call holder is limited to premium received. The same can be seen in diagram above.
- Virtually long put holder has possibility of high but not unlimited possibility of gain. In case of put price of underlying cannot fall below zero hence possibility of gain is limited. For short put holder possibility of loss is very high. Long put's loss is limited to premium paid and hence the gain of short put is limited to premium received.

4.4 Over-the-counter markets vs exchange

Derivatives can be traded on exchange or in over the counter markets. The key differentiation between the exchange and over the counter markets is, in exchange the standardised contracts which are defined by the exchange are traded by parties and in over the counter markets parties trade with each other directly or through some broker.

Exchange Traded markets

Derivative exchanges have been around for quite some time. The Chicago Board of Trade (CBOT), which was founded in 1848 to help farmers trade with merchants, is one of the most well-known exchanges. The Chicago Board Options Exchange (CBOE) was established by the CBOT in 1973 exclusively for option trading. Almost every corner of the world has access to the different exchanges.

Traditionally, the open outcry technique was employed by derivatives exchanges, which required dealers to physically meet on the trading floor and trade via hand signals. Trading is now done electronically in the modern world, with computers matching buyers and sellers. Algorithm trading is a relatively new phenomenon in electronic trading, in which a computer programmer creates an algorithm that can take derivative positions without the need for human participation.

Over-the-counter markets

Standardization of derivative contracts on exchanges is a source of concern for various parties. These standard contracts don't always match the requirements. On the other hand, OTC markets provide non-standardized contracts since two parties agree on conditions. Exchanges are similar to Amazon.com marketplaces, where sellers and buyers trade according to a standard product listing, whereas OTC markets are similar to your local market, where you meet the vendor in person, decide on the amount, and negotiate the price.

End users and dealers are both participants in the OTC market. Derivatives are used by end users to manage risk or gain exposure. Dealers, on the other hand, are huge financial institutions that provide end consumers with both buy and sell choices. To avoid risk, dealers frequently offset their positions with other dealers in a market known as the interdealer market. When trading with other dealers, end users often contact dealers directly, whereas dealers employ interdealer brokers. Because interdealer broker does not reveal the details of dealer's position to the counter

party, a dealer can keep their positions hidden from other dealers with the help of interdealer broker.

Over-the-counter markets were mainly unregulated before to the financial crisis of 2007-2008. Following the financial crisis, the OTC markets were subjected to new rules. When compared to exchange markets, the OTC market is seven times larger. It's worth noting that the size of the exchange market reflects the value of the assets underlying outstanding transactions, but the size of the OTC market reflects the total principle underlying outstanding transactions, inflating the size of the position. According to June 2017 data, the exchange traded market is worth USD 81 trillion, while the over-the-counter market is around USD 531.9 trillion.

Between 2014 and 2017, there was a decrease in the size of the OTC market, which can be ascribed to the widespread usage of compression. The next reading will cover compression.

4.5 Hedgers vs speculators vs arbitrageurs

Derivatives can be traded for various purposes depending upon the nature of the party trading it. There are three categories of traders in derivative market

- Hedgers
- Speculators
- Arbitrageurs

Here we will limit out discussion to just basic meaning of these participants. Explaining the actual process of say hedging or arbitrage will make this discussion complicated, hence actual process will be explained in later topics.

Hedgers

Hedgers participate in derivatives market to hedge their existing position. Assume you own 1000 stocks in RIL Inc. You are afraid of price falling. If you take a position in derivative (say put option on RIL Inc) which protects from price decrease, is called hedging. Hedgers are generally corporations, small institutions and funds who want to limit their risk side. Hedging reduces profitability due to cost of hedging or lost opportunity of extreme gains.

Speculators

Not all the participants enter into derivative trade to manage risk. Speculators enter into derivatives position to take risk in an attempt to gain if market moves in a favorable direction. Assume you are bullish on Indian stock market and take a long future position on market index. If market moves in favourable direction (moves up) then you can earn some profit, but if market moves in adverse direction, then you will incur losses. In this you being a speculator taking risk to gain on upward movement in the market. Speculators play very key role in market, by providing liquidity and ensure momentum in the market.

Arbitrageurs

Arbitrage involves taking advantage of inconsistencies in various markets. Arbitrageur's take the position in such a way that it generates risk free profits, but these profits are very low in value. Arbitrage do not exist for very long time (sometimes just few seconds or min) in liquid market. We will learn more about arbitrage in reading on forward futures pricing.

5 Exchange and OTC Markets

5 Exchange and OTC Market

Scope of this reading

This chapter examines how exchanges and clearing mechanisms mitigate counterparty risk in derivatives markets. It explains developments in central clearing, netting arrangements, and margining processes, including the determination of initial and variation margin requirements. The chapter compares exchange-traded and OTC markets, outlining their uses and associated risks across different classes of derivative securities. It analyzes specific risks in the OTC market and the role of collateralization in mitigating them, contrasting it with exchange margining systems. Finally, it discusses the use of special purpose vehicles (SPVs) in structuring and managing OTC derivative exposures

5.1 Exchanges

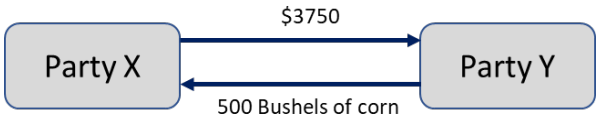
An exchange is a platform where parties can trade 'exchange traded instruments.' An exchange is similar to any other organization, but it is heavily regulated to safeguard the interests of its members. MCX (multicommodity exchange) in India and NYMCX (New York Mercantile Exchange) in the United States are specifically built for commodities futures exchange, ECX (European Climate Exchange) is for carbon financial instruments, and CBOE (Chicago Board Options Exchange) is for options exchange. Only standardized derivatives can be traded in exchange due to the exchange mechanism. In the discussion of this reading, as well as future readings, we will expand on this topic of standardization.

5.1.a Clearing process and Central Counterparties

Traditionally, exchanges handled activities such as contract standardization, dispute resolution among trading members, and the addition or removal of members from the exchange as needed (mainly member violates terms). In comparison to the past, as financial markets evolved, exchanges became more significantly involved in organizing trade activities. The exchange currently focuses on contract standardization and offering a trading platform for members, while the clearing procedure is now managed by the Central Counterparty (CCP). CCPs conduct the clearing process once a trade is executed on an exchange. CCPs serve two primary purposes:

Act as a counterparty for both the parties: Assume that party X and party Y have agreed to a long future corn contract at $7.5 per bushel (500 bushels lot size). If one of the parties defaults without a counterparty, the surviving party bears the loss. CCPs take positions for both parties once the trade is completed, acting as long for short futures holders and short for long futures holders. Both parties can rest assured that their contract will be honored with the help of CCPs, even if one of them defaults.

Without CCPs



With CCPs

Handling clearing process: The clearing process is the process of matching and reconciling contracts from the time they are entered into until they are settled. In the following readings, we'll discover more about the clearing process.

Another advantage of CCPs is the ease with which positions can be closed out. If one of the parties wants to close its position without CCPs, that party must go to the other party and discuss the closing. With CCPs as counterparties, parties interested in closing out positions can simply execute the opposite trade in the same contract with the same terms (for example, if the original deal was long 500 bushels of corn, the position can be closed by taking short 500 bushels of corn). Squaring off is another term for this process. When a party interested in closing out a position

squares off a trade by taking the opposing position in the trade, in this case, short 500 corn bushels, the trade will be matched with another party interested in the trade.

CCPs are extremely vulnerable to credit risk because they function as counterparty for both parties in a trade (risk that one of the parties will default and unable to repay the due at settlement). CCPs use the following steps to manage credit risk:

- Netting
- Margin requirements
- Default fund contribution

The following section will go over these measures in detail.

Netting

Netting is the process of merging a party's long and short positions to determine the party's net exposure to CCP. Assume Mr. John has a long position in gold futures for the month of June. If he takes a short position in 200 June futures contracts. Mr. John's net position is a long position in 300 contracts of gold futures in June. As a result, the net exposure to CCP is decreased to 300 contracts in short futures. In the next reading, we'll go over this issue in greater depth.

Margin requirements

Assume that on January 1st, a party takes a long position in 500 contracts of June gold futures. If the price of the underlying falls below the contract price, the party holding a long position in futures loses. Assume the contract price is $100 per contract, resulting in a net exposure of $100 multiplied by 500 contracts. Long position holders will lose $40 X 500 = $20,000 if gold prices drop to $60 by June. If the long position holder is hit with this loss all at once, he may default. This example only involves a $20,000 loss, but in reality, parties can lose millions of dollars. Margin rules are in place to safeguard the party and the CCP from this unexpected shock. The margin is the sum of money collected from a party to cover expected loss. CCPs may require margin payment in advance of engaging into a position. The amount of loss is charged to the margin account or collected on a periodic basis as the party incurs losses on the position. If a party fails to pay the margin call, the position is forced closed to protect CCP from further losses. There are three different kinds of margins.

- **Initial margin:** Margin is required to be paid to CCP when a transaction is entered into. To take a futures trade, assume the initial margin requirement is $10,000.
- **Maintenance Margin:** The party must maintain a positive margin balance called as maintenance margin. Consider a $6500 maintenance margin. If the balance of the margin account goes below $6500, CCP will send a margin call to the party, requesting payment to either replenish the margin account up to the maintenance margin or the initial margin, depending on the position. In the part below, we'll go over the specific margin requirements.
- **Variation margin:** Variation margin refers to the amount of money needed to replenish a margin account balance up to the initial or maintenance margin.

Note: Margin requirements are discussed in detail below.

Default fund contribution

CCP members are required to contribute to a default fund to offset CCP's losses in the event that a member defaults. This is a one-time payment that must be made by any new CCP member at the time of joining. If a member defaults, losses are absorbed in the sequence listed below.

1. Initial margin contributed by defaulting member.

2. Default fund contribution of defaulting member if initial margin is insufficient to cover up the losses.
3. Default fund contribution of surviving members, if losses are not absorbed by initial margin and default fund contribution of defaulting members.

5.2 Margin requirements

We'll talk about margin requirements in this section for products like futures, short sales, and margin purchasing.

5.2.a Margin requirements in futures contract.

Both long and short positions in future contract are subjected to margin requirements. Variation margins are required to take the position in futures contracts in addition to Initial margin.

Variation Margin

Futures contracts are settled daily, with the losing party paying the winning party the loss amount known as the variation margin. Consider a trader named Mr. Long, who is long on a $750 per contract June corn futures contract. One contract is 100 bushels in size. Mr. short has taken this short position. Please note that in real life, you never know who is on the other side, and CCP is counterparty for everybody, but for academic purposes, we are taking long and short positions in connection. This position was taken on the first day of the year. Corn futures price fluctuations will result in profit or loss for these parties. The table below is an example of how the daily fluctuation margin works. Long and short position holders are equally subject to margin regulations.

DAY	PRICE OF CORN FUTURES /BUSHEL	MR. LONG'S POSITION	CCP ROLE	MR. SHORT'S POSITION
DAY 1	$725	Long generates loss on position worth $25 ($750 - $725). This loss is paid to CCP in the form of variation margin which can be paid in cash.	CCP will collect the variation margin of $25 and transfers it into margin account of Mr. short.	Mr. short will receive variation margin in margin account which he can transfer to his bank.
DAY 2	$700	Futures price drops again to $700 and variation margin of $25 ($725 - $700) is to be paid to CCP.	Same as above	Same as above
DAY 3	$750	Futures price increases to $750 from previous closing. Long profits on price increase. Hence variation margin of $50 will be received in margin account.	CCP transfers margin of $50 collected from Mr. Short to Mr. Long's margin account.	Short needs to pay variation margin to CCP worth $50 on loss generated on price increase.
DAY 4	$775	Variation margin received from CCP worth $25 ($775-$750)	CCP transfers margin of $25 from collected from Mr. short to Mr. Longs margin account.	Short needs to pay variation margin to CCP worth $25 on loss generated on price increase.

The variation margin is sent once per day, but if markets are volatile, the frequency might be increased. There is no net cash inflow or outflow for CCP since futures contracts are always

matched, meaning that for every number of long holdings, there are an equal number of short positions.

Initial margin

Initial margin, in addition to variation margin, may be required by CCP. Initial margin can be paid in cash or in kind (marketable securities), and it must be deposited with CCP when the deal is executed. CCPs collect the initial margin in order to protect themselves from a party's default. Consider Mr. Long's earlier example. If Mr. Long fails to pay CCP variation margin on Day 2, for example, CCP may cancel his position and the loss will be compensated by the initial margin. If the initial margin is not collected, CCP will incur this loss. Regardless of whether the trade is long or short, the initial margin is collected. The exchange determines the initial margin based on the volatility of the futures price. If the market conditions change, the initial margin can be modified at any time by exchange/CCP.

Important Points:

- Because variation margins are concurrently transmitted from one party to another, CCPs do not pay interest on them.
- CCPs pay interest on initial margin since they hold the money that belongs to the member.

Collateral transfer as initial margin

If a member is unhappy with the interest rate provided by CCPs on cash margin payments, he can contribute liquid securities such as Treasury Bills as initial margin to the CCP. Haircut is applied when the initial margin is paid in collateral. If Mr. Long is obliged to pay $9000 as initial margin and a 10% haircut is applied if margin is provided in particular collateral, he must transfer securities worth $10000 to cover the $9000 initial margin. Because a 10% haircut is applied, the securities are valued at $9000 ($10,000 – 10%) for the purpose of initial margin.

When a member holds long and short positions in identical contracts at the same time, the margin requirement might be netted, lowering the initial margin need when compared to the margin requirement on the total of long and short positions separately.

5.2.b Initial, variation or maintenance margin in **futures contract** (For exam purpose)

Exam important note: The preceding section discussed the concepts of initial margin and variation margin. In the preceding part, I tried to present content that follows the GARPs curriculum. GARP presents this part in a way that suggests that the initial margin deposited with CCPs does not change due to losses or gains made by members, and that all price changes have been settled by the variation margin since day one see page 60 and 61 of GARP curriculum book no 3. GARP does not mention the joint discussion of initial margin, variation margin, and maintenance margin, which GARP has often tested in previous exams, in this reading from the GARP curriculum. The main problem is that GARP is sticking to old notions of initial and maintenance margins (which are not discussed in this reading, as shown by question 5.15 of Book 3 in the GARP curriculum. This is totally confusing and contradictory for students.

To provide more clarity, I wrote the above section according to GARP's curriculum, and in this section, we will cover the same topics from an exam perspective, so that you can answer questions from GARP's curriculum or practice papers on this topic.

Initial margin vs maintenance margin

The initial margin represents the preliminary capital deposited by a trader upon entering a futures contract, acting as a protective guarantee against potential losses. Conversely, the maintenance margin is defined as the requisite minimum balance a trader must uphold in their margin account to continue holding the position. Should the balance of the margin account fall beneath this predetermined minimum, the Clearing House (CCP) will initiate a margin call, compelling the trader to infuse additional funds to reinstate the account balance to its stipulated or initial level.

To elucidate, consider the scenario involving Mr. John, who engages in a futures contract necessitating an initial margin of $7,500 and a maintenance margin of $5,000. If Mr. John experiences a $3,500 loss on the second day, his margin account balance diminishes to $4,000, a consequence of subtracting the loss from the initial margin. This reduction places his account below the maintenance margin requirement. To amend this shortfall and comply with the margin call, Mr. John is required to contribute an additional $3,500, known as the variation margin, thereby restoring his account balance to the original figure of $7,500.

Further illustrating the principles of margin requirements, we examine Mr. X's strategy of taking a long position in corn futures, priced at $7.5 per bushel, with a contract size of 5,000 bushels. The stipulated initial and maintenance margins for this position are $15,000 and $10,000, respectively. This instance underscores the critical role of margin requirements in futures trading, highlighting the imperative for traders to ensure their margin accounts are adequately funded to meet both initial and maintenance demands, thus safeguarding the financial stability of their investment endeavors.

DAY	SETTLEMENT PRICE $	DAILY CHANGE X 5000	MARGIN ACCOUNT BALANCE $	MARGIN CALL
1	7.80	+1500 i.e. (0.3 * 5000)	16500 (15000 opening + 1500 change)	No margin call
2	7.25	- 2750 i.e. (7.80-7.25) * 5000	13750 (16500 – 2750)	No margin call
3	6.45	- 4000	9750 (13750-4000)	Maintenance margin requirement is $10000 and current margin is 9750 which balance is below maintenance requirement. Hence margin call of $5250 is made by exchange to restore balance to initial balance.
3			15000 (9750 + 5250)	
4	6.40	- 250	14750 (15000-250)	No margin call

5.2.c Margin requirement in options on stocks

In case of options a trader holding net long position in stock option has no potential future liability because losses are limited to premium paid upfront. Hence there is no margin requirement applicable for trader with net long position. On the other hand, in case of net short position in an

option, can generate negative payoff if the option is exercised. Due to the potential future liability in case of short option margin payments are applicable.

The Chicago Board Options Exchange calculate the margin that must be maintained each day. Following table presents the calculation of margin requirement for short call and short put positions.

	Short Call (Greater of A or B)	Short Put (Greater of A or B)
A	100% of the value of option plus 20% of the underlying stock price less the amount that the option is out of the money (reduce if option is out of the money.	100% of the value of the option plus 20% of the underlying stock price less the amount that the option is out of the money (reduce if option is out of the money)
B	100% of the value of the option plus 10% of the underlying stock price.	100% of the value of option plus 10% of the strike price.

Consider a call option on a stock ABC Inc with strike price of USD 40 trading at USD 3 per option and stock prices USD 35. Calculate the margin requirement on short call position.

The first step here is to check whether the option is out of the money or not. In our case option is out of the money, hence A is calculated as

A = 100% of 3 + 20% of 35 – 5 (out of the money difference 40-35)

A = 3 + 7 – 5 = 5

And B is calculated as

B = 100% of 3 + 10% of 40

B = 3 + 4 = 7

Margin requirement is greater of A or B above. Hence, margin to be paid by short option holder is $7 per option. Assuming, trader shorts 1000 options, the total margin requirement is $7000.

As the stock price and option price changes, margin requirements will change. Above steps will be followed for the new stock price and option price to calculate the margin and if the margin paid by trader is less than the margin as per changes in stock price and option price, trader needs to pay variation margin. If trader fails to pay margin call, his position is closed.

Because the margin posted with CCP belongs to trader, CCP pays interest on the cash margin balance.

5.2.d Short Sale

Concept of short sale: In short sale, trader borrow stock and sell it for certain time. Because these stocks are borrowed, he must return stocks to original holder of stock. To return these borrowed stocks trader must buy it back and return it. The main goal of short selling stocks is to earn from falling stock price. Consider, it's stock is trading at $100 and you are bearish on this stock (i.e. you expect price will go down). Hence you decide to short sell this stock for a month. At the time of short sale you will get $100 from this sale proceeds. at the time of closing this position you need to buy back this stock at the current market price at that time. Now there are two possible scenarios, either stock price will go up to say $120 or stock price will go down to say $80. If the stock price goes down as expected a short seller will earn $20 ($100 from sale proceeds - $80 spent on buy back of stock). If stock price increases to $ 120, short seller will incur loss of $20 ($100 from short sale - $120 spent to buy back stock).

This short selling is very risky because if stock prices moves up, short seller incurs losses. Virtually there is possibility of unlimited loss. Hence, strict margin requirements are applicable for short seller of stock. Retail trader who choose too short a stock in the US it's typically required to post margin equal to 150% of the stock price at the time of short position is initiated and maintenance margin of 125% is applicable.

Margin requirements

In the above example we saw how short sale works. In real life a trader who wants to short sale stock simply request broker to arrange the stocks for short sale. When the short sell is completed broker does not pay proceeds to the trader. Sale proceeds are kept in hold as a margin. These sell proceeds are good enough as a security its stock price stays stable or goes down. but this does not provide any protection from any adverse movement in stock prices. Hence, initial margin requirement of 150% of the short sale is applicable, in which 100% comes from the sale proceeds from the short sale and 50% is collected in cash from the short seller. Consider the above example, if trader short sales stocks worth $100 then he is required to post the margin of $50 in cash which makes the total margin of $150 which is 150% of the stock price. Assume, trader shorts 100 such stocks, the margin requirement is $15000 (150*100). The maintenance margin of 125% is calculated for every price movement as mentioned below,

- Day 1- Stock price $110
  - Maintenance margin requirement is 125% of 110 X 100 stocks = $13750.
  - Current margin balance is $15000, hence no variation margin payment is required.
- Day 2 – Stock Price $120
  - Maintenance margin requirement is 125% of 120 X 100 stocks = $15000
  - Current margin balance is $15000, which is sufficient to cover maintenance margin, hence no margin payment is required.
- Day 3 – Stock price $130
  - Maintenance margin requirement is 125% of 130 X 100 stocks = $16250
  - Current margin balance is $15000, hence margin call payment of $1250 is made to restore balance up to maintenance margin level.

Note: In case of short sale Variation margin payment is required only to restore margin balance up to maintenance margin level and not up to initial margin level**. Interest is paid on the margin balancee by CCP.**

5.2.e Buying on Margin

Concept: In buying on margin also referred as margin buying, broker lend funds to trader to buy shares or some asset. For example, a trader buys 100 shares at USD 200 on margin. Total cost of buying stock in this trade is UDS 20000. In this purchase, some part of the funds will be provided by broker in order to purchase share as a loan. Remaining amount is provided by the trader in the form of margin.

Assuming, 50% initial and 25% maintenance margin requirement, trader needs to pay 50% of the purchase cost upfront as initial margin to enter into trade. Hence, trader needs to pay USD 10,000 upfront to purchase shares worth USD 20,000. This remaining USD 10,000 is loan from the broker to purchase shares. Following steps shows how margin account works in case of buying on margin.

Day 1: Stock price $190: Margin account balance after adjusting for losses is $9000 ($10,000 initial margin - $1000 loss). Maintenance margin requirement is = $4750 ($19000 * 25%). No margin payment required.

Day 2: Stock Price $175: Margin account balance after adjusting for losses is $7500. Maintenance margin requirement is = $4375 ($17500 * 25%). No margin payment required.

Day 3: Stock Price: $145: Margin account balance after adjusting for losses is $4500. Maintenance margin requirement is = $3625 ($14500 * 25%). No margin payment required.

Day 4: Stock Price $115: Margin account balance after adjusting for losses is $1500. Maintenance margin requirement is = $2875 ($11500 * 25%). Margin account balance is insufficient because maintenance margin requirement is more than the balance in margin account. Hence margin payment is required to restore margin balance up to maintenance margin requirement. Hence, margin payment of $1375 (2875-1500) is to be made. When this payment is made, adjustment is also made in loan account which is provided by broker. Loan account balance post adjustment is $8625 ($10000-1375). We can reconcile this with asset value. Asset worth 11500 is supported by loan from broker $8625 and margin balance of trader $2875.

Note: Shares purchased in margin buying, is deposited with broker as collateral.

5.3 Over the counter markets

We discussed basics of OTC markets in the previous Reading No: 4. In this section we will discuss some specific point relating to OTC markets. Traditionally OTC derivatives have been cleared bilaterally meaning 2 parties transact with each other and decide on the clearing process, netting agreements, and the quality of collateral. However, with the introduction of CCPs in the OTC market a part of OTC market is handled by CCPs now for some derivatives. Post 2007 2008 global financial crisis the use of CCP increased in OTC markets. Interest rate derivatives are most popular type of derivative which accounts for about 80% of the value of the in OTC market. Major portion of interest rate derivative transaction in the OTC market are interest rate swaps. We will discuss more on interest rate swaps in this book in later readings.

A major disadvantage of OTC market is the credit risk when trades are cleared bilaterally. It is important to note that the credit risk on the derivative is much less than on the bond or a loan with the same principle. This is mainly because the notional is not exchanged in derivative transactions and value at risk is only up to the value generated on the derivative transaction. If the derivative has negative value, there is no exposure and if it has positive value the potential loss is equal to that positive value only. The negative value of derivative indicates that the party is liable to pay some amount to counter party, hence there is no risk involved for this party because he is the one who is paying to counter party. On the other hand, when it comes to positive value which indicates the party has receivable from counterparty, this raises the credit risk of counterparty won't be able to pay this sum.

The probability of counterparty defaulting, and total life of derivative are interlinked in falling manner –

- As the life of the derivative increases it increases the probability of counterparty default.
- The market variables that determine the value of derivatives are likely to move more during the life of the derivative as the life of the derivative increases.

5.4 Risk mitigation techniques in OTC market

In this section we will discuss various credit risk mitigation tools and techniques used in the OTC market.

5.4.a Bilateral Netting in OTC Market

Netting can be applied in bilaterally cleared OTC trades if two market participants agree. Both parties would enter into a master agreement that would apply to all the derivatives they trade. If one of the parties' defaults, all the outstanding derivatives are be netted and considered as single transaction. As per the Bank Of International Settlements, netting agreement reduces the total credit exposure in derivative markets.

5.4.b Collateral

The next tool for management of credit risk in the bilaterally cleared OTC market is the posting of collateral. The credit support annex (CSA) of master agreement between the 2 parties specifies how the required collateral is to be calculated and what securities are allowed to be posted. With the collateral requirements haircut applicability can also be mentioned in the agreement.

5.4.c Special Purpose Vehicle

Special purpose vehicles SPV also called as special purpose entities SPE, are design to separate credit risk legally by forming a separate company. Sometimes SPVs are created to manage large projects. We will discuss more on SPVs in book number 4 and in very detail in FRM Part 2. In recent developments in financial market, SPVs are used to create derivatives from pool of assets such as mortgages and credit card loans. SPVs are structured in a way that it offers high credit rating, however, the payoffs will not be affected by the credit worthiness of the SPV.

5.4.d Derivative Product Companies

DPCs Derivative product companies are well capitalize subsidiaries of dealers design to receive AAA credit ratings. This means that dealer may have poor credit rating, but well capitalised DPC would receive AAA credit rating which makes other companies comfortable in trading with this DPC.

Please note credit risk is not eliminated by DPCs because parent company is exposed to credit risk and default of parent will impact DPC. The consequence of parent defaulting is the DPC being sold to another entity or all the transactions being closed out at mid market prices. DPCs are non-existent post 2007 08 crisis.

5.4.e Credit Default Swap

Credit default swap CDS are insurance like contracts between the protection buyer and protection seller. The buyer pays regular premium to seller and if there is a default by specified entity the seller make the payment to buyer. The credit default swap market grew rapidly between 2000 - 2007 but it has declined since then. Monolines are the companies which are designed for selling CDS. Some insurance companies like AIG also sold huge amount of CDS and suffered severe loss because of this in 2007 crisis.

6 Central Clearing

6 Central Clearing

scope of this reading

This chapter analyzes the mechanics and role of central counterparties (CCPs) in derivatives markets, explaining how central clearing differs from bilateral clearing and illustrating the novation and multilateral netting process. It evaluates the advantages and disadvantages of central clearing for OTC derivatives and reviews key regulatory reforms that have promoted its adoption. The chapter compares margin frameworks in centrally cleared and bilateral markets and explains how margin mitigates counterparty risk. It also assesses the broader market impact of central clearing and examines the risks faced by CCPs, clearing members, and non-members.

6.1 Central clearing

In the previous reading, we covered the fundamentals of Central Counterparties (CCPs). CCPs require members to post margin for enabling the exchange to effectively manage credit risk. It's been rare for CCPs to fail while dealing with exchange traded products. The French clearing house Caisse De Liquidation in 1974 and the Kula Lumpur Commodity Clearing House are two rare examples of such failure. Please keep in mind that such failures are uncommon, and the futures market has always been able to handle market volatility. CCPs and exchanges have learned from these failures and are today regarded as quite safe.

Members of CCPs must post initial and maintenance margins to mitigate risk. If the markets are volatile, initial margin requirements are changed more often, and members may be asked to make variation margin payments throughout the day. In rare cases, CCP may require members to decrease their exposure.

We'll concentrate on CCPs in OTC markets, which work similarly to CCPs in exchange markets. The difference is the OTC market products are not the same as exchange products. Most exchange traded contracts are only good for a few months, while OTC contracts can last up to ten years. In comparison to exchange trading, the average trade size is relatively large in OTC. Another distinction is that exchange traded futures contracts have a high liquidity, whereas OTC contracts are less liquid. The variation margin computation is impacted by the OTC market's limited liquidity. Because of the low liquidity, unique models are needed to determine the initial and variation margins in the OTC market.

Three large CCPs for clearing OTC transactions are

- SwapClear
- ClearPort
- ICE Clear

CCPs are very critical for smooth functioning of global financial system hence in case of financial stress, they'd certainly receive some type of bailout.

6.1.a The operation of CCP in OTC derivatives market

Risk mitigation mechanisms utilised by CCPs, such as margins and default fund contribution, were already discussed in the previous section. If no member defaults, the CCPs have a net zero cash flow in variation margin. This is due to the fact that the CCPs have a matched book (equal buy and sell positions) and do not take market risk. Market risk exists if a member defaults, as the CCP closes out that member's position.

Using historical data, the initial margin requirements are calculated. Typically, CCPs set the initial margin so that if it takes 5 days to close out a member's position, the initial margin will cover the losses 99 percent of the time. If the initial margin is insufficient to cover losses in the event of a member default, the default fund contributions from defaulting members are utilised to cover the losses. If it is insufficient to cover the losses, non-defaulting members' contributions to the default fund are used. Even if these funds are used, if losses are not absorbed, CCP's equity is at risk.

If a member defaults, the exchange holds an auction, asking other members to bid on the transaction by accepting the defaulting member's offsetting position. Members of the CCP have an incentive to participate in this auction process because if the CCP fails to quickly closeout defaulting members' positions, the default fund contribution of the remaining members is jeopardised. If the auction fails, the CCP may be able to distribute losses to members who have

recently achieved gains. In addition, the CCP have the option of tear up the transaction and distribute it to members.

CCPs recover their operating costs by charging per-trade fees, and they may also earn interest on initial margin in excess of what is given to members. CCPs are often owned by their members, and any extra profits are paid to the members. Some CCPs are also owned by outside investors, creating a competitive environment among them, and encouraging CCPs to enhance their systems. There's also a chance that CCPs will try to compete by lowering initial margin requirements and default fund contributions, thereby increasing CCP risk. OTC CCPs subjected to higher regulations and often not allowed to take risks unrelated to their main activity of clearing OTC transactions.

6.2 Regulations of OTC Derivatives Market

Following the financial crisis of 2007-2008, new restrictions were imposed, resulting in a rise in the use of CCPs in the OTC derivative market. CCPs were previously mainly unregulated. Leaders at the G-20 summit in September 2009 were mostly concerned about the systemic risk posed by OTC markets. This is the danger that a default by one derivative dealer will result in losses for other dealers, perhaps causing a domino effect of losses for other members. In the worst-case situation, the financial system's stability could be jeopardised.

G-20 Summit in 2009 resulted into three major regulations affecting the OTC derivatives,

A. Requirement that all the standardised OTC derivatives should be cleared through CCPs. Standardised derivatives include plain vanilla interest rate swaps and credit default swaps on indices. The purpose of this requirement is to create an environment where dealers have less credit exposure to each other reducing interconnectedness and systemic risk.
B. Requirement that standardised OTC derivatives be traded on electronic platform to improve price transparency. If there is an electronic platform for matching buyers and sellers, the prices at which products trade should be readily available to all market participants. These platforms are called swap execution facilities (SEFs) in the US and organised trading facilities (OTFs) in Europe. In practice, standardised products are passed automatically to CCP once they have been traded on these platforms.
C. Requirement that all traders in the OTC market be reported to a central trade repository. This requirement provides regulators with important information on the risk being taken by participants in OTC market.

Regulation A and B is only applicable for transaction between two financial institutions or between financial institution and non-financial entity deemed systematically important. This excludes the dealers from trading on electronic trading platform and using CCPs when trading with non-financial end users.

The requirement of CCPs to be used for standardized interdealer transactions, lead to huge growth in the volume of OTC transactions being cleared through CCPs.

6.3 Standardized Vs NON-STANDARDIZED transactions

For a OTC CCP to clear a product, following condition must be satisfied,

1. The legal and economic terms of the product must be standard within market

2. There must be generally accepted models for valuing the product so that CCPs can calculate variation margin.
3. The product must trade actively.
4. Extensive historical data on the price of the product should be made available to enable initial margin requirements to be determined.

The 3rd condition is very important, because for less actively traded products, it might be difficult to unwind the position in case the member defaults. Secondly, it is not worthwhile for CCPs to develop system for not actively traded products.

Currently, interest rate swaps and credit default swaps on indices are classified as the standard. The other standard products, such as options on interest rate swaps and single name credit default swaps, may be added at later stage. It is very unlikely that the exotic derivative product will be classified as standard products in foreseeable future.

The G-20 summit in 2011 established initial and variation margin limits for uncleared derivatives. This action was primarily adopted as a countermeasure to dealers evading the intent of the earlier rule of 2009 by adding features to standardise items in order to make them slightly non-standardised and therefore escape CCPs requirements.

The new rules are being phased in between 2016 and 2020 requiring margin to be posted for unclear derivatives traded between the two financial institutions or between the financial institution and systematically important non-financial entity. Under the new rules, initial margin and variation margin must be posted. The variation margin on uncleared trades is usually transferred from one counterparty to another counterparty directly. However, the initial margin cannot be handled in this way. Hence the regulations require initial margin on unclear transaction to be transmitted to 3rd party to be held in trust. The initial margin should cover the greatest decrease in the value of contract estimated to occur over a 10 day. With 99% confidence in stressed market conditions.

6.4 Netting vs Bilaterally Cleared Trades

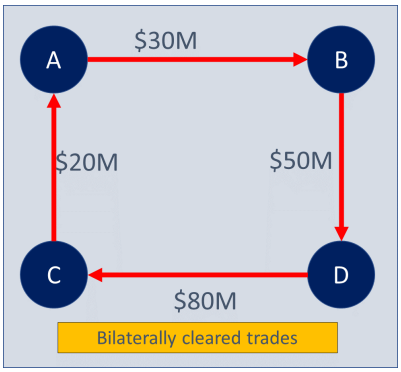
When the contracts are cleared bilaterally there are master agreements between every pair of participants covering all the contracts between them. The agreement is made as per the requirements provided by International Swaps and Derivatives Association. If we compare this with the transactions cleared with the help of CCP, all the participants must agree to terms of CCPs assuming these participants are members of CCP. Each participant is also required to post initial margin and variation margin and also required to make contributions to default fund.

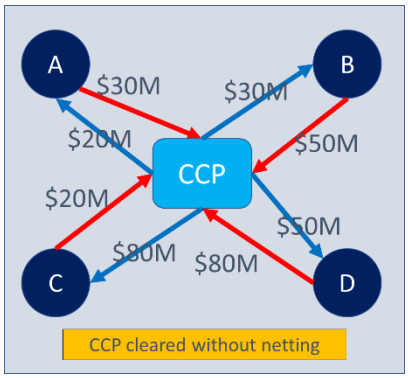
Even if the transactions are cleared through CCPs it might lead to complications because there are more than one CCPs. This means even if all the trades between the clearing members are cleared centrally, they might be cleared through different CCPs. Members of CCP clear the trades bilaterally with non-members. These non-members must post initial and variation margin with the member who is clearing their trades.

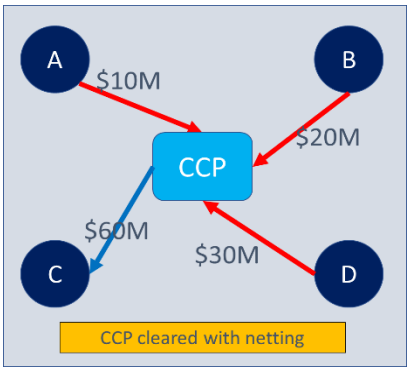
OTC transactions are not settled daily, in some cases the settlement occurs periodically and sometimes at the end of the contract's life. However, CCPs values the contract at least once a day and transfers the required variation margin reflecting the change in the net value of outstanding contract. Consider a situation, Mr A and Mr B in a particular OTC contract where Mr. A is required to transfer variation margin to Mr B. In this case Mr. B (receiver of variation margin) is required to pay interest on variation margin to Mr. A (payer) because this variation margin does belong to Mr A(payer). This is because the contract is settled at the periodic basis and not on the daily basis.

These margins posted by the financial institutions could be put to a better use hence institutions trade these margins as cost of borrowed funds.

CCP may give rise to an increase in netting. The following illustration shows four parties trading with each other bilaterally. Red line indicates the payable amount for each party. For example, Party A has payable $30M to B and receivable $20 from Mr C. Without CCP, Party A is exposed to $20M default from Party C. When these trades are cleared through CCPs, now the payable is (red line) to and receivable is (blue line) from one CCP. Because CCP has the payable and receivable from the same party, it can be netted off which is shown in last diagram. This is the process of netting, which can be done with the help of CCPs.







6.5 Advantages and disadvantages of CCPs

Following are the advantages of clearing trades with CCPs.

- **Easier exit for market participants:** When the trades are cleared bilaterally market participant who wants to exit the trade can only do it by approaching the original counterparty and trying to negotiate on the terms. If original counterparty does not agree when exiting from the contract is difficult. With the help of CCP participants can take the opposite position in the trade to exit.
- **Lower Credit Risk:** Credit risk is lower in CCP cleared transactions due to risk mitigation measures applied by CCPs.
- **Interoperability (Not happening currently):** Participants use multiple CCPs, hence they require to post initial margin to respective CCPs for trading, hence netting off of posted margin with different CCPs is not possible. In future CCPs may work on some solution to where initial margin from different CCPs can be combined and participant need to pay less initial margin.
- **Loss mutualization:** When trades are cleared through CCPs, losses coming from the default by any member is distributed to other members. Taking small losses by multiple members is safer compared to a big loss taken by one member.
- **Better operations management:** When trades are cleared bilaterally, market participants incur huge expenses on operations like contract management and validation, default resolution, settlement etc. CCPs can handle these functions in a better and cost-effective manner. However, any operational problem experienced by CCP could have widespread consequences on the members.
- **Improved liquidity:** The ease of netting and exiting from the contract for market participants, improves liquidity in OTC market.
- **Standardized Documentation:** Central clearing encourages the development of standard documentation for OTC derivative transactions.

Disadvantages of CCP

CCPs Intel both moral hazard and adverse selection risk. We discussed moral hazard and adverse selection in previous reading on insurance companies. The basic concept is same here.

- **Moral Hazard:** Market participants have less incentive to concern themselves with the riskiness of the companies they trade with when the risk will be passed onto the CCPs.
- **Adverse Selection:** Dealers have a choice between clearing transaction through CCP or clearing it bilaterally. If the dealer considers the credit risk of counterparty to be high, he might consider clearing it through CCP. If this keeps happening CCP might end up creating a big pile of risky counterparty transactions.
- **Procyclicality:** When the markets are volatile, CCPs increase the initial and the variation margin requirement for the members. This is the same time when members are already struggling with their portfolio due to high volatility. When CCPs increase initial margin requirement and default fund contributions, it exacerbates the liquidity shortages faced by the financial institutions. This is because they might need to sell securities at lower rates to pay increased margins.

6.6 CCP Risk

Arguably, new regulations for OTC market replaces too big to fail banks with too big to fail CCPs. If the CCPs fail, it would be disaster for financial system. Advantage with the CCPs is they are easy to regulate due to simpler organization structure. The key activities of CCPs are

- Admitting members.
- Valuing transactions.
- Evaluating initial margin and default fund contributions.
- Managing systems for netting, margin transfers and so on.

The emergence of CCPs has resulted in risk being transferred from corporations that are difficult to control to companies whose operations are more open to scrutiny. The dangers that CCP faces are as follows.

- **Positive correlation among the defaulting members**: Economic conditions affects all the CCP members in similar manner. If one of the members defaults in such situation, others are likely to. Hence the regulators require CCPs to conduct a stress test involving imaginary adverse event to determine whether they would survive and conduct close out efficiently if multiple member's default.
- **No consideration to credit quality of the member:** When deciding the initial margin and default fund contribution CCPs consider the risk involved in the transaction and not the riskiness of the member.
- **Members might resign:** In case of default by members, if auction process fails CCP may force other members to share the losses and thereby cause more defaults. Which might lead to resignation among the members unwilling to stay in this CCP model.
- **Model Risk:** CCPs in the OTC market are more reliant on the valuation models in determining the transaction value and clearing variation margin transfers. If the model functions poorly the operations of the CCP may be compromised and members dispute may follow. Models are also used for initial margin calculation and flawed model can result into lower initial margin, which might not be sufficient to cover up the losses in case of member's default.

- **Liquidity risk:** CCPs hold billions of dollars of initial margin is faced with the trade-off between the return it gets by investing in the cash and the liquidity constraints of its investment. Liquid investments tend to provide lower returns. CCPs need some of their investment to be readily convertible into cash in the event of one or more member's default. It is important to assess the liquidity of the investment which CCP is making in stressed market condition, because members are likely to default in stressed market conditions.
- **Other risks:**
    - Fraud.
    - Computer failure.
    - Litigation costs.
    - Losses on investment of the initial margin and variation margin.

7 Futures Markets

7 Futures Market

Scope of this reading

This chapter explains the structure and key features of futures contracts, including contract specifications, trading volume, open interest, delivery terms, price limits, and quoting conventions. It develops the concept of convergence between futures and spot prices and distinguishes normal and inverted futures markets. The chapter analyzes margin requirements and marking-to-market, highlighting their role in risk management and hedge accounting. It also describes delivery mechanics versus cash settlement, evaluates different order types, and compares futures with forward contracts, including the role of exchanges in both exchange-traded and OTC transactions.

7.1 Exchanges and Operations of Exchange

Futures contracts are traded all over the world. The largest futures exchange in the world is the CME Group. Other large futures exchanges are the NSE National Stock Exchange of India, the Intercontinental Exchange, the Shanghai Futures Exchange, etc. Exchanges perform operations like

- Defining standard contracts.
- Exchange CCP becomes the counter party to all trading members.
- Settling trades daily by flowing margins.
- Members can closeout the position by entering into offsetting position.
- Members post initial margin and contribute to default fund.
- Members clear the trade of non-members and maintain margin accounts to protect themselves against the non-members default.

Most futures contracts are closed out before delivery because of its ease to closeout.

7.1.a Open Interest

The total number of contracts in existence at any given time in an exchange is known as open interest. Open interest should not be confused with open order. An open order is one that has been placed (buy or sell) but has yet to be execute. For instance, suppose the current market price of a futures contract is $100, and you place an order to long it at $80 (limit order). Because there is no seller at this pricing point, this order will not be executed. This is called open order. If this order is executed at some point in time, it becomes open interest.

Consider the following scenario: A recently established exchange has just begun operations today. As a result, no previous futures contracts exist in an exchange. The table below provides a step-by-step count of open interest in the exchange. We'll assume that everyone is trading in the June Gold Futures contract.

LONG ORDER	SHORT ORDER	REMARK	OPEN INTEREST
MR A PLACED ORDER OF 500 CONTRACTS AT $2000	Mr B placed order of 300 at $2100	Seller is not willing to sell at the price requested by buyer, order stays open.	No open interest because contracts are not executed yet.
MR A RAISES PRICE TO $2100 DUE TO UNAVAILABILITY OF SELLER.	Same as above	There is a match of seller and buyer price, hence order will be executed. But seller is willing to sell only 300 contracts. Mr A gets long position in 300 contracts and 200 is still open order.	300 contracts. Please note, every contract has two sides, long and short. 300 open interest shows 300 long positions and 300 short positions.
MR A KEEPS THE OPEN ORDER.	Mr C is willing to sell 200 contracts at market price.	This order will get executed and Mr A will get 200 contracts more.	500 contracts.

MR C DECIDES TO LONG 100 CONTRACTS AT MARKET RATE.	Mr B takes short position in 100 contracts at market rate.	Mr C was short on 200 contracts and now he takes the 100 long. This will result into squaring off of Mr Cs position and he is left with 100 short contracts. On the other hand Mr B will get 100 more contracts in short.	500 contracts. Open interest stays the same in this case, because 100 contracts squared off by C and taken long short by B. You can think this as a switching positions in those 100 contracts, where C exits and B enters the short position.
MR B DECIDES TO TAKE LONG POSITION IN 300 CONTRACTS.	Mr A decides to take short position in 300 contracts.	Mr B currently holds total 400 shorts out of which he decides to long 300 contracts and hence he is left with 100 short. Mr A holds total of 500 long contracts and takes 300 short and will be left with 200 long. Both the positions above are squaring off.	200 contracts in open interest. Here, two parties are squaring off their positions and no new position is being taken. This will reduce open interest to 200. Final tally of long and short is, Mr A total long 200 Mr B total short 100 Mr C total short 100. We can see total of long and short is equal.

We can summarize this illustration in following manner,

- When both members are taking new position, the open interest increases.
- When one member is closing out positions while the other member is taking the new position, the open interest remains the same.
- When both the members are closing out their respective positions the open interest decreases.

Trading volume is total number of contracts traded in a day in an exchange. The trading volume can be greater than the open interest at the end of the day if members are closing out their positions.

7.2 Specifications of Contract

Exchange defines the specifications of futures contract. In this section we will discuss the specifications of contract –

The Underlying Asset

Underlying for financial assets is straight forward because of inherent simplicity. Like futures on index is simple to accommodate in futures. However, when it comes to underlying asset is a commodity the grade of commodity that could be delivered must be specified. Consider, futures contract on Gold, which can be 22K or 24K, hence grade of commodity must be mentioned. At the time of delivery, different quality can be delivered for price adjustment. We will see example of price adjustment based on quality of underlying in Cheapest to Deliver in reading Interest rate futures in the same book. The failure by the exchange to adequately distinguish grades of the underlying assets could cause the contract to fail.

Contract Size

The contract size is the total unit of underlying assigned to each contract. For example, contract size of gold futures is 100 troy ounces of gold. Exchanges responsible for setting up the size of its contracts. Exchanges wants to attract both retail investors and large corporations hence it needs to ensure the size matches the interest of these investors. Typically, the contract size on financial assets tends to be much greater compared to that on the agricultural products. Exchanges also developed smaller contracts that are meant to appeal to retail investors. Like CME group offers regular size contract on NASDAQ as well as mini contract. Mini contract in NASDAQ trades more actively.

Delivery Location

The delivery location is the location where underlying is supposed to be delivered. In case of commodities, transportation cost makes the specification of the delivery locations is very important. For some contracts, cost incurred due to delivery location may be accounted into the price of underlying asset.

Delivery Time

Future contracts are referred by their delivery months. The precise date at which the delivery is made during the month of delivery varies from contract to contract. The short position holder can choose among the delivery date specified by the exchange. Exchange determines the delivery month, time when contract starts trading and time when contract stops trading.

Settlement price is the futures price at the close of trading and it is used for determining the daily settlement. Based on the changes in the daily settlement prices margin transfers are done.

Price Quotes

For some future contracts, the price quotation is not straightforward. Hence the trader must be aware of the quotation structure of a futures contract. We discuss the corn futures example in reading number 4. Corn futures in CME group are quoted as cent per bushels. The bond futures in CME group is quoted as 1/32nd in fraction. We will learn more about bond quotation in later readings.

Price Limits

Price limit is the limit set on how much a futures price can move in a one day. This price limits can be revised from time to time. If the price limit either on the upside (limit up) or downside (limit down) is touched, trading is normally halted for the day. The main purpose of the price limits is to prevent the large price movements due to speculation. This price limits can also create a hindrance in information captured by the price, if the sudden large movements in price are due to some market news.

Position limit

The position limit is mainly applicable for speculator which specifies the total position he can hold. The purpose of position limit is to prevent speculators from creating undue influence on the market.

7.3 Delivery Mechanism

As we discussed in previous section, futures contract are rarely settled by physical delivery of underlying. If trader wish to buy or sell the underlying, this can be done in spot market. The situation might arise when trader wishes to settle contract by delivery, hence mechanics of physical delivery is mentioned in futures contract. Following table provides the details of

mechanics of physical delivery. In case of delivery, almost rights like date of delivery and quality are available with short position holder.

STEP	ACTION	REMARKS	DEADLINES
STEP 1	When the short position holder wishes to make delivery he must issue notice of intention to delivery to CCP.	For commodity contract notice mentions number of contracts delivered, location of delivery and quality of underlying.	Notice of intention to deliver must me issued between the period first notice day and last notice day. Notice period is in the month of delivery. Consider June futures contract on corn, the window for notice of intention to deliver is 1st June to 15th June.
STEP 2	CCP then choose one or more parties with long position to accept delivery.	Exchange allocates delivery notice to member who had net long position or can also be issued at random.	NA
STEP 3	Once the notice is allocated to a member he cannot refuse.	Exchange might provide some time for member who not willing to take delivery, so that he can find other willing member.	Time allowed to find other willing member is from the date on which notice is allocated to member.
STEP 4	Settlement price on the last trading day is price long needs to pay for the delivery.	Please note, unlike options, futures are settled on daily basis. Hence, settlement price is the price taken for settlement and not the price at which futures contract is entered into.	Last trading date is few days prior to last date for notice issue. Say 13th June. In our case it is two days prior to last date on which notice of intent to deliver can be issued by short position holder.
STEP 5	Delivery at the location as provided by short in notice.	CCP will ensure delivery and settlement in cash. Delivery may involve warehousing cost.	

7.3.a Cash settlement

To avoid the delivery process traders generally prefer settlement in cash. However, regulators prefer physical delivery over cash settlements because cash settlements appear to be like gambling. However, for future contracts on indexes are generally encouraged to settle in cash by regulators. The physical delivery (i.e., transfer of ownership of shares) of index is problematic because index is the portfolio of different stocks and delivering this portfolio will result into a lot of complications and transaction costs. Also, future contracts whose underlying is weather etc are also settled in cash.

7.4 Miscellaneous discussion related to Futures

7.4.a Patterns of Future Prices

When the future price increases with time to maturity, is considered as normal market. The inverted market is when the future price decreases as the time to maturity increases. Some assets may also have pattern that are partially normal and partially inverted. Oil futures for example sometimes exhibit in normal market and sometimes inverted market.

7.4.b Market Participants

Futures market participants can be classified as

- **Futures commission merchants or introducing broker**: Participants who accept orders to trade from the retail or other clients. Under the US Commodity Exchange act, they are subjected to minimum capital requirement and registration. Futures Commission brokers may or may not be member of an exchange.
- **Locals:** Are traders who trade on their own account. Locals are not typically member of an exchange.

Locals and the client of futures commission are classified as scalpers or day traders. Scalpers generally hold futures position for a very short duration, generally same trading day.

7.4.c Order Types

While placing the order to buy or sell, traders can put some conditions on that order. In the following table we will discuss the type of order and the type of conditions which can be placed in that order.

Order Type	Explanation
Market Order	The type of order in which trader requests to buy or sell futures at the available market price. The disadvantage of this type of order is the trader might end up entering in position at very unfavourable price. The advantage is the order is placed quickly.
Limit Order	Is the order which is executed at a prespecified price. Consider particular futures contract it's trading at $100 and you want to take long position at $95. So, limit order with buy price of $95 can be placed. In this case order is executed only if market price comes down to $95. In similar fashion a seller place limit order at a higher price say $105. Short position will be entered only if market prices reaches to $105. If the price requirement is not met then order will not be executed.
Stop loss order	Stop loss orders are designed to limit a traders loss on a certain position. Assume you are holding a long position in particular futures contract which is currently trading at $100. if the future prices goes down you will incur losses. To protect yourself from the losses you can put a stop loss on your position at say $90. If market price of futures contract declines to $90 then this contract will be shorted, which will result into squaring off of your position and hence limiting the loss up to $10 per contract. Similarly, a short can put stop loss at say $110 and if price reaches to $110, his position will be squared off by taking long position. Stop loss system works automatically which triggers the squaring off of position. This creates pressure on markets. Say market price of futures is falling, which is the situation of more supply and less demand. When stop loss is triggered for multiple traders, it increases supply in the market and makes situation worse.
Stop Limit order.	This is the combination of stop loss order and limit order. Assume the market price of a specific futures contract is $100. You can place stop limit order, to buy futures with limit buy at $95 and stop loss at $90. In this case order will be executed if market price reaches to 95 and if price falls further then position will be squared off.
Market if touched order.	MIT order becomes the market order if market price reaches at certain price. Assume you take long position in some futures at $100 which you want to exit if price of futures increases to $115. So you can put MIT order at $115 and attempt to earn profit of $15. Please note, if certain price in MIT order is reached then order will get executed at market price. In our case, if market

	price of futures touch $115 and suddenly drops to $112, then order will be executed at $112. This is different from limit order where order is executed only if trade is possible at a certain price, $115 in our case.
Discretionary order	Order is delayed by broker in the hope to get better pricing.
Duration orders	By default, order exist for one trading day in which order gets cancelled if it is unexecuted. Duration order is the order in which trader can put condition relating to duration of existence of order. Fill or kill order is an order that is cancelled if it is not fully executed immediately. On the other hand, open order also called as Good till cancelled order stays open till it is cancelled. If not cancelled, it can stay open for remaining life of future.

7.5 Regulation of futures market

Future market regulations differs from country to country. CFTC - Commodity Futures Trading Commission is the regulatory body for futures market in US, which ensures Future markets are open, transparent, competitive, and financially sound. CFTC sets position limits for speculators. Financial crisis of 2007-08 lead to increase in responsibilities for CFTC, which now ensures that the standard OTC derivatives are traded and cleared as per the new rules.

7.5.a Accounting Rules

Accounting rules require, gains and losses from the futures contract should be accounted for as and when they occur. Futures contracts are settled daily so that the cash corresponding to profit is realised in the year in which the profits are accounted for. This process is referred to as marking to market. Consider the 100 long futures position in specific contract trading at $100 in 2019. Assume price reaches to $120 by the end of fiscal year. Hence, profit of $2000 ($120-$100 X 100) should be booked for this fiscal year. When this position is hedged, it could lead to increased volatility in reported profits if hedging is not accounted for. If the contract accounts for hedge accounting, gains/losses from hedge can be accounted for in the same year as the actual transaction. The Financial Accounting Standard Board (FASB) has issued guidelines for hedge accounting which cannot be used by US companies. The International Accounting Standards Board (IASB) has similarly issued guidelines.

The rules of hedge accounting requires, hedge must be fully documented, hedge must be classified as effective in which effectiveness must be tested periodically. Taxation has similar issues for future trading. Generally, futures contracts are treated as if it is closed out in the tax year and profit and loss is charged for taxation. However, hedging transactions are exempt from this rules.

7.6 Forwards vs Futures

Even the forwards and futures contracts are similar in core purpose, there are some differences. Most forward contracts are on foreign exchange and interest rate. On the other hand, futures contracts are available on the wide variety of financial and non-financial assets. Forward contracts are OTC traded whereas futures contract are exchange traded. Forward contracts are subject to credit risk, whereas futures contracts are not because it is cleared through exchange CCPs. Futures contracts are rarely settled by delivery, whereas forward contracts are usually settled by delivery. Forward contracts are difficult to closeout and futures are easy to close out. Forward contracts usually specify single delivery date, whereas futures contract specify delivery. Forward contracts are customized whereas futures contracts are standardised.

8 Using Futures for Hedging

8 Using Futures for Hedging

Scope of this reading

This chapter develops the theory and mechanics of hedging with futures contracts. It distinguishes between short and long hedges and evaluates the arguments for and against hedging, including its impact on firm profitability. The chapter defines basis and basis risk, explains their sources, and analyzes cross hedging using the minimum variance hedge ratio and hedge effectiveness. It determines the optimal number of futures contracts, incorporates the tailing adjustment, and explains how stock index futures can be used to modify portfolio beta. Finally, it examines long-term hedging through a stack-and-roll strategy and the associated rollover and basis risks.

8.1 Introduction

Hedging vs Speculation: derivative contracts can be used for hedging as well as speculation. Assume you hold 1000 barrels of crude oil currently trading at $115/barrel. You wish to sell this oil after 3 months. This gives you exposure to crude oil price fluctuation because change in price of crude oil after 3 months might result into losses. To protect yourself from this price fluctuation risk, you can take position into 3 months brent crude oil futures contract currently trading at $116/barrel. This process is called hedging. When the trader has exposure to various factor like exchange rates, equity or commodity prices, futures contracts can be used to reduce this exposure. If trader takes the position in derivatives like futures without holding any position(long or short) in asset, it is called as speculation. With the futures being standardized contracts, eliminating risk exposures completely is mostly impossible.

8.1.a Long hedge vs short hedge

Following table summarizes this topic.

	LONG HEDGE	SHORT HEDGE
WHAT IS THE FUTURES POSITION?	Long position in futures contract	Short position in futures contract.
WHEN TO HEDGE?	When the trader wants to reduce the exposure due to price increase in underlying asset.	When the trader wants to reduce the exposure due to price decrease in underlying asset.
WHO SHOULD TAKE?	Trader currently holding short position in asset.	Trader currently owns the asset.
HOW HEDGE WORKS?	Trader holding short position in asset, loses on the price increase of an asset. Long hedge is the position which gains if underlying price increases. This loss generated from the short position gets compensated by the long futures position's gain.	Trader holding long position in asset, loses on the price decrease of an asset. short hedge is the position which gains if underlying price decreases. This loss generated from the long position gets compensated by the short futures position's gain.
CONSEQUENCES:	To hedge the position, trader must let go of the favorable price movements in the underlying assets. (Check the following illustration)	

Illustration Explaining the short hedging process:

- Asset position: Long Brent crude 1000 barrel at $150/barrel.
- Hedge Position: Short Brent crude futures @$150, contract size 1000.

Trader has a long position in futures and suffers a loss if the underlying price drops. Short futures contract holder benefits from the price decline. The table below shows the 3 scenarios with different underlying price at the end of the contract and net profit or loss made by trader in unhedged and hedged position.

	UNDERLYING POSITION (LONG)			HEDGING POSITION (SHORT)	
	Underlying Price	Position value 1000 units	Gain or loss on position (without hedging)	Gain or loss on the hedge position	Net position gain or loss (including hedging)
CASE 1	$135	$135,000	($15,000)	$15,000	$0
CASE 2	$150	$150,000	$0	$0	$0
CASE 3	$165	$165,000	$15,000	($15,000)	$0

Illustration Explaining the short hedging process:

- Asset position: Short Brent crude 1000 barrel at $150/barrel.
- Hedge Position: Long Brent crude futures @$150, contract size 1000.

Trader has a short position in futures and suffers a loss when the price of the underlying goes up. Long futures contract holder benefits from the price drop. The table below shows the 3 cases with different underlying price at the end of the contract and net profit or loss for trader in unhedged and hedged position.

	UNDERLYING POSITION (SHORT)			HEDGING POSITION (LONG)	
	Underlying Price	Position value 1000 units	Gain or loss on position (without hedging)	Gain or loss on the hedge position	Net position gain or loss (including hedging)
CASE 1	$135	$135,000	$15,000	($15,000)	$0
CASE 2	$150	$150,000	$0	$0	$0
CASE 3	$165	$165,000	($15,000)	$15,000	$0

Alternate explanation: Suppose a trader has a long position in Brent Crude and wants to sell crude after three months. He got Brent Crude oil for $135 and wants to sell at $150/ barrel. This table shows how hedging can make sure the trader gets $150 for his sale (assuming futures is trading at $150.

	UNDERLYING PRICE AT MATURITY	SALE VALUE AT MATURITY (CASH INFLOW)	GAIN OR LOSS ON SHORT FUTURES POSITION.	SALE VALUE NET OF HEDGING
CASE 1	$135	$135,000	$15,000	$150,000
CASE 2	$150	$150,000	0	$150,000
CASE 3	$165	$165,000	($15,000)	$150,000

This table shows how a trader's realized sale value is equal to $150,000 irrespective of the underlying price at the maturity date.

8.2 Advantages and disadvantaegs of Hedging

Shareholders do not prefer hedging: The purpose of hedging is to reduce risk at the company level by generating gains on the futures positions. The same hedging process ends the opportunity to gain extraordinary profits if the underlying price moves in favorable direction. Shareholders prefer firms taking risk in order to generate extraordinary profits. Hedging reduces their profits. Shareholders can always hedge their share of risk by diversified investments instead.

There may be little or no exposure: Sometimes there is no exposure to firm even if the firm is holding some position. Assume a manufacturer of semiconductor chips needs the precious metals

which is used in these chips. These metals are used as raw material and increase or decrease in price of these metals will impact chip price. In this case, semiconductor manufacturer is not exposed to price fluctuation risk because same is getting charged in the final price of the chip and his margin of profit is intact irrespective of price fluctuations.

Hedging reduces gains or results into losses: The hedging process is costly. Firm should always give due consideration to the value generated from the hedging should not be lower than the cost incurred on hedging. If hedge is dynamic hedge i.e. hedge position is always adjusted with changing market conditions, then it creates the huge impact on the profitability of the trade. This might also result into losses.

8.3 Futures contract for hedging

In the previous section we discussed how can we hedge the underlying position directly using futures on same underlying. This might be true for some assets, but in most cases futures one same assets are not available in the market. For example, generally the futures contracts are not available on stocks. If you own portfolio of stocks, you cannot find direct futures contract with the same underlying and the futures market. Hence, we need some alternative futures contracts which resembles the underlying position. If your portfolio consists of say stocks of banks, then the good alternative to hedge this position is index futures like the Bank Nifty futures available in NSE India. Because the direct futures contracts are not available, we need to find the number of contracts which provides the optimal hedge for the existing position. This is three step process as mentioned below-

- **Step 1:** Find the correlation between underlying asset and the hedge instrument. Also find the standard deviation off underlying and hedge instrument. (Exam note: Mostly these values will be provided in exam and you don't need to calculate it. If GARP requires you to calculate these values then you can use TI BA II Plus calculators STAT function)
- **Step 2:** Calculate the hedge ratio:
  - HR=β = $\rho \frac{\sigma_S}{\sigma_f}$ = $Correlation\ (spot, Futures) \frac{SD\ of\ spot}{SD\ of\ futures}$
  - The alternative formula for hedge ratio = $\frac{COV_{FS}}{\sigma_F 2}$ = $\frac{Covariance\ of\ Spot\ and\ futures}{SD\ of\ Futures\text{^}2}$
- **Step 3:** Find the number of futures contracts to long or short for hedging using hedge ratio
  - Number of contracts = HR (β) X $\frac{Value\ of\ portfolio}{Futures\ price\ X\ Multiplier\ (i.e. units\ in\ each\ contract)}$

Illustration:

- Portfolio Value = Rs 10,000,000
- Standard Deviation of Portfolio = 10%

Following futures are under consideration.

PARTICULARS	S&P INDEX FUTURES	NIFTY FUTURES	BANK NIFTY FUTURES
TRADING AT	4000	15000	35000
STANDARD DEVIATION	12%	20%	22%
CORRELATION WITH PORTFOLIO	0.45	0.62	-ve 0.15
COVARIANCE	0.0054	0.0124	-0.0033
CONTRACT SIZE	50	50	20

Find the number of contracts needed for hedging of the portfolio.

Solution:

Particulars	S&P Index Futures	Nifty Futures	Bank Nifty Futures
Hedge ratio using Correlation	0.45 X 0.10/0.12 = 0.375	0.62 X 0.10/0.20 = 0.31	-0.15 X 0.10 / 0.22 = -0.068
Hedge ratio using covariance	0.0054 / 0.12^2 = 0.375	0.0124 / 0.20^2 = 0.31	-0.0033 / 0.22^2 = -0.068
Total number of contracts required for hedging (setup)	$0.375\frac{10000000}{4000X50}$ 18.75 Contracts = 19 Contracts*	$0.31\frac{10000000}{15000X50}$ 4.1 Contracts = 4 Contracts	$-0.068\frac{10000000}{35000X20}$ -0.97 Contracts =- 1 Contract
Position long or short	Short 19 Contracts	Short 4 Contracts	Long 1 Contract
Explanation	Trader has long position hence the position to hedge the portfolio is short.	Trader has long position hence the position to hedge the portfolio is short.	Trader has long position but unlike the instrument which is used to hedge is negatively correlated. Hence futures position is long.

*Since futures contracts cannot have fractional positions, they should be rounded up/down to match the position. Note that rounding up means over hedging and rounding down means under hedging. For exam purpose, pay attention to what the question is asking for? If the question is asking for 'number of contracts to fully hedge the position' this means under hedging is not acceptable but over hedging is. So always round up the total number of contracts. But if the question is asking for 'rough (or similar suggestive word number of contract needed to hedge' then hedging can be done to the nearest number (up or down to get the closest number from the fraction value.

Interpretation of Hedge ratio (very important for theory question in exam):

Hedge ratio as the name suggest the ratio of position and futures value (notional value = Futures price X contract size X total number of contracts to hedge).

- Beta < 1: Beta (hedge ratio) of contract is less than 1 say 0.375, indicates, for every 1% change in futures value, underlying price is changing by 0.375%. Hence the notional value of hedge instrument used in hedging is always less than the position value. We can also say that for every 1% change in position, futures will change by 2.66% (1/0.375).
- Beta = 1: When beta is equal to 1, futures notional value is equal to position value. This is because, for every 1% change in futures value will change position by 1%.
- Beta >1: Assume the Beta of 1.5. This means for every 1% change in futures value, position value will change by 1.5%. We can also say for every 1% change in position value futures value will change by 0.6666%. Because futures contract is unable to recover loss, we need more futures notional value to cover losses for hedging.

Hedging Reconciliation

Using case of S&P hedging we will try to reconcile the hedge assuming the existing position lost by 1%. Following table shows how the loss on the position is covered up by the gain generated in short futures position.

PARTICULARS	CALCULATION	LOSS OR GAIN
CURRENT POSITION (10,000,000) DECLINES BY 1%	10,000,000 x 1%	Loss 100,000
CHANGE IN FUTURES NOTIONAL VALUE	1/Beta = 1/0.375 = 2.66666%	
NOTIONAL VALUE OF FUTURES	19 Contracts X 4000 X 50 = 3,800,000	
GAIN ON THE SHORT FUTURES POSITION IF FUTURES GAIN BY 2.66%	3,800,000 X 2.6666%	Gain = 101330.00 Difference of 1330 is due to over hedging (rounding up).

8.4 Tailing the Hedge

Assume on the day 0 trader hedges the position by taking the short position in 19 contracts (extending same illustration S&P Futures hedging from previous section). On the next day, after the daily settlement in futures contract, it might result into over hedged situation. To adjust the daily settlement of the futures contract a trader can opt for hedge tailing, which is adjustment in futures contract used in hedge by change in underlying and futures prices.

Illustration on tailing the hedge:

- Current portfolio value = 10,000,000
- Value and size of futures = 4000 and 50
- Hedge ratio = 0.375
- Futures price next day: 4150
- Spot price next day 4010

Number of contracts to short = 0.375 X $\frac{10{,}000{,}000}{4000X50}$ X $\frac{4010\ (Spot)}{4150\ (Futures)}$ = 18.11 = 18 Approx

In the original position, trader short 19 contracts. On the next settlement day after tailing the hedge, only 18 contracts are required. Hence trader should square off position in 1 contract by taking long position in same 1 futures contract. Tailing the hedge if done on daily basis can be very expensive strategy because of expenses incurred to take the long or short position in contracts required for adjustment.

8.5 Beta adjustment

When we hedge using the hedge ratio as mentioned in previous discussion, the total beta of the position (portfolio + futures) is 0. This means theoretically, position is immune to systematic (market) risk. If the trader whishes to keep the some portion of the Beta (called as target beta β*), this can be done using beta adjustment.

Number of contracts = $(\beta * -\beta)X$ $\frac{Portfolio\ value}{Futures\ value}$

Illustration:

- Portfolio value = 10,000,000
- Beta of portfolio = 1.5
- Target beta = 0.5
- Futures value = 1500

- Contract size = 50

	COMPLETED HEDGE	ADJUSTED BETA HEDGE
FORMULA	$(0 - \beta)X \frac{Portfolio\ value}{Futures\ value}$	$(\beta * -\beta)X \frac{Portfolio\ value}{Futures\ value}$
NUMBER OF CONTRACTS (SHORT)	$(1.5)X \frac{10,000,000}{1500X50}$ = 200 short	$(0.5 - 1.5)X \frac{10,000,000}{1500X50}$ = 133 Contracts
BETA POST HEDGING	**0**	**0.5**
	RECONCILIATION	
LOSS DUE TO 1% CHANGE IN PORTFOLIO	1,00,000	1,00,000
NOTIONAL VALUE OF CONTRACT	200 X 1500 X 50 = 15,000,000	133 X 1500 X 50 = 9,975,000
CHANGE IN THE NOTIONAL POSITION	1/1.5 = 0.666%	1/1.5 = 0.666%
GAIN ON FUTURES	15,000,000 X 0.666% = 100,000	9,975,000 X 0.666% = 66433
LOSS ON HEDGED POSITION	0	33576*

33576 is the result of retained Beta of 0.5 by trader. A trader retained 1/3rd beta (0.5/1.5) hence the 1/3rd loss (33576 / 100000) on the original position should be born by trader.

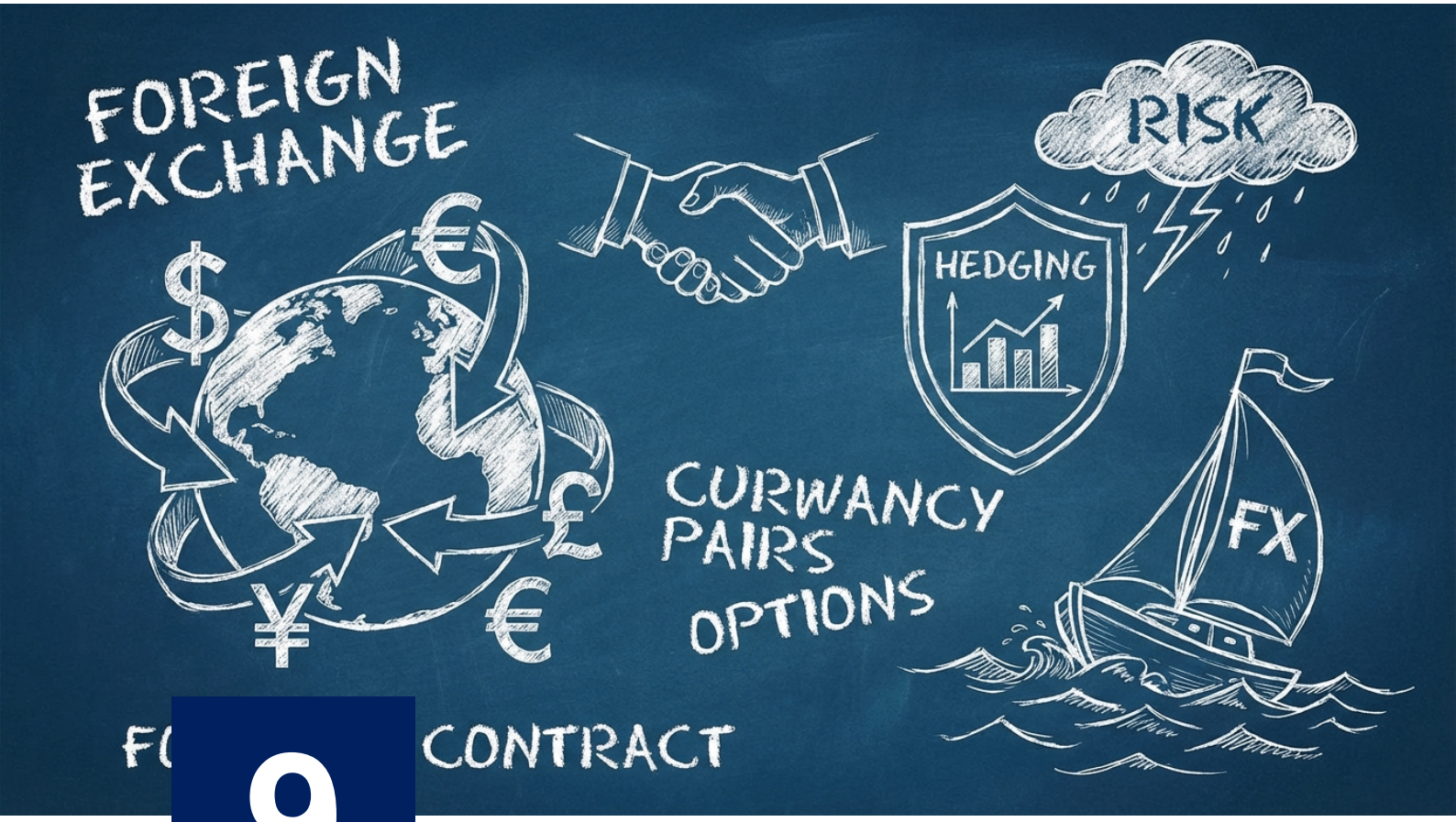
Reasoning behind beta adjustment:

- Firm can take the risk according to risk appetite by retaining some beta.
- Lesser expensive hedging.
- Potential to gain if the movement is favorable (like 1% gain on original position).

8.6 Rolling the Hedge forward (Stack and roll)

If a trader has to hedge for a lengthy period of time, say two years, but the only future contracts available are for shorter periods, he can use the rolling hedge forward approach. Rolling the hedge, also known as stack and roll, is a simple strategy in which a trader takes a position in the required amount of short-term futures contracts and continues to take fresh positions in future contracts when current future contracts mature. This method is repeated until the hedge is completed (2 years in our case).

9 Foreign Exchange Markets



9 Foreign Exchange

Scope of this reading

This chapter examines foreign exchange market mechanics, including spot, forward, and futures quotes, bid–ask spreads, and the distinction between outright and swap transactions. It defines transaction, translation, and economic risk, provides examples of each, and explains hedging approaches, including multi-currency option strategies. The chapter analyzes factors determining exchange rates and evaluates the impact of currency appreciation and depreciation. It develops purchasing power parity and the relationship between nominal and real interest rates, and derives forward exchange rates using interest rate parity under a no-arbitrage framework, distinguishing between covered and uncovered parity conditions.

9.1 Spot Vs Forward Vs Futures Quotations

Direct quote vs indirect quote

Direct quote: When the home currency is quoted as one unit foreign currency. In USA CADUSD = 0.80USD means 1Candadian dollar is equal to 0.75 United States Dollar. Same can also be written as CAD/USD or USD/CAD in some cases. GARP generally provides the meaning of these quotations.

Indirect Quote: When the currency is quoted as 1 unit of home currency, it is called as indirect quotation. For example, In USA, USDCAD = 1.25 CAD is indirect quote. Which means 1 USD is equal to 1.25CAD.

ISO 4217 quotation standards:

To summarize, ISO 4217 provides the three letter currency quotation in which first two letter stands for country and last letter stands for currency name. Example

- USD = US D = United States Dollar
- GBP = GB P = Great Britain Pound
- INR = IN R = Indian Rupee

There are some exceptions to this quotations rule, like EUR for Euro which does not follow this rule for obvious reasons.

Bid – Ask Quotations

Bid is the buy rate of currency and ask is the sale rate of currency.

Assume USDINR (1USD rate) = 75.0000-76.0000, which means the rate at which USD can be bought against INR is bid rate 75 in this and rate at which USD can be sold against INR is ask rate 76 in this case. The difference between bid and ask is called as bid-ask spread. The spread is wider if the volatility is high or large amount of trades are taking place and vice versa. Ask rate is always higher than the bid rate.

Trade between	Bid Rate 75.5050	Ask Rate 75.7050
Interbank market (Price maker) and Currency Dealer (Price Taker)	Bid rate is the rate at which interbank market buy currency from dealer.	Ask rate is the rate at which interbank market sells currency to dealer.
Currency Dealer(Price maker) and consumer (individual or firms)	At this rate dealer buys from consumer. This is after adjustment for margin. If the margin is 0.50 then rate quoted by dealer is 75.5050 – 0.50 = 75.0050. Rule: Bid Rate quoted by dealer = Interbank bid rate – margin.	At this rate dealer sells to consumer. This is after adjustment for margin. If the margin is 0.50, then the rate quoted by dealer is 75.7050 + 0.50 = 76.205 Ask Rate quoted by dealer = interbank ask rate + margin.

Please note: Bid ask spread is always higher for dealer compared to interbank market. This is the effect of margin adjustments done by dealer. The earning of interbank market is bid ask spread but main source of earning for currency dealer is margins.

Spot Quotations

Rates quoted in immediate(spot) delivery market are spot quotations. It is quoted in bid ask quotations. USDINR = 75.5025 – 75.5050. Spot bid ask spread is 0.0025

Forward Quotations

These are for futures currency trading. Forwards are quoted in points.

Assume Three months forward points USDINR = 12.50 – 15.50. Then the rate which is applied is

- Bid rate = 75.5025 + 0.001250 = 75.50375
- Ask Rate = 75.5050 + 0.001550 = 75.50655

In the above forward quotations points are mentioned in increasing order which means the rate forward is trading at premium. If the rates are quoted in decreasing order, then it the forward is trading at discount. Assume three months forward USD INR = 15.50 -12.50. Then the rate which is applied in forward is

- Bid rate = 75.5025 – 0.001550 =75.50095
- Ask Rate = 75.5050 – 0.001250 = 75.50375

9.2 Outright (Forward) and FX swap transaction

Outright forward trade is the forward sell/buy agreement between two parties.

FX swap transaction: Is swap arrangement in which trader borrows home currency and converts it into foreign currency by buying foreign currency and at the same time selling it in the forward market.

9.3 Risks in Forex

9.3.a Transaction risk

Transaction risk in forex relates to risk arising due to the transactions made by the importer or exporter of goods. Assume an Indian exporter who exported goods worth $1,000,000 today and As for the terms of credit amount will be received by exporter after three months. The current spot price is Rs 75 per USD. If after three months the price of USD declines to Rs 70, exporter will lose of this trade at 5(75-70) X 1,000,000 = Rs 5,000,000 Due to currency exposure. There is always uncertainty regarding the future price of a currency and the transaction risk is the risk related to these are uncertainties relating to future price of currency.

9.3.b Translation risk

Translation risk relates to the financial statements of a firm who is operating in multiple countries. Assume an Indian firm operating in two other countries United States and Canada. Currently the assets in United States are worth USD50 million and Canada is CAD30 million. At the time preparation of financial statements, the firm has to show these assets in the local financial statement after translation. Based on the currency rates these assets will reflect in financial statements and hence can increase or decrease the assets value for the firm in the financial statements. This is the translation risk that is the risk arising from translation of assets or liabilities from one currency to another to present in the financial statement. Please note there is no actual loss in this scenario, however it affects the firm because assets value might decline after translation.

9.3.c Economic Risk

This risk emerges for the firm as a result of currency fluctuations affecting the firm's competitive advantage. Consider a company that manufactures goods for which the majority of the raw materials are imported from another country. The price of these goods is determined based on the firm's current import cost. The cost of procuring raw materials has increased significantly as a result of currency fluctuations, and the firm has had to raise the price of items by 10%. This could result in the company losing its competitive advantage and hence is economic risk for the company.

9.4 Factors that determine the exchange rate

Exchange rates are mainly affected by

- Balance of payments and trade flows: The general rule is
  - Country A exports > Country B exports – Country A currency will appreciate due to demand of that currency.
  - Country A Import > Country B Import – Country A currency will depreciate due to supply of that currency.
- Monetary policy: More supply of money in country will result in depreciation of that countries currency.
- Inflation: Explained below.

9.5 Purchasing power parity and Interest rate parity

Inflation and interest rates affect the exchange rates. Before we begin the discussion, we will discuss the relationship of inflation and interest rate.

Nominal interest rate (charged by banks) = inflation rate + Real interest rate.

We can see in the above equation inflation and nominal interest rate (or just interest rate) are positively related and hence the effect of both the factors works in same manner on the exchange rate. The real interest rate has very small contribution. Assume the inflation of 7% and real interest rate (paid by bank) 0.2% , then the rate you receive from the bank on deposit is nominal rate of 7+0.2 = 7.2%.

We can use the inflation and interest rates to gauge the forward exchange rate, as discussed below.

9.5.a Purchasing power parity

Is based on inflation and assume the exchange rate fluctuation is the result of inflation in respective country. Assume

- USDINR Spot = Rs 75
- Inflation in USA = 2%
- Inflation in India = 5%

The one year forward rate of USD INR is calculated as

$$Forward - n\ year\ _{USDINR} = Spot_{USDINR} \frac{(1 + Inflation\ in\ home\ currency)^n}{(1 + Inflation\ in\ Foreign\ currency)^n}$$

$$Forward - 1\ year\ _{USDINR} = 75\ \frac{(1+0.05)^1}{(1+0.02)^1} = Rs\ 77.20$$

Given the inflation rate stays constant, we can say INR value against USD will depreciate in 1 year and USD will appreciate against rupees.

Hence, we can say Dollar will appreciate against rupees by 3% in future.

Calculation (77.20-75 / 75)X100 = 3%

9.5.b Interest Rate parity

We will extend the above discussion and will apply same principles on interest rate parity. Interest rate parity assumes the exchange rate is the outcome of interest rates(nominal) in the respective countries. Assume

- USDINR Spot = Rs 75
- Interest rate in USA = 3%
- Interest rate in India = 6%

The two year forward rate of USD INR is calculated as

$$Forward - n\ year\ _{USDINR} = Spot_{USDINR}\ \frac{(1+IR\ home\ currency)^n}{(1+IR\ Foreign\ currency)^n}$$

$$Forward - 2\ year\ _{USDINR} = 75\ \frac{(1+0.06)^2}{(1+0.03)^2} = Rs\ 79.43$$

Given the interest rate stays constant, we can say rupees value against USD will depreciate in 2 year and USD will appreciate against rupees.

If interest rate parity or purchasing power parity fails to reflect in forward exchange rates it will result into arbitrage.

9.5.c Covered vs uncovered interest rate parity

Covered interest rate parity (CIRP) is predicated on the notion that the forward exchange rates between any two countries' currencies are a direct reflection of the disparity in their respective interest rates. This principle hinges on the concept of eliminating opportunities for interest rate arbitrage, meaning that investors should not be able to generate risk-free profits by exploiting interest rate differences across countries. Essentially, CIRP posits that the potential gains from borrowing in a country with lower interest rates, converting the borrowed funds into another currency, and then investing in a country with higher interest rates, are offset by the corresponding forward exchange rate. This ensures that, once hedged with a forward contract, the return on investment in foreign currency is equalized to the domestic interest rate, thereby nullifying any advantage from arbitrage activities.

On the contrary, uncovered interest rate parity (UIRP) operates under a different set of assumptions. It suggests that the expected movements in exchange rates over time are taken into account so that the anticipated return on investments in different currencies aligns, regardless of the prevailing interest rate differentials. Unlike CIRP, UIRP does not rely on the existence of forward rate agreements to forecast future exchange rates based on current interest rate disparities. Instead, it is founded on the expectation of future exchange rates, asserting that these expectations adjust in a manner that the expected returns on investments in various currencies converge to a common rate. This theory implicitly acknowledges the role of market expectations

and investor sentiment in shaping exchange rate dynamics, which, in turn, influence the returns on international investments.

While CIRP emphasizes the mechanistic adjustment of forward rates to prevent arbitrage, UIRP focuses on the adaptive expectations of market participants, proposing that the forex market naturally corrects to equate expected returns across different currencies. This expectation-based adjustment process under UIRP implies that investors' forecasted returns, after accounting for expected changes in exchange rates, should be equivalent, irrespective of the currency in which the investment is made. However, because UIRP relies on expectations rather than contractual agreements like forward rates, it introduces a greater degree of uncertainty and speculation into the assessment of future currency movements and their impact on investment returns.

10 Pricing Financial Forward and Futures
11 Commodity Forwards and Futures

10 Pricing of Financial & Commodity Forward

(Combined Discussion on reading 10 and 11)

This chapter develops the pricing framework for forwards and futures across financial and commodity markets. It distinguishes investment and consumption assets, explains short selling and profit calculation, and compares forward and futures contracts, including their pricing relationship with spot prices. The chapter derives forward prices using arbitrage arguments, differentiates forward price from contract value, and values forwards on assets with and without income. It applies interest rate parity to foreign exchange forwards and analyzes stock index futures and index arbitrage.

For commodities, the chapter explains the cost-of-carry model, storage costs, lease rates, convenience yields, and carry markets, and develops the no-arbitrage pricing formula for commodity forwards and futures. It evaluates arbitrage strategies, synthetic commodity positions, and the relationship between forward/futures prices and expected future spot prices, incorporating the role of systematic and non-systematic risk.

10.1 Introduction

In this reading we will discuss forward and futures pricing for commodities (metals, oils, etc.) and financial assets (stocks, indices). Discussing these two topics simultaneously will improve understanding and provide the difference forward/futures pricing of stocks and commodities .

10.1.a Investment assets vs consumption assets

Investment assets are financial assets whose value is derived from a claim. For example, shares are investment assets and have claim in net assets of company. Consumption assets are non-investment assets held to consume. For example, Jet fuel is consumption asset which is used by airline companies. Commodities can be consumption assets like oils, spices, etc. or investment assets like Gold. However, financial assets are investment assets.

10.1.b Short selling concept

Short selling is the selling of some securities by borrowing it for time period, and buying it back at the end of this time period to return it to the owner from whom securities were borrowed. These securities are borrowed from your broker only and process works in automated mode. You put order for short sell, broker will provide securities (which belongs to his other client) for short sell and order is executed. When you square of this position broker will buy securities at market price and return it to the owner. The short sell is executed when the trader has the bearish perspective on the security. Intention is to sell at higher rate and buy it back at lower rate. The difference is the income of short seller. However, when the short sell is executed, owner of the security whose securities were used in short sell loses dividend on the security. The short seller must compensate this dividend.

Illustration:

A trader short sold 1000 securities of ABC Inc at $100 in the month of January. ABC Inc declared divided of $20 in the month of February. Trader squared off his position in the month of March at case 1) $105 or Case 2) $75. Calculate the profit or loss to trader in short sell in both the cases.

CASHFLOWS FOR SHORT SELLER	CASE 1	CASE 2
Cash inflow at short sell in jan 2022. 1000 shares at $100	$1,00,000	$1,00,000
(Less) dividend compensation by short seller to owner of security. 20 x 1000	$20,000	$20,000
(Less) buy back at	$105,000	$75,000
Net gain /(loss) to short seller	($15,000)	$5000

10.2 Forward pricing stocks and commodities

Underlying principles of forward pricing for stocks and commodities are same but it differs in implementation due to inherent nature of these assets.

Please note: The following explanations are provided in order to simplify this discussion. Actual reasoning behind the forward pricing is slightly different. We will discuss the explanation/reasoning behind the forward pricing in arbitrage section of this reading.

Underlying principles:

Expense incurred by forward seller is added in forward price. Forward contract is trade in future. Trader who wishes to sell assets in future will incur loss of interest which he would have

earned by selling in spot and depositing funds at risk free rates. At the same time, trader who buy in forward he would earn interest by depositing funds at risk free rate by not paying same funds to buy in spot market, Hence, forward seller would charge this loss in forward price. If the asset sold in forward is commodity, then forward seller might incur storage cost and same will also be charged in forward price.

Income earned by forward seller is reduced from forward price: Assume the asset is dividend earning stocks which forward seller wish to sell, he will earn dividend on the same assets by not selling in spot and hence he should reduce this income from forward price.

The incomes and expenses incurred by forward seller differs in shares and commodities. Following is the list of income expenses incurred on shares and commodities.

	Shares	**Commodities**
Expense (added in forward price)	Interest	Interest(Risk free rate) Storage Cost
Income (reduced in forward price)	Dividend	Lease Convenience Yield

We will discuss above points in the following sections.

10.2.a Interest rate

When the trader is selling forward, he is losing interest as we discussed above. Hence, the forward price is

Forward price = Spot price + interest expense.

There are two ways interest expenses provided in question

- Interest rate(Risk free rate) in effective terms
- Interest rate(Risk free rate) continuously compounded terms

Illustration:

- Current spot (S0)price is $150
- Forward contract time(t) to maturity 2 year
- Risk free rate (r): 10%
- Calculate 2 year forward price assuming interest rate is effective or continuously compounded rate.

	Assuming effective rate	Assuming CC rate
Formula	$F = S_0 X (1+r)^T$	$F=S e^{rt}$
Calculation	$F = 150 X (1+0.10)^2$	$F = 150 X e^{0.10X2}$
Forward rate	181.5	183.21

Professors note for Exam Note: GARP generally provides specifically if the rate is CC or effective, so use the formula to suit this requirement. If no specific mention of CC rate or effective rate for interest rate, we don't have enough clarity from GARP about what compounding method should be assumed.

10.2.b Storage Cost

Storge cost is incurred by the forward seller by not selling asset in spot and hence cost must be included in the forward price. Storage cost is only applicable for commodities and not for financial assets.

Storage cost(U) can be provided in the following variations:

- In Dollar Terms
  - Storage cost paid in advance
  - Storage cost paid at the end
  - Storage cost paid in the mid
  - Storage cost paid monthly (not covered in FRM curriculum).
- In the rate terms

Illustration:

- Spot price = $150
- Risk free rate r = 10% CC
- 6 months rate = 9%
- Term = 1 year
- Storage cost U = $15

Calculate the 1 year forward price assuming storage cost is paid in the advance, paid after 6 months and at the time of maturity.

	U paid in advance	**U paid after 6 months**	**U paid at the maturity**
Formula	$F = (S+U)e^{rt}$	$F = (S + PV(U))e^{rt}$	$F = Se^{rt} + U$
Calculation	$F= (150 +15)\ e^{0.10x1}$	PV of U = $15Xe^{-0.09*0.58}$ PV of U = 14.33 $F = (150 + 14.33)\ e^{0.10x1}$	$F = 150\ X\ e^{0.10x1} + 15$
Forward price	182.35	181.61	180.77

If storage cost is provided in rate terms for example 2% then forward price can be calculated as

$F = S\ X\ e^{(r+U)t} = 150\ X\ e^{(0.10+0.02)1} = 169.124$

10.2.c Dividend

Dividend is applicable for stocks. Dividend is earned by forward seller of shares, by selling it in forward because forward seller gets to keep the ownership and hence dividend is earned by him.

Dividend can be provided in terms of

- Yield
- Value

Illustration:

- Current stock price = 150
- Risk free rate (r) = 10%
- Case 1: Dividend in yield = 2%
- Case 2: Dividend in value = $10 paid after 3 months (discount rate 8%)
- Time to maturity = 1 year

Calculate the 1 year forward price of stock for both the cases.

Solution:

Formula using yield form	Forward price using yield
$F = S \times e^{(r+d)t}$	$F = 150 \text{ X } e^{(0.10-0.02)1} = 162.50$
Formula using dollar value	Forward price using dollar value
$F = (S - PV(D))e^{rt}$	$PV(D) = 10e^{-0.08*0.25} = \$9.80$ $F = (150-9.80)\ e^{0.10*1} = 154.945$

10.2.d Lease and Convenience Yield

Lease: An asset owner who is forward seller can lease out the asset and earn some income. This is possible because s/he is selling in forward and hence able to keep the ownership of the asset till the maturity of forward contract. This is income for the forward seller and hence he should reduce this income from forward price charged to forward buyer. Lease rate is provided in a rate form and applied in formula like dividend in yield form.

- **Example:** A Gold Jewelry manufacturer who also deals in Gold forward contracts, can earn some income by leasing out the Gold till the maturity of forward contract.

Convenience Yield: An asset owner who is forward seller can get convenience yield by keeping assets ownership with him till the maturity of the forward contract. Convenience yield is very special case of yield because it is not applicable for every forward seller and also rate of convenience yield is not directly observable.

- **Example:** A Gold Jewelry manufacturer who deals in Gold forward contract may get some convenience by not selling Gold in spot. By holding Gold for this period he might be able to maintain normal Gold stock level required in manufacturing process, which offers convenience. However, this convenience can not be directly evaluated and hence it is assumed in the price. For exam purpose, we will be provided with the assumed rate of convenience.

Lease and Convenience yield cannot be earned together at the same time because the lease rate is earned by leasing commodity to other party however, convenience yield is earned by keeping the commodity in own possession.

Illustration:

- Gold spot price (1gms) = $60
- Risk Free rate (r) = 10%
- Case 1: Lease rate = 7%
- Case 2: Convenience yield = 1%
- Time to maturity = 1 year

Calculate the 1 year forward price of the Gold (1gms)

Solution

- Forward price(with lease rate) = Spot $e^{(r-l)t}$, where l is lease rate.
- Forward price = $60 \text{ X } e^{(0.10-0.07)1} = \$61.82$
- Forward price (with convenience yield) = Spot X $e^{(r-c)t}$, where c is convenience yield.
- Forward price = $60\ e^{(0.10-0.02)1} = \$65$

10.2.e Treatment when rates are given in continuous and effective rates

Let's take the example of Forward pricing of Gold with lease rate (same can be extended to all the other factors which are mentioned in the form of rate).

- Gold spot price (1gms) = $60
- Risk Free rate (r) = 10%
- Lease rate = 7%
- Time to maturity = 1 year

Calculate the forward price assuming rates are effective and continuous compounding.

Rate assumed effective:

- Forward price(1 year) $= 60 \text{ X } \frac{(1+0.10)^1}{(1+0.07)^1} = 61.68$

Rate assumed Continuously compounded:

- Forward price = $60 \text{ X } e^{(0.10-0.07)1} = \$61.82$

10.3 Forward price vs futures price

In all the above calculations we are calculating theoretical forward price. Forward prices and futures prices under same terms are approximately same and the difference is ignorable. Hence in the next section we will apply same principles of forward pricing on futures pricing. However, existence of approximation means there is difference. Hence for exam purpose, we need to understand why this negligible difference arises in the forward and futures pricing.

One of the key difference in forward and futures which affects the pricing of these derivatives is the daily settlement of futures contract. The amount received by party gaining on the position can invest this amount. This investment can be favorable or unfavorable to the party gaining on the contract which might result in the difference in the pricing. This depends upon the interest rate and asset prices correlation. For exam purpose, remember the following statements

- If the asset prices are positively correlated with interest rates, this makes futures contract more lucrative than the forward contracts for long futures holder and hence futures will be priced slightly higher. (Reason is discussed below)
- If the asset prices are negatively correlated with interest rates, this makes futures contract less lucrative than the forward contract for long futures holder and hence futures contract will be priced slightly lower.

Reason: Assume asset prices are positively correlated with interest rate. This creates two impact when the interest rate rises 1) Underlying asset price will increase and hence long futures contract will get payment in settlement and 2) Same amount can now be invested at increased interest rate. If the asset price is negatively correlated with interest rates, then if the interest rate falls, it will result in positive payoff for the long futures but now he needs to invest the same amount at lower interest rates.

10.4 Arbitrage in futures

In the previous section we discussed the difference in forward vs futures prices. These are theoretical prices calculated using the formula which are approximately same in both forward and futures. However, in case of futures which is traded in the exchange, there might be some

difference in theoretical futures price vs actual futures price and hence generates the arbitrage opportunity.

Assume the theoretical futures price (Ft) = $100 and actual futures market price(Fa) = $120. In this case arbitrage opportunity can be exploited. The basic rule here is sell expensive and buy cheap. In this case, futures in market is trading expensive, hence sell futures i.e. take short position in futures. If the reverse is true, if say futures in market is trading at $80 then it is trading cheap and hence take the long position in futures. Please note theoretical price here is for comparison and we can't trade in theoretical price. Depending on the market price is cheaper or expensive we choose from the two-arbitrage strategy 1) Cash and carry arbitrage and 2) Reverse cash and carry arbitrage. Following table summarizes both the strategies.

Professors note: In video classes I provide two methods to remember the steps in arbitrage one is intuition-based method and second is memory based (just remember the steps). It is difficult for me to pass on the intuition in this text format, hence I would recommend you use memory based method to remember these steps.

	Cash and carry arbitrage when Ft < Fa		Reverse cash and carry arbitrage when Ft>Fa	
Given information	Spot price = 100, risk free rate = 10% Ft(calculated) = 110 Fa(Market) = 120 Time to Maturity = 1 year		Spot price = 100, risk free rate = 10% Ft(calculated) = 110 Fa(Market) = 100 Time to Maturity = 1 year	
Cash flows: At the initiation of contract	**Borrow funds** to buy security in spot market.	+100	Short **sell security** in the spot	+100
	Buy security using borrowed funds	-100	**Invest funds** at market interest rates	-100
	Sell Futures contract (because trading expensive)*	0	**Buy Futures** contract (because trading cheap)*	0
A) Net Cash Flow		0		0
Cash flows At the maturity of contract (after 1 year)	Settle short futures by delivering commodity (and receiving money) at $120.	+120	Withdraw investments made previously. Value of investment at maturity is 100 + 10%	+110
	Repay borrowed funds using sale proceeds from delivery. 100 + 10% (interest rate)	-110	Settle long futures contract by taking delivery@100	-100
B) Net Cash flow		+10		+10
Net Arbitrage Gain (A-B)		+10**		+10

*There is no cash flow in taking long or short position in futures. The cash flow of margin is ignored, which should be taken into consideration in practice (real life) but for exam purpose it is generally ignored to reduce complexity of illustration.

** Because arbitrage process assumes all the factors relevant to arbitrage are known to us, which makes fixed value gain certain. Hence, we can also calculate the present value of arbitrage gain by

simple discounting. In exam, pay special attention on the time at which arbitrage gain should be calculated. If no explicit information is provided in the exam simply stick to above steps.

What to expect in exam?

Arbitrage is very favorite area of GARP. In exam there are two possibilities, either GARP will provide theoretical price directly or you will be provided information using which you need to calculate theoretical price first (which we already know from previous sections). Rest of the information like actual price, interest rates and time to maturity is always provided in the exam.

10.5 Valuation vs pricing of forward contract

In the above sections we discussed the pricing of forward contracts. Value and pricing are two different things. Price is at which trade will be settled. However, valuation is done for the purpose of accounting and marking to market. At the inception, value of every forward contract is zero. Value is generated (+ve or -ve) after the inception of the contract because the underlying factors change during the course of time.

Value of the forward contract (for long position holder)

= Spot price of asset (adjusted for dividend income) – Present value of Forward price

Illustration

- Current spot price (dividend paying asset) = $1000
- Risk free rate = 10%
- Dividend yield = 2%

Calculate the forward price and value of the forward contract on the next day assuming the spot price increased to $1050.

Forward price $= 1000 \text{ X } \frac{(1.10)\text{^}1}{(1.02)\text{^}1} = 1078.43$

Value of the forward contract = 1050 X (1/(1.02)^1) – 1078.43 X (1/(1.10)^1 = $49.020

The value of forward contract 49.020 should be marked to market which is indicative of current gain on the forward position. The value of forward contract will change given the changes in underlying price in spot market.

10.6 Special points related to commodities forward and futures

Commodities differs from the financial assets due to the nature of these assets. Following are the key differences in commodities and financial assets.

Storage Cost: Communities are the physical assets and hence requires storage which is not applicable for the financial assets.

Location Dependency: the price of commodities is location dependent because there is cost involved in delivery of the commodities on the given location. Whereas financial assets are merely contract nowadays maintained in the electronic form and can be delivered to any location in the world within few clicks.

Lease: The commodities can be lent to other party in order to earn the lease income. This can be compared to the financial assets short sale , however leasing and short selling works differently.

Risk Based Pricing: financial assets are priced based on the risk taken by the investor. However the factors which influence the price of the commodity are very different which can range from the time duration, location etc.

10.6.a Factors Impacting the prices Of Agricultural Commodity, Metals, Energy And Weather Derivatives

Agricultural commodity: The demand is evenly distributed throughout the year, and output is seasonal. To compensate for this mismatch, agricultural commodities must be stored, which has an impact on the price of agricultural commodities forward contracts. Agricultural commodities are also affected by harvest quality, government regulations, and weather conditions.

Metals: Metals, unlike agricultural commodities, are not affected by weather and may be stored at a low cost. Metal prices are influenced by factors such as the cost of mining or producing metals, government regulations, foreign exchange rates, and so on.

Energy: The nature of energy products is vastly different from one another. Crude oil, for example, is easier to transport and has comparable market pricing around the world. As a result, crude oil futures are a stable derivative. Electricity is another energy product that is difficult to store. The demand for electricity, on the other hand, is quite dynamic and varies from day to day. As a result, electricity derivatives are extremely volatile. Natural gas is the final energy product we'll discuss. Natural gas has a steady production but a changeable demand that varies by season. Natural gas is expensive to store, therefore future costs will vary by region.

Weather: Weather derivatives are derivatives on weather events such as monthly rainfall, temperature, and so forth. Energy corporations are the primary users of weather derivatives.

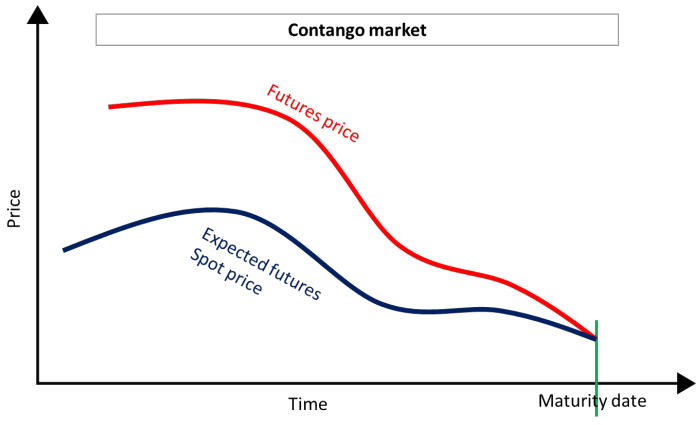
10.7 Contango and Backwardation

Expected futures spot price vs futures price: Futures(derivative) price is based on the model with the support of current spot price as per the previous discussion. Expected futures spot price is what market expects the future (going forward in time) price of asset will be. The futures price should converge to the spot price at the maturity, else arbitrage opportunities will arise.

June future(derivative) price = Spot price in the month of June.

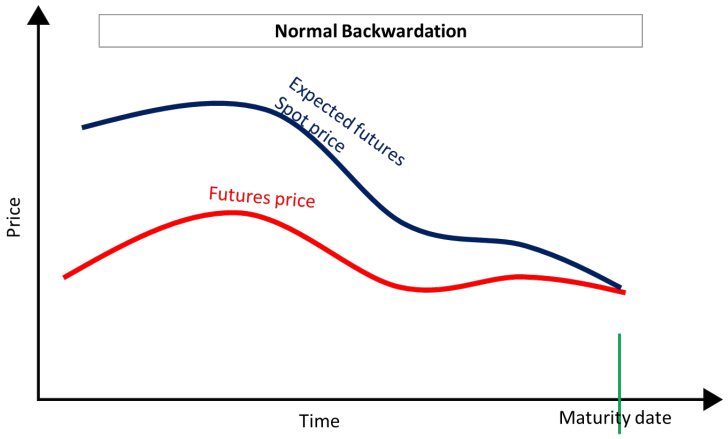
Contango market

When the futures price (F) is trading above Expected Futures Price E(St), the market is contango market. Contango is also used in the reference when the futures price is trading above the current spot price.



Normal backwardation:

When the expected futures price E(St) is trading above the futures price F, then market is called as normal backwardation. Normal backwardation sometimes is also referred to a market when the futures price is trading below the current spot price.



10.7.a Basis and Basis Risk

Basis is the difference in futures price and spot price. Assume, current month is January in which Feb Futures is trading at 120 and the spot price today is 110.

Basis = Spot – Futures= 110– 120 = -10

If the asset which is being hedged is different from the hedge instrument's underlying, then we can tweak the above formula as

Basis = Spot price of asset under hedge – Futures price of hedge instrument

Key properties of basis (in an ideal scenario)

- The basis decreases (in magnitude) with respect to time.
- The basis is zero at the maturity if both asset which is being hedged and underlying of the futures which is used to hedge is same.

Basis widens when the difference between the spot and the futures is more and basis narrows when this gap is shorter. Hence, the basis is expected to get narrower as the time to maturity approaches to zero.

Basis risk

As shown in the above diagram, the spot price and the futures price should ideally meet at maturity. But this does not happen. When the spot price and the futures price do not match at the end of the contract, this is called basis risk. Basis risk occurs in futures trade because of two main factors -

- Futures positions are closed out prior to the delivery date specified in the contract.
- Asset hedged is different from the underlying of the futures contract because not all the assets are available in futures contract.

Basis risk creates uncertainty in hedging and might result into losses in the hedge.

12 Options Market

12 Options Market

Scope of this reading

This chapter introduces the fundamental characteristics of options, including types, position variations, payoff and profit profiles, and common underlying assets. It explains the specifications of exchange-traded stock option contracts, including adjustments for nonstandard products, and analyzes how dividends and stock splits affect contract terms. The chapter also describes trading mechanics, commissions, margin requirements, and exercise procedures for exchange-traded options. Finally, it defines and distinguishes warrants, convertible bonds, and employee stock options.

12.1 Introduction

The option which can only be exercised on the expiration date is known as European option and the one which can be exercised on or before expiration date is American option. In all the previous discussions we focused on European options. In this reading and in coming we will discuss European and American options simultaneously. Given the fact that both the options are overall same with only one difference being the time to expiration, American option can be more favorable to trader and hence may be more expensive depending on the other properties of option. This also adds the complexity in the valuation of American option when compared to European option. American options are mostly exchange traded and European options can be exchange or OTC traded.

Intrinsic value: Intrinsic value the value of the option on or before expiration. Intrinsic value of

Call = max (0,S-X)

Put = max (0,X-S)

We can also compare intrinsic value with the payoff of the option. The difference of Call price and the intrinsic value of the option is time value of the option.

12.2 Types of underlying assets

Stock options:

- These are options with shares of company as underlying.
- Exchange traded American style options
- Adjusted for stock splits (explained in coming readings) but not for cash dividends.

Index Options

- These are options on stock indices and generally European options.
- Traded in both exchange and OTC
- Payoff depends on index level.
- Cash settled

ETF options

Are similar to Index options except for

- American Style options
- Settled by delivery instead of cash

12.3 Specifications of exchange traded options

12.3.a Maturity

CBOE stock options are assigned one of the following maturity cycles

- January, April, July, and October (January Cycle)
- February, May, August, and November (February cycle)
- March, June, September, and December (March cycle)

Understanding the maturity Cycles: Third Saturday is of every month is the expiration date for the options of the current month. The cycle is based on this third Saturday and changes in prior and after the third Saturday.

- **Prior to Third Saturday:** Options trade for maturity month – Current month, next month(as per calendar month), and next two month from the current months cycle. Assume the current date is 15th January(prior to third Saturday) and stock is in the January Cycle. The options can be traded for the maturity month – January(current month), February(Next calendar month), April and July(next two months from the current months cycle).
- **After Third Saturday:** Options trade for the maturity month – Next month, next to next month, and next two months from the current months cycle. Assume the current date is 27th Jan (after third Saturday) and stock is in the January Cycle. The options can be traded for the maturity month – February(next calendar), March(next to next calendar), April and July(next two months from same cycle).

Trade takes place on every business day until the maturity date.

Weekly options: Weekly options mature on Friday except for third Friday of the month. These are short duration options with 8 days(Starts on Thursday and ends Friday) on existence and hence are highly affected by time decay. We will learn more about the time decay in Reading properties of options(Book3) and Greeks(Book 4).

LEAPS: These are long term options (long term equity anticipation securities). It provide the maturity upto three years and mature on the third Friday of the January month each year.

12.3.b Strike Price

CBOE sets option strike price as multiple of USD 2.50 when the underlying price is trading in the range of $5 and $25 and multiple keeps increasing as the range increases. At the beginning three strike prices closest to the current price are listed and new strike prices are added to the list as the stock price changes. Calls and puts are referred to as the class of the options. The option series is the all the options listed with the same maturity date. Strike price is adjusted for dividends(non cash) and stock splits.

12.3.c Nonstandard options

- FLEX options are non standard options which provides non standard terms like strike price, maturity date and variations of European and American options.
- Cliquet options are options on indices which provides a payoff equal to the sum of monthly capped returns provided by the asset.
- Asian options: Provides the payoff based on the average price of the underlying asset during the life of the option.

12.4 Effects of dividend and stock splits on options

To understand effects of dividend and stock splits on option one must know how these factors impact underlying stock price. Following table provides the summary of impact, however for better understanding of these factors please review Falcon's FRM Prequel Course available on Falconedufin.com.

Factors	Effect of underling stock price	Effect on options
Dividend in Cash	Underling price drops by dividend value approximately.	Not adjusted for Cash dividend.
Stock Splits	Stock price is adjusted for stock splits. Assuming 1:1 stock split, the one stock is divided into two and hence the price is reduced to half.	Options strike price is adjusted for stock split. For 1:1 stock split, the strike price is reduced to half.
Stock Dividend: i.e stocks are provided as dividend.	Adjusted for stock dividend and exactly same treatment as stock splits.	Strike price is adjusted for stock dividend and exactly same treatment as stock split.

12.5 Trading Commissions and margin requirements

12.5.a Trading

- We already discussed major portion of this section, hence review only key points.
- Option contract size is 100 options.
- Market makers quote bid (long option price) ask (short option price) on options. Market makers earn on bid ask spread.
- Option broker provides option trading facility for retail trader.
- Options positions can offset when opposite positions on same options are taken.
- Exchanges limit the number of options which can be traded on stocks is known as position limit.
- Exercise limit is equal to position limit which specifies the total options which can be exercised.

12.5.b Commissions

Brokers charge trading commission from the option traders which depends on trade size and broking type. The commission structure vary from broker to broker, however, generally placed as fix commission + % on trade amount. Some brokers also set commission based on fixed commission depending on trade amount range and not directly as a % of on trade amount.

12.5.c Margin Requirements

This discussion is similar to margin requirements we discussed in previous reading, hence we will only focus on key points

- Options with maturity less than 9 months cannot be traded on margin.
- Options with more than 9 months maturity can be traded at margin with the maximum borrowing less than 25%.
- Long options holder is not required to post margin.
- Short call must post margin based on rules (as discussed in previous readings).
- Trader can withdraw funds if balance is more than maintenance margin.
- Options margins are handled by Option clearing corporation (OCC) and all trades must be cleared through OCC.

12.5.d Over the counter market

Options are traded in both OTC and exchanges. However, stock options are traded majorly on exchanges. Other options like currency, interest rates etc. are traded on OTC market. The advantage of OTC options is customization according to clients needs. Also Exotic options which we will study in coming readings are also traded in OTC market.

12.6 Warrants and convertible bonds

Warrants generally are call options issued by corporations on own stock. However, can also be call or put on some other assets. Warrants are traded on exchange. The differentiating factor in warrants and other options is, warrants are issued by corporations only. Assuming warrant on own stock, if long position holder decides to exercise these warrants then, he needs to intimate corporation and corporation will issue new stocks which are then bought by long at strike price. Generally warrants are issued with bonds which provides the bond holders option to buy companies stocks. The warrants are attached with bonds in order to make bond issue more attractive for investors.

Convertible bonds: These are similar to warrants with the difference being, bonds are converted into stocks of the company at predetermined exchange ratio. The bond holder will only exchange bonds with stocks only if the market value of bond is less than the value of stocks exchanged.

13 Properties of Stock Options

13 Properties of stock Options

Scope of this reading

This chapter analyzes the fundamental determinants of option pricing, identifying the six key factors that influence an option's value. It establishes no-arbitrage upper and lower bounds for options on both dividend-paying and non-dividend-paying stocks. The chapter develops put–call parity, applies it to the valuation of European and American options with and without dividends, and expresses the relationship in forward price terms. It also evaluates the economic rationale and optimality considerations for early exercise of American call and put options.

13.1 Six Factors which affects option price

The price of the stock option can depend on

- So - Price of the underlying stock
- X - Strike Price
- r - Risk free rate
- σ - Volatility
- t- Time to maturity
- D - Dividend

This reading also discusses the impact of these factors on the call and put option prices. This is bit difficult to understand without learning the Readings from the Book 4 Binomial option pricing and BSM model for option pricing. Hence, here we will review only table providing summary of above-mentioned factors impact on option prices. Once you learn the BSM and Binomial option pricing, you will understand the reasoning behind these impacts.

Table

- ✓ *+ sign is indicative of positive impact of factor on option prices. Means if the factor increases the option price will increase and if factor decreases the option price will decrease.*
- ✓ *(-) sign is indicative of negative impact of factors on option prices. Means, if the factor increases the option price will decrease and if factor decreases the option price will increase.*
- ✓ *CE and PE are European call and put, respectively.*
- ✓ *CA and PA are American call and put, respectively.*

Factors	**CE**	**PE**	**CA**	**PA**
S0	**+**	**-**	**+**	**-**
X	**-**	**+**	**-**	**+**
Time to expiration	*	*	**+**	**+**
Volatility	**+**	**+**	**+**	**+**
Risk free rate	**+**	**-**	**+**	**-**
Dividend	**-**	**+**	**-**	**+**

*indicates – there is no direct impact of time to expiration on European options. However, for American options, more time to expiration means more possibility option being exercised at favorable price.

Reasoning in general:

Stock price: The factor which increases the possibility of option will get exercised will create the positive impact on option price and vice versa. If the underlying price increase it will increase the probability of call getting exercised and reduce the probability of put getting exercised. This impact is same for both European and American options.

Strike Price If we consider strike price, higher the strike price lesser the probability of call getting exercised and more probability of put getting exercised. Hence strike price has negative impact on call and positive impact on put.

Dividend has reducing (Negative) impact on stock prices, and stock prices are positively linked call and negatively with put. Hence dividend will create the opposite impact on call and put because dividend and stock prices are negatively linked (Increase in dividend will reduce stock price more).

Risk free rate: The general economics principle can be applied here. The interest rate has the positive impact on asset prices (stock). Hence, increase in interest rate will affect stock prices positively and the hence the impact of stock price and interest rate will have same relationship with call and put.

Exam important Note: Volatility is friend of all options. Hence in the table we can see irrespective of the option type, it has positive impact on all options. The reason is higher volatility in general increases the possibility of option getting exercised because stock prices fluctuate more in higher volatility. This part is better explained in reading Book 4 BSM model for option pricing. For exam, you must remember, volatility is friend of all options (I know, am repeating this statement in same paragraph, from this you can understand the importance of this statement from the exam perspective).

13.2 Early exercise decision in American option

13.2.a Call Option Early Exercise

The sole difference between the American and European options, as we learned in previous chapters, is that the American option can be exercised before the time to expiration.

Q: The question now is whether or not an American call option holder should exercise his option before it matures.

Ans (must remember): When a stock does not pay a dividend, it is never an optimal idea to exercise an American call option early. Our answer will alter, though, if the stock produces a dividend, which we will discuss later.

Reasoning: The call option is held by two sorts of parties. The first is for those who wish to purchase stock at a later date (t expiry date) and avoid price fluctuations, while the second is for those who want to speculate. The table below illustrates how the exercising call option is never optimal for both parties.-

Party A: Call option used in hedging.	Party B: Call for Speculation
Exercises option early: To buy stock early using an option, the holder must pay the strike price today and, in the process, he will lose the interest from the time of early exercise to the due date of exercise. Assuming option is exercised early party will have shares in his portfolio at the time T, priced at St.	**Exercises option early:** If a speculator believes that the intrinsic value of an option has reached its peak and the price will now begin to fall, he will exercise the option early. As a result, he wants to lock in the greatest price gain as a payoff. Remember that speculation isn't interested in accepting delivery and if he receives delivery, he will promptly sell the stock to avoid being exposed to a price drop.
Does not exercise option early: In this case option may or may not be exercised at the expiration date depending on underlying price. If the option is exercised at the expiry, trader will have Stock at St in his portfolio which is same as above (when he exercised it early). However, he saved interest by not paying for stock early. If he does not exercise option at expiration, which means underlying is trading at lower	**Does not exercise option early:** Speculator can enjoy extra profit with same option by not exercising it. He should take following steps instead of exercising option early At time To 1.Short sell stock 2.Invest cash earned from short sell at Rf. + At time T-

rate than the strike price and now he can buy same asset at lower price.	1.Recollect invested cash and interest earned on it 2.Exercise option if stock price is above strike price Or buy stock at current price if it is below strike price but he must own stock to square off short sell position. 3. Close short sell. This is more beneficial because speculator gets to earns extra interest and also gets the opportunity to gain extra if price falls below strike price, buys at lower price—settles short sell and gains additional profits (cash earned from short sell and money paid to buy stock to cover short sell).

Impact of dividend on early exercise of American option: American option can be exercised early just before ex-dividend date if and only if the dividend amount outruns the interest gain from the early exercise. In terms

$D > X — X^*$

- D= Dividend
- X = Strike Price
- X* = PV of strike price.

13.2.b Put Option Early Exercise

Properties of Call option and put option may differ in some cases. In case of put option it is sometimes optimal to exercise it early even if stock does not pay dividend. When we exercise put option we get cash by selling stock which can be invested at Rf. But to gain this interest you loose on small opportunity of selling underlying at higher rate if underlying rising above strike price. Hence American put option early exercise is trade off between

- Receiving the strike price early so it can be invested to earn interest rand
- Benefitting from the optionality in circumstances where the stock price moves above the strike price.

13.3 Upper and Lower Bound for Call and Put Options

Upper bound of an option is maximum (virtually) price of the option long is ready to pay. Lower bound of an option is minimum (Virtually) price of the option long should be charged by writer of the option in any circum- stances. Following is the table stating upper and lower bound of an option.

LOWER BOUND	OPTION TYPE	UPPER BOUND
MAX (S-PV(X),0)	Call European	S
MAX (S-X,0)	Call American	S
MAX (PV(X)-S,0)	Put European	PV(X)
MAX (X - S,0)	Put American	X

- X = Strike price
- PV = Present Value
- S = Underlying Price

13.3.a Reasoning Behind Upper and Lower Bounds

Upper bound (Maximum value option can reach)

- **Call option** pays difference between underlying stock price S and strike price X. If we assume X to be zero, maximum gain on call option can be S—0 = S and hence in any circumstances price of the call should not go above S. This is for both American and European call option.
- **Put Option** Pays difference between strike price and underlying stock price. If we assume stock to go bankrupt and hence price is zero the maximum gain on put can be X (i.e. X-0 = X). However European option cannot be exercised early even if stock price is zero, hence the maximum price of PE is present value of X.

Lower Bound (Minimum value of option)

Explaining lower bound is bit complicated and hence we will take the help of virtual portfolios for each call and put and try to understand it. It is recommended to watch video.

Call Option: Consider two portfolios that could be held up prior to the maturity of the option.

Portfolio A: Call + Cash equals to PV of X

Portfolio B: The Stock

Here we assume, PV(X) is invested at risk free rate till the expiration date of the option and hence it pays X at the expiration date. Hence portfolio A will always pay at least amount equals to X.

- Scenario 1: Stock price is above X. Portfolio A will pay X + Payoff on call which sums to total value of option's underlying stock. B pays stock price. In this case payoff is equal for both the portfolios.
- Scenario 2: Stock price is below x. A will pay only X as option is lapsed. B will pay stock price. In this case A pays more than B.

Considering both the scenarios we can say portfolio A is always at least equal to B. Hence current price should be

C + Pv(X) >= S

If we adjust this equation, we can say C >= S– PV (X). We know value of C cannot be negative hence,

C>= max (S-PV(X),0)

As American option can be exercised early, above equation can be refined to

C>= max (S –X, 0)

If stock pays dividend, dividend must be adjusted in following manner

CE>= max(S— PV (X) - PV (D), 0)

Put Option: Consider **two portfolios** Portfolio C : European put option + Stock Portfolio D: Cash equal to PV (X)

- *Scenario 1:* Stock price is below X and hence option is exercised. C will pay payoff (X-S) + Stock price, hence it sums to strike price of an option. D will pay X. Hence both portfolio pays equal amount.

- *Scenario 2:* Stock Price is above X and option is lapsed. C will pay only Stock price and D will pay X. In this case C is more valuable than D.

Considering both the scenarios we can say C is always at least equally valuable as D. Hence in current pricing C>=D.

PE + S >= PV(X)

PE >= PV(X) - S or say max (PV (X) - S,0)

For American option

PA >= X—S or Say max (X—S,0)

If stock pays dividend,

PE >= max (PV (X) - S + PV (D), 0)

Impact of dividends on early exercise: Dividends make it more likely a call option will be exercised early, they make it less likely that a put option will be exercised early. This is because the stock price is reduced due to the impact of dividend which reduces the probability of call option getting exercised and increases the probability of put option getting exercised.

In general exercising becomes less attractive to the holder of put option when-

- Stock price increases.
- Interest rate decreases.
- Time to maturity increases.
- Dividend expected during the life of the option increases.

13.4 Put call parity

Put-call parity is a fundamental principle in options pricing that establishes a specific relationship between the price of a European call option and a European put option with the same strike price, expiration date, and underlying asset. This principle helps ensure that there are no arbitrage opportunities in the market for these financial instruments. The concept is based on the premise that the combined positions of a call option and a short position in a put option (or vice versa) should have the same payoff as a certain position in the underlying asset and cash.

The formula for put-call parity is expressed as:

$$\boldsymbol{C - P = S - PV(K)}$$

where:

- C is the price of the call option,
- P is the price of the put option,
- S is the current price of the underlying asset,

- PV K is the present value of the strike price K, discounted at the risk-free interest rate \(r\) over the time to expiration T.

This equation essentially states that buying a call option (which gives you the right to buy the asset at a certain price) and selling a put option (which obligates you to buy the asset at the same strike price if the option is exercised) should be equivalent to buying the underlying asset outright

and borrowing the funds necessary to buy it at the strike price at the time of the option's expiration.

Illustration:

Let's consider an example to illustrate put-call parity. Suppose we have:

- A call and a put option on the same stock,
- The strike price is $100,
- The risk-free interest rate is 5% per annum,
- The time to expiration is 1 year,
- The current stock price is $100,
- The call option price is $10.

To calculate put price we can,

$10 - P = 100 - 100e^{-0.05\ X\ 1}$

P = 5.12

14 Trading Strategies

14 Trading Strategies

Scope of this reading

This chapter examines structured option strategies used for hedging and income enhancement. It explains the rationale and payoff implications of covered call and protective put strategies, and describes the structure and required conditions for constructing principal protected notes (PPNs). The chapter analyzes various spread strategies, focusing on their payoff calculations and strategic applications, and evaluates combination strategies by detailing their payoff functions and associated risk–return profiles.

14.1 Introduction

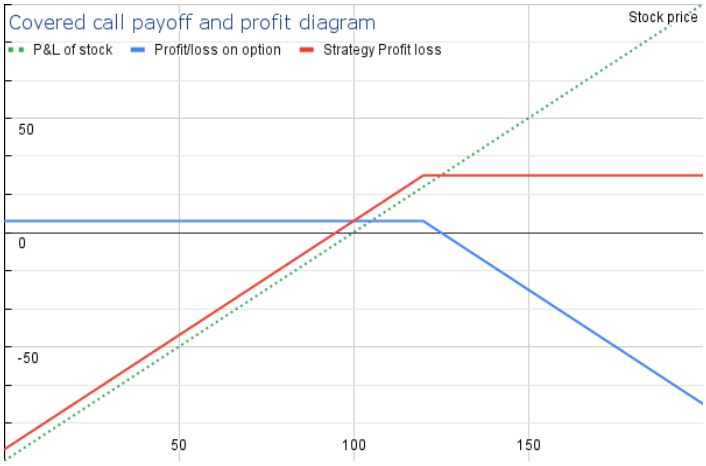
In the previous readings we discussed the plain vanilla options and how it can generate the payoffs for long option position holder. In this reading we will discuss how to create the option trading strategy using different combinations of options to generate profits in certain market conditions. For exam you need to learn

- Remember the composition of strategy.
- When the strategy is profitable.
- Which strategy is expensive or cheap compared to other strategy.
- The payoff profit graphs of the strategy.
- Disadvantages of strategy.
- Calculation of payoff at expiration at a given stock price.

14.2 Covered call and protective put

Covered Call (short call while owning stock):

The goal of this strategy is to make money by selling call options that are "out of the money." Selling calls can be risky because if the stock price goes up above the strike price, it can lead to a loss. However, if you own the stock itself, you can use it to cover the call option if needed. That's why this strategy is called a covered call – because the call option is backed or "covered" by the stock you own.



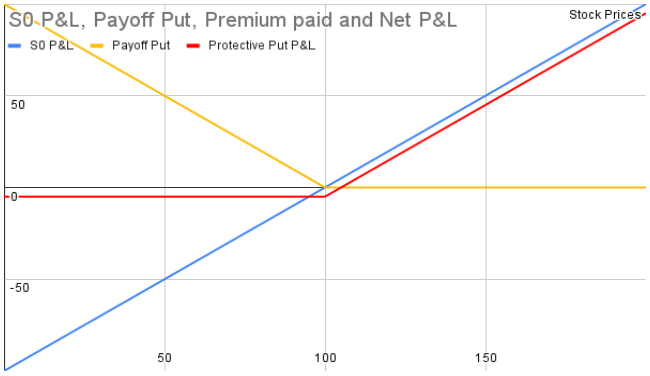
Professors note: To get the better insights of all the strategies taught in this reading, the simplest method is creating a scenario, construct payoff diagram and see yourself how the strategy works. This will help you in two ways, you will be able to understand the impact of individual factor in strategy and lean how all these components in the strategy result in final payoff.

Homework: *Construct the payoff/ profit diagram for covered call for following scenario. (Also check the workbook providing all the strategies examples).*

Stock currently trading at $150. Short call at strike price $140 assuming premium paid is $5. Assume stock price at the maturity ranging from 100 to 200 (increase by 10 per step – 100,110,120,130,140, etc.). Feel free to use spreadsheet.

Protective Put (Owning stock and long put)

This is the simplest strategy among all. The aim is not to earn profit but to protect(hedge) the existing stock position. Trader owns stock and to hedge his position from falling stock prices he takes the long position in put option. The aim here is to reduce the downside risk.

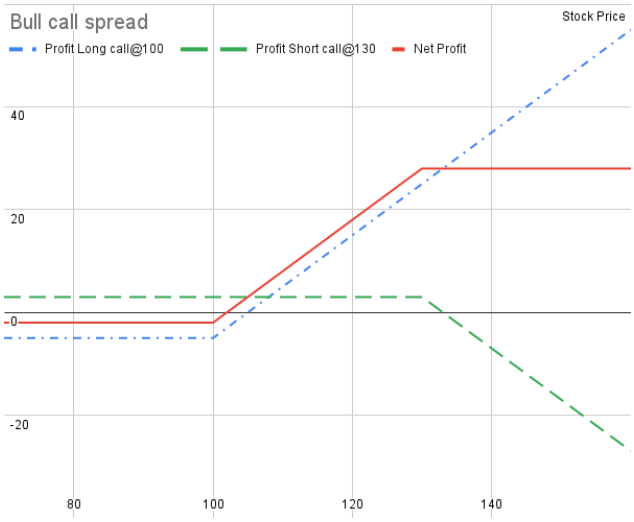


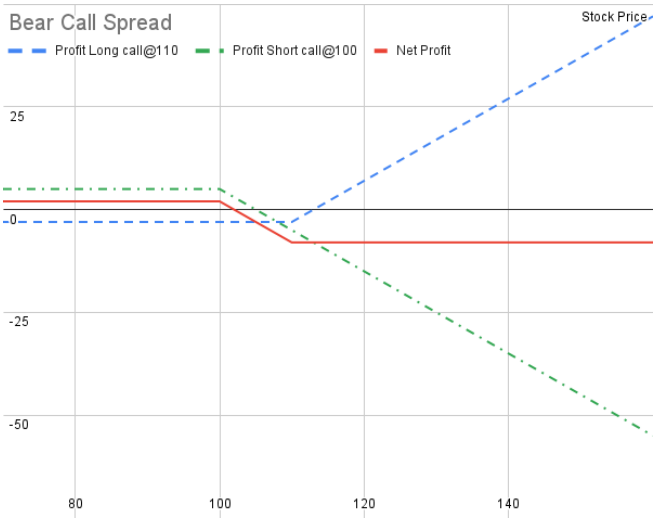
14.3 Spread Strategies

14.3.a Bull and Bear Spread

Following table summarizes the Bull call and bear call spread strategy.

STRATEGY	BULL CALL SPREAD	BEAR CALL SPREAD
WHEN TO UTILIZE?	When the trader is bullish on stock/market.	When the trader is bearish on stock/market.
AIM	Is to utilize the upward movement of the market	Is to utilize downward movement in the market.
COMPOSITION	**Long call** at **lower** strike price **Short** call at **higher** strike price Both at same expiration date	Long call at higher strike price Short call at lower strike price. Both at same expiration date
REASONING BEHIND THE COMPOSITION	Trader is bullish on the market hence the long call. Short call is mainly used to lower the overall cost of position at the same time trader also expects that there is limit to upward movement and short call is not likely to get exercised.	The trader is bearish on the market, so they sell a short call to earn a premium. They believe the market will decline, meaning the option won't be exercised. However, there's a risk if the market goes up, resulting in a loss for the short call. To counter this, the trader buys a long call at a higher strike price. If the stock sees a significant upside, the loss from the short call will be offset by the long call at the higher strike price.
EXAMPLE	Long call at strike price 100 by paying premium $5 Short call at strike price 130 by collecting premium $3 Hence overall cost of strategy is reduced to $2.	Short call at strike price 100 by collecting premium $5. Long call at strike price 130 by paying premium $3. Hence the net premium collected by trader in this strategy is $2.



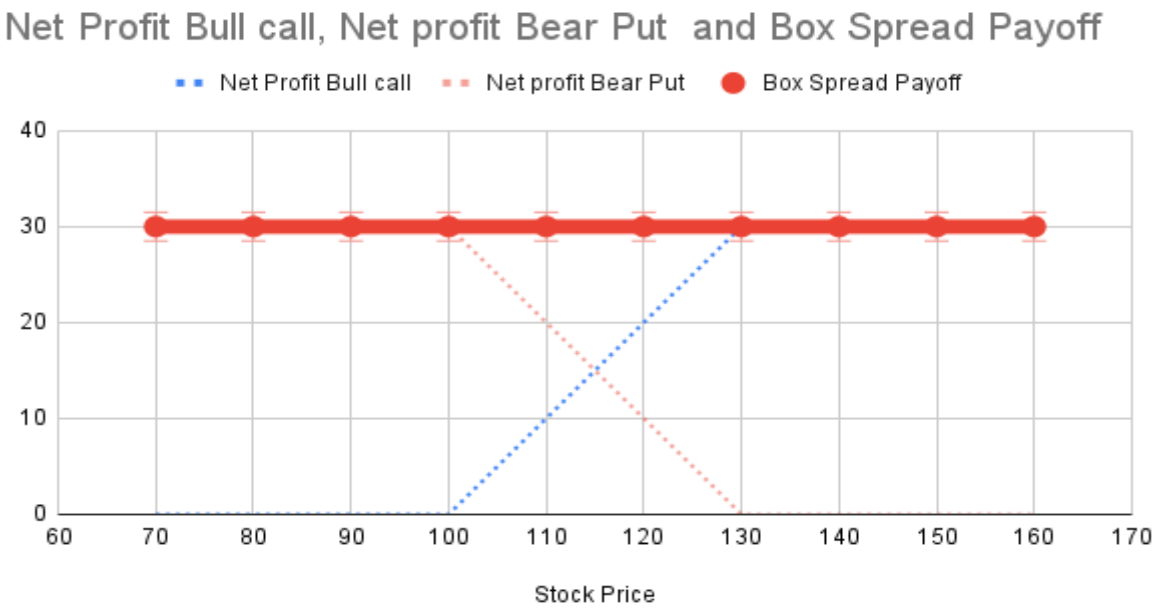


Bull and bear spreads can also be constructed using put options.

- Bull put spread: Short put at higher strike price + Long put at lower strike price.
- Bear Put spread: Long put at higher strike price + Short put at lower strike price.

14.3.b Box Spread

This is the combination of bull call spread, and bear put spread strategy with same strike prices (Lower and upper) and time to maturity. Box spread produces the payoff which is equal to Upper strike price (UX) – Lower strike (LX) price. Because of this certainty in payoff, the cost of setting up this strategy is PV of (UX – LX). If the price of the strategy is less than this value, then arbitrage exists, and opportunity can be exploited by taking long position in box spread. Please note that only European options can be used to construct a box spread and not American option.



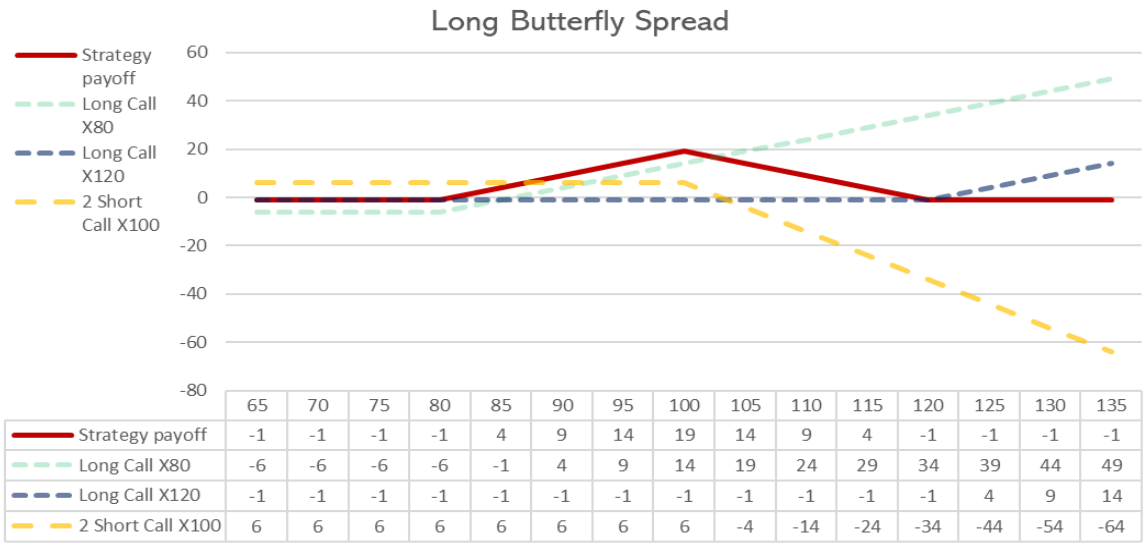
14.3.c Butterfly spreads

Butterfly spread is named because of its shape of profit diagram. Butterfly spread can be long butterfly and short butterfly. GARP covered only long butterfly in the curriculum hence we will also focus on long butterfly strategy only.

Composition: Long Call at lower strike price (say $80) + Long call at higher strike price (say $120) + 2 short calls at middle strike price which is average of high and low strike price ($100 i.e. 120+100/2). At same expiration date.

When to enter this strategy: When the trader expects that the stock price at the expiration will be close to the middle strike price (short call X). i.e. he is **not expecting any large movement** in the stock price and **price will move in the range of upper and lower strike price.**

Profit diagram:



	65	70	75	80	85	90	95	100	105	110	115	120	125	130	135
Strategy payoff	-1	-1	-1	-1	4	9	14	19	14	9	4	-1	-1	-1	-1
Long Call X80	-6	-6	-6	-6	-1	4	9	14	19	24	29	34	39	44	49
Long Call X120	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	4	9	14
2 Short Call X100	6	6	6	6	6	6	6	6	-4	-14	-24	-34	-44	-54	-64

14.3.d Calendar Spread

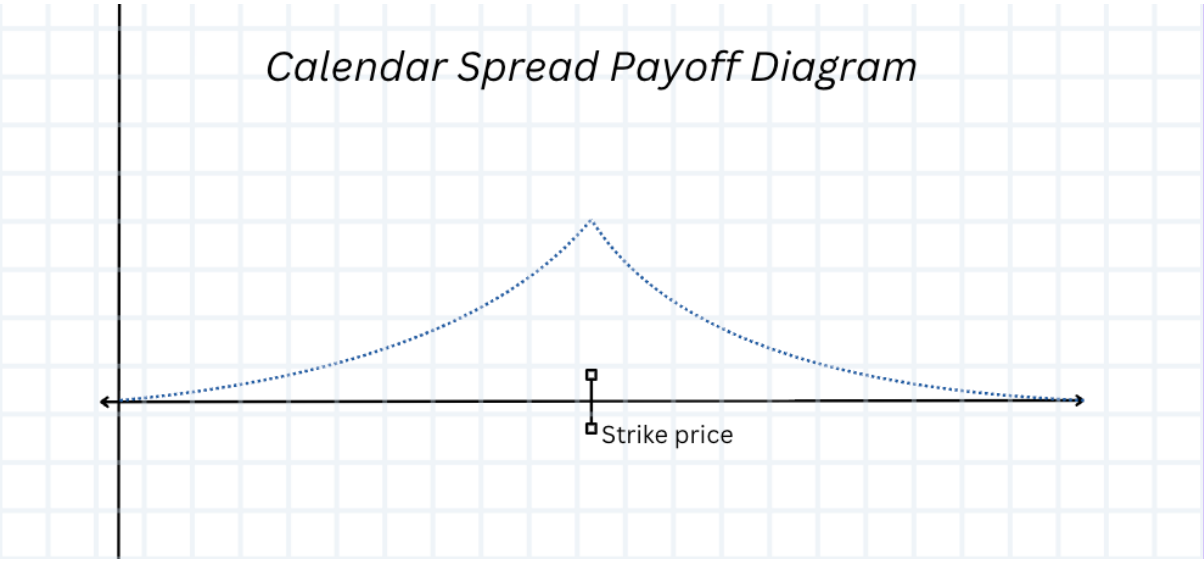
All the strategies we discussed and will be discussed in this reading requires all the options in the strategy expiring at same date. However, in calendar strategy we use **two options** with different expiration dates.

Calendar strategy composition: In this strategy trader takes position in long call with long maturity and short call with short maturity. Both the options have same strike price.

Payoff: The payoff of calendar strategy is like butterfly strategy but produces convex payoff. The reason for convex payoff is when the short duration short call reaches to maturity first, the long call is yet to mature and the value at the time is S-PV (strike price). This discounting effect creates the curve shape. Calendar spread can be created using calls or puts.

When to enter this strategy: Remember the composition of option, payoff is like butterfly but convex, hence the strategy useful when investor expects there won't be a large movement in price.

Payoff Diagram: Source GARP Book



14.4 Combinations strategy

In spread strategy we used either call or put to construct the strategy. Now we will see combination strategy which uses combination of call and puts both.

14.4.a Straddle

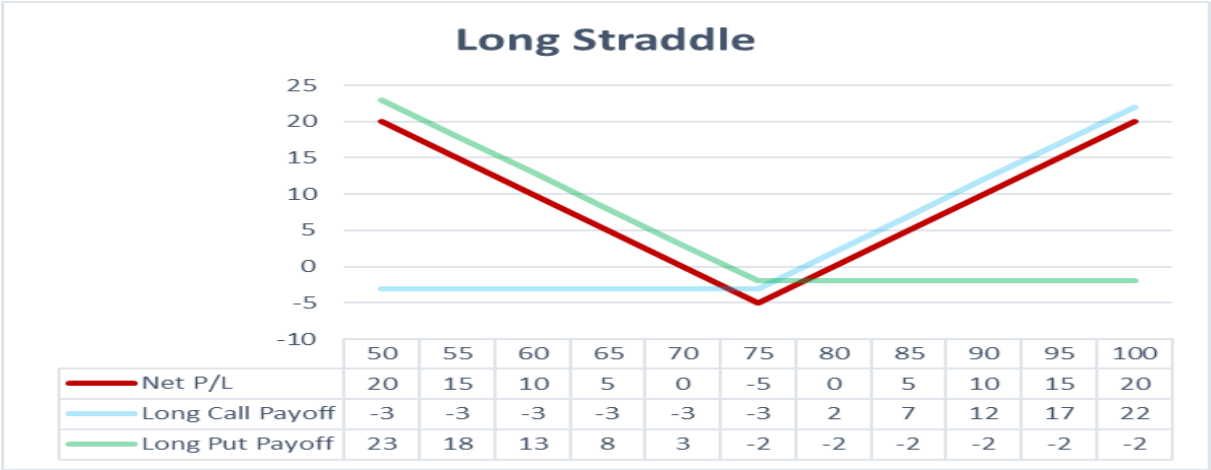
Composition: Long Call and Long Put at same strike price and expiration. Usually strike price is close to current trading price of the underlying. Eg. Long Call option at X = 120 and Long Put at X = 120, time to expiration for both is 3 months. When both the call and put are long positions we call this as long straddle. Similarly, we can also create short straddle by taking short position in call and put.

When to use this strategy: The trader is expecting large movements in market. The movement can be upward or downwards but must be large movement (remember how this differs from butterfly strategy).

Note: *Straddle, strangle, strip, and strap strategies are betting on volatility. If the volatility is high, then the strategy becomes more valuable.*

Position	Long Call	Long Put
Strike Price	75	75
Premium	-3	-2

Payoff diagram:



	50	55	60	65	70	75	80	85	90	95	100
Net P/L	20	15	10	5	0	-5	0	5	10	15	20
Long Call Payoff	-3	-3	-3	-3	-3	-3	2	7	12	17	22
Long Put Payoff	23	18	13	8	3	-2	-2	-2	-2	-2	-2

14.4.b Strangle

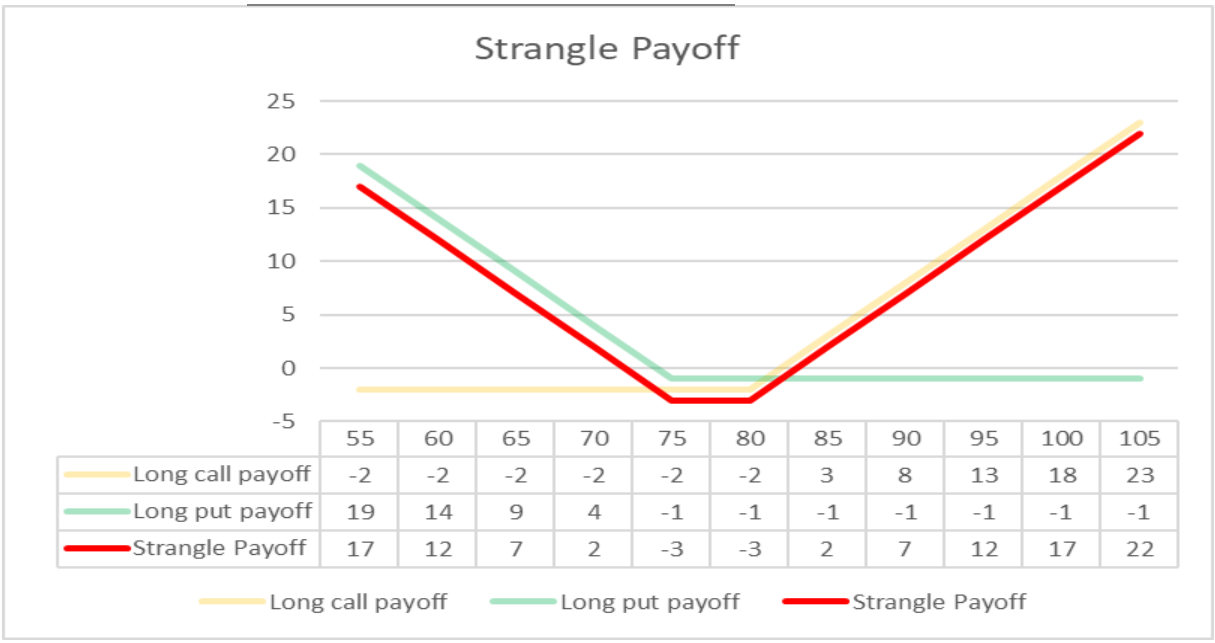
This strategy is same as straddle except the strike price of long call and long put are different.

Composition: Long call at higher strike price (generally higher than current price) and long put at lower strike price (generally lower than current price). **The reason to keep strike prices at different points is it reduces the overall cost of strategy** (Imp statement for exam). For exam purpose remember, strangle is cheaper strategy compared to strangle.

When to use this strategy: This reasoning is same as straddle. The only differentiating point here is, due to gap in strike prices price movement should be more to generate profits. Check the following diagram.

Payoff Diagram:

Position	Long Call	Long Put
Strike Price	80	75
Premium	-2	-1



	55	60	65	70	75	80	85	90	95	100	105
Long call payoff	-2	-2	-2	-2	-2	-2	3	8	13	18	23
Long put payoff	19	14	9	4	-1	-1	-1	-1	-1	-1	-1
Strangle Payoff	17	12	7	2	-3	-3	2	7	12	17	22

14.4.c Strip and Strap

Strip and strap both are almost same as straddle. The reasoning of taking strip and strap strategies are same to straddle. Following is the differentiating factors of strip and strap.

Composition:

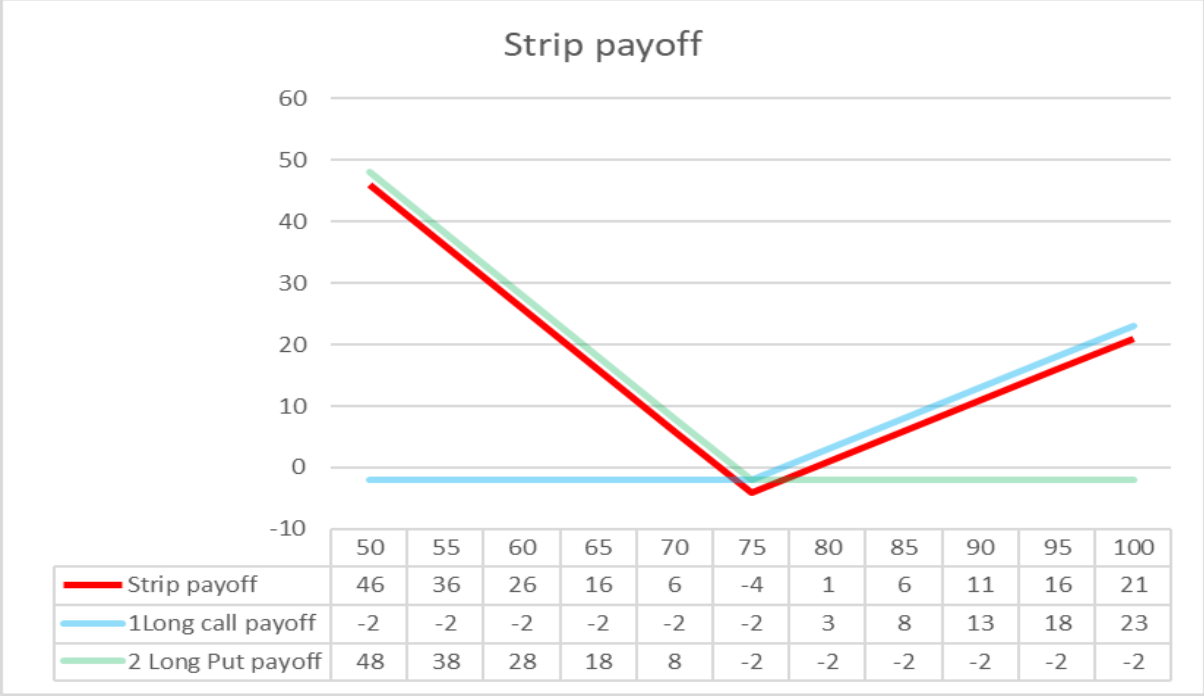
Strip: Two put and one long call at same expiration and strike price.

Strap: One put and two long call at same expiration and strike price**.**

Reasoning: Like straddle in strip, the trader anticipates significant market movement, with a bias towards downward movement, so they use two puts instead of one. Conversely, in strap, they expect substantial movement favoring upward direction, so they employ two calls instead of one.

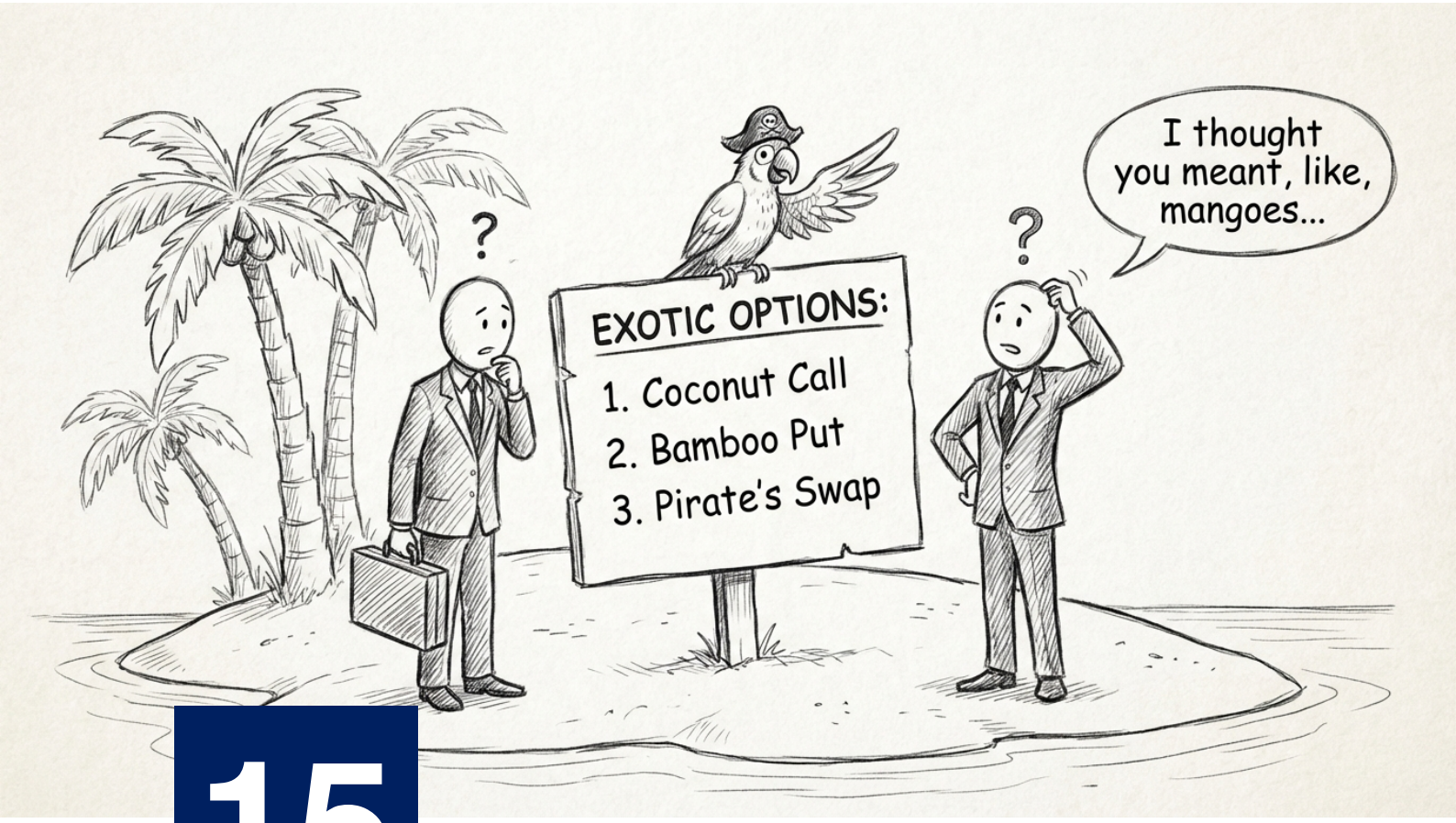
Payoff Diagram: Diagram looks same as straddle, but slop of downward gain is steep in strip and upward gain is steep in strap.

Position	Long Call	2XLong Put
Strike Price	75	75
Premium	-2	-1



	50	55	60	65	70	75	80	85	90	95	100
Strip payoff	46	36	26	16	6	-4	1	6	11	16	21
1Long call payoff	-2	-2	-2	-2	-2	-2	3	8	13	18	23
2 Long Put payoff	48	38	28	18	8	-2	-2	-2	-2	-2	-2

15 Exotic Options



15 Exotic Options

LEARNING OBJECTIVES

This chapter distinguishes exotic derivatives from plain vanilla derivatives and explains the factors driving the innovation of exotic products. It discusses how derivatives can be structured as zero-cost products and how standard American options can be modified into nonstandard forms. The chapter analyzes the features and payoff structures of key exotic options, including gap, forward start, compound, chooser, barrier, binary, lookback, Asian, exchange, and basket options. It also contrasts volatility and variance swaps and explains the principle of static option replication and its application in hedging exotic options.

15.1 Introduction

In the previous discussions we discussed plain vanilla options(European and American options) which are highly liquid options traded on the exchange. In this reading we will discuss exotic options which are customized form of options traded in the OTC market. Exotic options works on the same principles of plain vanilla options with customizations in one of the following features of option

- Strike price
- Expiration date
- Spot price at the maturity

These customizations can take any form based on traders' requirements. However, there are some well-known customizations to convert plain vanilla into exotic products. In this reading we will discuss these exotic options which are with well-known in the market. One can also say that these customizations in options are standardized.

15.1.a Benefits of exotic options

Following are the benefits of exotic options.

- Offers more efficient hedging than the plain vanilla option.
- Ability to limit the exposure or increase exposure to specific factors.
- Can also be used for tax or regulatory purposes.

15.1.b Packages

In the previous reading we discussed option strategy. We can think of it as a package of plain vanilla option which offers unique features which was not present in the single option. These packages are sometimes referred as exotic options.

15.1.c Zero cost products

Zero cost derivative products does not require upfront payment of premium to enter into position. The premium is to be paid at the maturity which makes the product a zero cost product. Because the premium is paid at the maturity it must be adjusted for the interest rate (same as futures contract).

Example: Consider a European call option converted into zero-cost product. Because premium is paid at the maturity, the value of premium paid at maturity = $C\ (1 + r)^t$, where C is premium on call.

Hence the payoff on zero cost call = $\max (St - X - C(1+r)^t, - C(1+r)^t$

Unlike the plain vanilla option which generates either positive payoff or no payoff for long option holder, zero cost product generates either positive or negative payoff. (Must remember of exam)

Future style option: Future style options are Future contract on the options payoff. In this contract the underlying is the payoff of the option. Futures style options are traded on the CME Group and Eurex.

15.2 Exotic variation of American Option

American options are exchange traded options that can be exercised at any time before they expire. There are some exotic variations of the American option that have restrictions on the early exercise, for example.

1. The option may have an initial lock out period in which it cannot be exercised. For instance, Employee stock option in which the option can only be exercised in the vesting period.
2. The option may have specific dates when it can be exercised. One such variation is Interest rate Bermudan option in which the option can be early exercised but only on interest rate reset dates.

Or the option may have a changing strike price. The option can be exercised early but the strike price may increase or decrease over time.
Valuation: In Book 4, we will learn about Binomial option pricing and BSM option pricing. The Binomial option pricing method can be used to value American options. The same method can be modified to account for the non-standardization in American option. For example, exotic American options can be valued using Binomial method.

15.3 Exotic European options

15.3.a Forward Start Option

Options which begin at a future time. Employee stock options are forward start option. Forward start options are at the money at the time it starts.

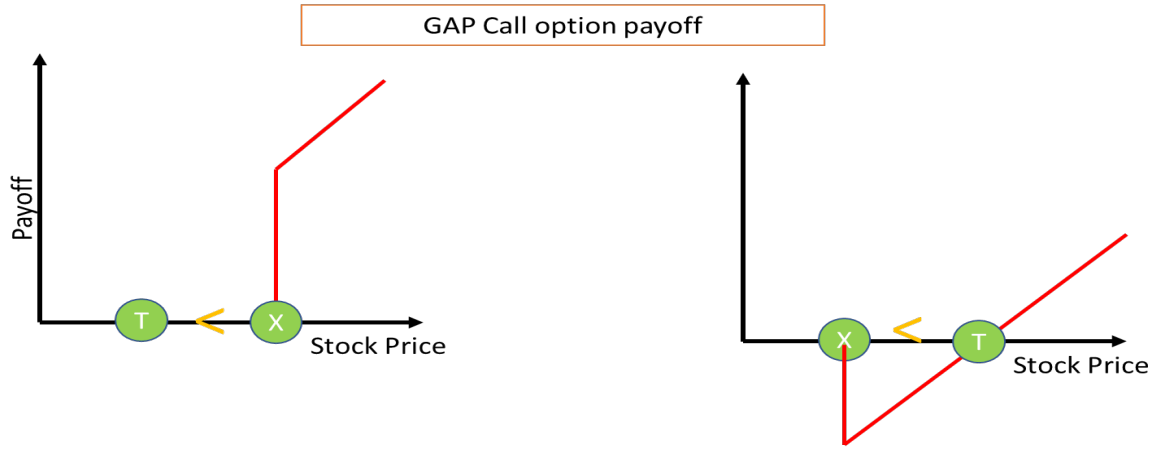
Cliquet Options: There are series of forward start options with rules to determine strike price. Assume a Cliquet option with two options one starting at the end of one year and another starting the end of two year and both the options are with one year maturity. The strike price rule can be, the strike price of option is equal to underlying price at the start of the option, so that the option is always at the money at the start of option.

15.3.b GAP Option

Gap option can be call or put option. A GAP option has trigger (T) and strike price (X). Apart from this rest of the features are same as plain vanilla option. The value of payoff of this option is the difference of S and X, but the payoff is only made if the trigger is breached. Trigger is breached if underlying price is above trigger in case of call option and underlying is below trigger in case of put option. For example,

- **Call option** with X = 100 and T = 120. At the maturity if
  - S0 is more than X but less than T, say 110 then payoff is not made because S0 < T.
  - S0 is more than T, say 140, Payoff is S-X = 140 – 100 = 40.
- **Put option** with X = 100 and T = 80, at the maturity if
  - S0 is less than X but more than T, Say 90, then payoff is not made because S0>T.
  - S0 is less than T, say 70, then payoff is X – S = 100 – 70 = 30

Please note, in the GAP option, payoff calculation is same as plain vanilla option, but it is made only if the trigger is breached. This creates the unique situation in case of negative payoff for long option holder. This can happen if the trigger is set below strike price in case of call or trigger is set above strike price in case of put. For example,



Call option with X = 500 and T = 400. At the maturity if S0 is at 450, then trigger is breached and payoff will be made. For call, payoff = S – X = 450 – 500 = -50. This is the negative payoff in option for long option holder. If you look carefully, we are not applying max (S-X,0) payoff rule here. For GAP option, the Payoff is S-X for call and X – S for put and we do not apply max() rule here.

GAP option can be compared to insurance contract where insured person has to bear the initial loss even if the loss event is triggered and insurance company will only make payment of claim if the loss is above certain limit.

15.3.c Chooser Option

In chooser option holder of option has the option to choose whether the option is put option or a call option. At the beginning the option is neutral (neither call nor put), and after the certain time is over holder decides if it is call or put option. For example, assume a European call option with two-year maturity, where holder must decide whether it is call or put at the end of one year.

15.3.d Binary Option

Binary option pays the fixed payoff or fixed asset if option is exercised. There are two classes of binary options.

- Cash or nothing (call or put): Fixed amount of payoff is made if option is exercised. For example, assume cash or nothing call option with X = 100 and Payoff = 50. If the S0 at the maturity is above strike price, say 110, then the payoff is 50. Cash or nothing are also referred to as digital options.
- Asset or nothing (call or put): These are same as cash or nothing, but instead of cash, asset is delivered in this class.

Due to the nature of the binary options which provides the discontinuous payoffs, these options may be subjected to manipulation. Assume, a cash or nothing option with X 500 and Payoff = 150. One day before maturity price of the underlying is 490. Option holder might try to influence the price of underlying so that it becomes exercisable.

Cash or nothing options are used in fraudulent activities and are banned in several countries.

15.3.e Asian Option

Asian option provides a payoff which is the arithmetic average of underlying prices during the life of the option. The average price is usually calculated using the end of the day price. Hence the payoff of an Asian option is

- Average price option Call = max (Average S0 – X, 0)

There is another variation of Asian option in which strike price in the payoff is replaced with average of stock price.

- Average strike option call = max(S0 – Average S0, 0)

Asian options are cheaper compared to vanilla options and are better for hedging mainly for forex exposure hedging using Asian currency option.

15.3.f Lookback Option

Lookback option's payoff depends on the maximum or minimum underlying price reached during life of the option. There are four types of lookbacks options

Floating lookback call: (replaces strike price)

Payoff = max (asset price at maturity – minimum price of asset in the life of option, 0)

Floating lookback put option (replaces strike price)

Payoff = max (maximum price of asset in the life of option – asset price at the maturity)

Fixed lookback call option (replaces underlying price)

Payoff = max (maximum price of underlying – X, 0)

Floating lookback put option: (Replaces underlying price)

Payoff = max (X – minimum underlying price, 0)

Lookbacks are more expensive than vanilla because it offers highest payoff due to replacement of maximum or minimum values in payoff calculation.

15.3.g Barrier options

Payoff depends on whether the asset price reaches a particular barrier in the life of option. Please note, there is difference between the GAP and barrier option. In GAP option, the trigger is checked at expiration on the other hand the triggers of barrier are tested during the life of the option. Barrier options are European type of option.

- Down and out: Option ceases to exists if asset price moves down below the barrier level during the life of option.
- Down and in: Option come into existence only if the price moves down below the barrier level during the life of the option.,
- Up and out: Option ceases to exists if asset prices move up above the barrier level during the life of the option.
- Up and in: Option comes into existence if asset price moves up above the barrier level during the life of the option.

Please note, movement of the option should be tested from the inception of the option, hence movement up or down should be from the inception price of the underlying.

When option ceases to exit, it also called as knock out option and where option comes into existence it is also called as the knock in option. Barrier options are less expensive compared to vanilla options.

Exam important note: Options prices increases as the volatility increases which we have studied in properties of option reading and will elaborate more in Book 4 BSM reading. This is not always true for the barrier option. If the knockout option is near to barrier volatility will impact the option price negatively whereas for knock and in option near to barrier volatility will impact the option prices positively.

15.3.h Compound Options

In Chapter 4, "Introduction to Derivatives," we explored the concept of derivatives whose underlying asset can be another derivative, exemplified by compound options. A compound option is essentially an option on another option. The strike price of a compound option is based on the price of the underlying call option, while the underlying option itself acts typically like a standard asset like a stock or currency.

There are four main types of compound options:

1. **Call on call option**: This grants the holder the right to purchase a call option at a predetermined strike price. For example, if the underlying call option has a strike price of $4 and a maturity of 3 months, the holder can exercise this option if the price of the underlying call option exceeds $4 at the end of the specified period.

2. **Call on put option:** Similar to the above, this option allows the holder to buy a put option at the strike price upon maturity. The key difference here is that the underlying asset is a put option rather than a call option.

3. **Put on call option:** In this scenario, the holder has the right to sell a call option at the expiration of the put on call option. For instance, if the strike price of the put option is $5, the holder can exercise the option if the underlying call option's price falls below $5. This ensures that the sale price of the underlying call option is at least equal to the strike price.

4. **Put on put option:** Similar to the put on call option, this option grants the holder the right to sell a put option upon expiration. Once exercised, the option operates like a standard put option until the exercise date.

These compound options offer traders strategic opportunities to manage their positions and hedge against market fluctuations effectively.

Difference between the call on option and put on option

Assuming the option on option is exercised, call on option holder is long position holder of that underlying option and put on option holder becomes the writer/seller of that underlying option.

Compound option provides more leverage than the plain vanilla option. Compared to the plain vanilla option compound options are more sensitive to change in volatility. Compound option can also be valued using the BSM model of option valuation which we will study in Book 4 Valuation and risk models of FRM Part I.

15.3.i Asset Exchange option

The holder of the option gets the right to exchange the asset for one another. Assume the exchange option owned by trader in India on USDINR currently trading at Rs 70. Assume at the maturity, USD becomes more valuation (Rs fallen), trader will exchange the assets i.e. rupees with dollar.

15.3.j Basket Option

Basket option as the name suggest, is the option on basket(Portfolio) of assets. Basket options are appropriate hedging tool where firm is seeking to hedge the portfolio with single trade. This helps in reducing the cost of hedging for the firm. Basket options depend on the correlation between the returns of assets in the portfolio. Higher the correlation lesser the diversification benefit and hence more expensive basket option.

15.4 Exotics on volatility

Exotic option can also be structured which creates the dependence on volatility of the asset instead of price of the asset.

15.4.a Volatility swaps

The payoff of the volatility swaps depend upon the realized volatility and not on the price of underlying. Volatility swap is the forward contract on realized volatility of an underlying asset. A trader swaps the pre specified volatility for the realized volatility at the end of the period. Assuming the A is the notional principle amount in the swap, then the payoff for the provider of fixed volatility is equal to

A X (Realized volatility – Pre specified volatility)

Assume a trader entered S&P volatility swap on to provide the volatility of 5% against the realized volatility at the notional of 1,000,000. If the realized volatility is 8%,

The payoff = 1,000,000 X (0.08-0.05) = 30,000

15.4.b Variance swap

The variance swap is same as volatility swap, except for the rates are variances (which is volatility square) instead of volatility. The payoff then is

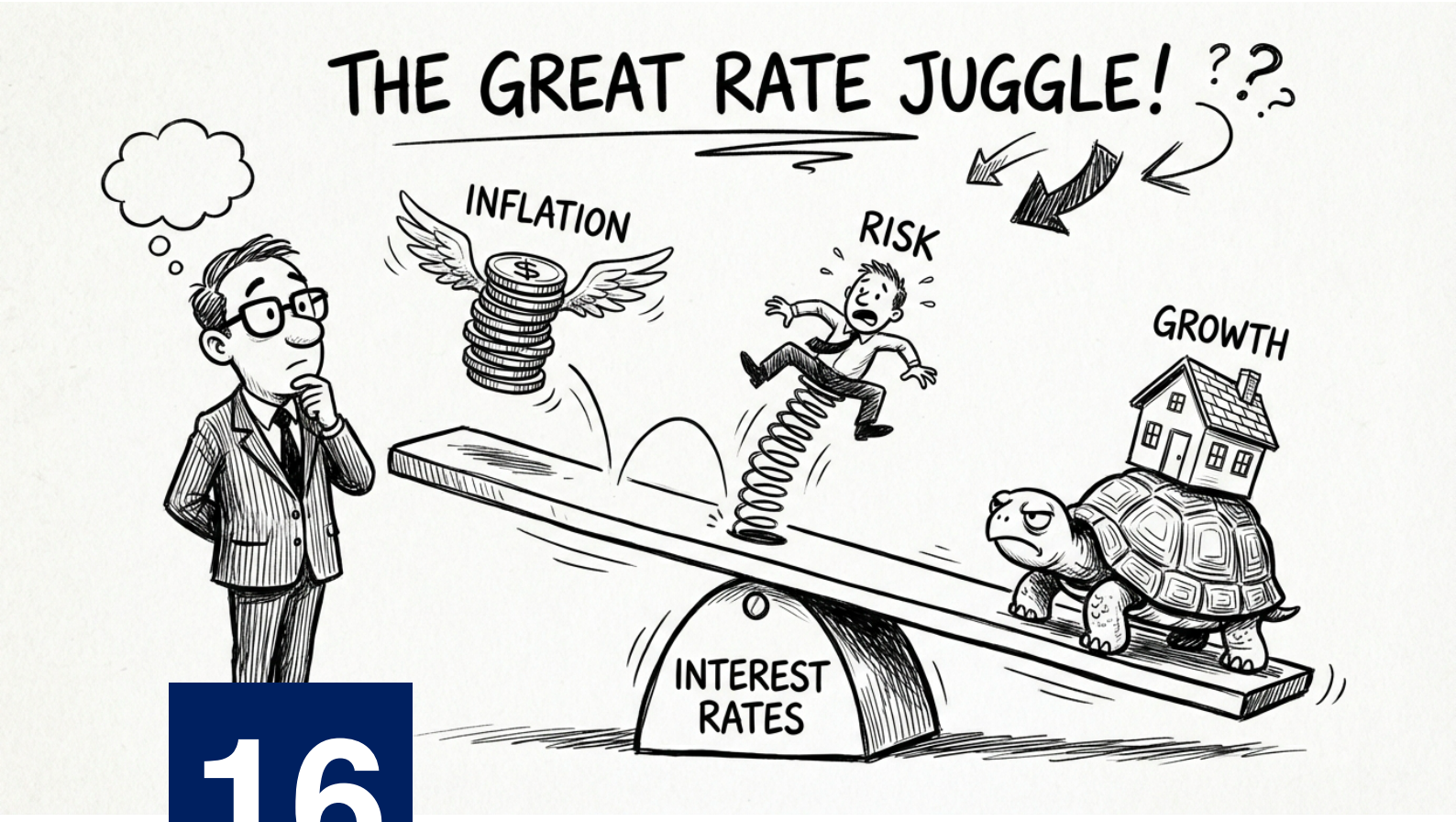
A X (Realized variance – Pre specified Variance).

15.5 Hedging exotic options

Compared to vanilla options, exotics may be easier or difficult to hedge depending on the type of exotic options. The exotics like Asian option are easier to hedge (than vanilla) because of low sensitivity to the asset prices. On the other hand, almost exotics with discontinuous payoff like barrier options are difficult to hedge because the sudden movement of exercisability of the option.

To deal with complicated exotic's hedging, traders developed the procedure called static options replication. The principle is, if the two portfolios are worth the same on some boundary must also be worth the same at all interior points. Hence, if one can find the plain vanilla option which is worth the same as an exotic option on a boundary, the exotic option can be hedged by shorting the portfolio.

16 Properties of Interest Rates



16 Properties of Interest Rate

LEARNING OBJECTIVES

This chapter introduces key interest rates, including Treasury rates, LIBOR, and repo rates, and clarifies the concept of the risk-free rate. It develops time value of money concepts through compounding and rate conversions, and applies spot rates to bond valuation and forward rate derivation. The chapter also values forward rate agreements and analyzes interest rate risk using duration, modified duration, and dollar duration, highlighting the limitations of duration and the role of convexity in improving price sensitivity estimates. Finally, it compares the major theories explaining the term structure of interest rates.

16.1 Compounding and discounting

Future value and present value: Future value and present value is the backbone of the financial markets. When it comes to fixed income securities which is topic of discussion for this section, compounding and discounting is the foundation. Future value is the value of todays money in future generated due to time value of money and present value is the present value of future money.

Assume we invest $100 today at risk free rate of 10% (like bank deposit or treasury bond). The value of money invested today at the some point in future say 1 year is future value of money. To calculate the future value of $100 we can simply

Future value (at the end of 1 year) = Present value + Interest earned

FV(1year) = 100 + (10% X100) = 110

Hence the future value of 100 at the end of 1 year is 110.

If we restructure above formula, we get

FV(1year) = 100 + 10% X 100 = 100 (1 + 10%) = 100 (1+0.10) = 100 X 1.10 = 110

In the above formula 1.10 is the compounding factor which is time value adjustment factor which gives future value of present investment. If we have to find out the future value of todays investment after two years, we can use

FV(2years) = 100 + 10% X 100 + 10% (100+10%X100)

Take a look at the last term, in which we are adding 10% on 100+10% of 100. This is because the assumption is, when we are making investment, the total value of investment at the end of 1 year (100+10%X100) is the investment value and interest is earned for second year is earned on value at the end of 1 year hence interest added for second year is 10% (100 + 10% x 100). If we restructure above formula, then we get

FV (2Year) = 100 + 10% X 100 + 10% X 100 + 10% X 10%X100 = 100 $(1+10\%)^2$ =100 (1.10^2)

We can keep doing this for 3 years , 4 years etc. The formula we use to calculate future value of investment is

FV(n years) = PV $(1+r)^n$

So for future value at the end of 5 years, we can simply use

FV(5 years) = 100 (1+0.10) ^5 = 161.5

In the above formula $(1+r)^n$ is compounding factor assuming the amount is reinvested every year.

Note: Compounding is indicative of growth and hence compounding factor is treated as growth factor.

Present value: As we discussed, present value is the value of future cash flow today. Hence to calculate present value we just need to tweak above formula.

FV = PV $(1+r)^n$

PV = FV X $\frac{1}{(1+r)^n}$

Hence the present value of cash flow of 120 at the end of 2 year can be calculated as

PV = 120 X $\frac{1}{(1+0.10)^2}$ = 120 X 0.8264 = 99.17

In the above equation, $\frac{1}{(1+0.10)^2}$ is the discounting factor which is just reciprocal of compounding factor. The value of discounting factor for 2 years at 10% is 0.82644. Similarly we can calculate, discounting factor for 1 year, 3 year and so on.

16.1.a Compounding and discounting frequencies

In the above illustrations we used risk free rate as 10%. Here we assumed the 10% interest rate is effective annual compounding rate i.e. the interest is earned at the end of every year. If we assume the rate of 10% semi annual compounding, means interest is earned every 6 months at 5% (10%/2) and for 10% quarterly compounding, interest is earned every 3 months at 2.5% (10%/4). In this case 10% / 4 is r/m in formula where m stands for total number of compounding frequency in a year (m = 2 for semi annual, 4 for quarterly and 12 for monthly compounding frequencies). Hence the formula of present value and future value must be tweaked to make this adjustment.

$$Future\ value = Present\ value\ X\ (1 + \frac{r}{m})^{nxm}$$

To calculate future value of 100 at the end of 2 years invested at the interest rate of 10% quarterly compounded.

$$Future\ value = 100\ X\ (1 + \frac{0.10}{4})^{2*4} = 121.84$$

Compounding factor = $(1 + \frac{r}{m})^{nxm}$.

Similarly, we can use the above factor to calculate present value.

To calculate present value of future cash flow of 121.84 received at the end of 2 years,

Present value = Future value X $\frac{1}{(1+\frac{r}{m})^{nxm}}$ = 121.84 x $\frac{1}{(1+\frac{0.10}{4})^{4*2}}$ = 100

Hence discounting factor = $\frac{1}{(1+\frac{r}{m})^{nxm}}$

16.1.b Continuously compounded discounting and compounding

In the previous section, we discussed discounting and compounding factors for frequencies like quarter, month or annual. However, in some cases compounding can be continuous (every moment). In this case we need to take the support of exponential factor e (Euler's number e = 2.7182….).

Formula (when rate is continuously compounded)

Future value = Present value X e^{nr}

Present value = Future Value X $\frac{1}{e^{nXr}}$ = e^{-nXr}

This operation can be done easily with the help of TI BA II Plus calculator.

To calculate the present value of 150 cash flow at the end of 5 years at the rate of 10% continuously compounded, we can

Present value = 150 $e^{-5\ x\ 0.10}$ = 90.97

And Future value of 90.97 at the end of 5 years

Future value = 90.97 x $e^{5\ x\ 0.10}$ = 150

When the rate is continuously compounded,

- Compounding factor = e^{nxr} (note: Value is always more than 1)
- Discounting factor = e^{-nXr} (Note: value is always less than 1 but never negative)

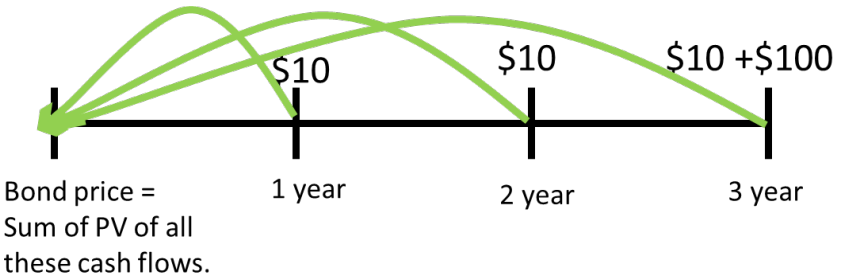
Homework: Fill the following table of compounding (CF) and discounting factors (DF).

TIME (YEARS)	FREQUENCY	RATE	CF	DF
2	12	15%	?	?
1	4	?	1.0824	?
5	2	?	?	0.67556
10	Continuous	5%	?	?
2	Continuous	?	1.105	?
3	Continuous	?	?	0.8352
??	Continuous	9%	1.8776	?

Prof Note: Solving this table will help you gain expertise in discounting and compounding factors. This is one of the core abilities one should have to solve fixed income questions.

16.2 Bond pricing

Bonds are the securities which pays fixed coupon rate at fixed interval and face value at the maturity of the bond, hence this security is fixed income security. Zero coupon does not pay any coupon and only pays the face value at the maturity of the bond.



Assume a Treasury bond with face value of $100, pays 10% coupon annually with 3 years maturity left, to calculate theoretical price of the bond P_0 assuming 5% risk free rate, we use formula.

Note: Treasury bonds are semiannual coupon paying bonds and not annual. We are using annual assumption just to keep calculations simple. When we use treasury bonds which are risk free, the discount rate is risk free rate. If we have bond of any private corporation, then the rate used for discount is Risk free rate + Risk premium.

$$P_0 = C_1 \frac{1}{(1+r)^1} + C_2 \frac{1}{(1+r)^2} + \cdots .. + (C_n + FV) \frac{1}{(1+r)^n}$$

Where, C is coupon value, r is risk free rate, FV is face value/maturity value of bond

$$P_0 = 10 \ \frac{1}{(1+0.05)^1} + 10 \ \frac{1}{(1+0.05)^2} + 110 \frac{1}{(1+0.05)^3} = 113.61$$

Solving this equation will give us the present value of the bond, but that's laborious which we can avoid with the help of TI BA II Plus calculator by using TVM function in calculator.

Steps: Clr > TVM, 100 > FV, 5 > I/Y, 10 > PMT, 3 > N , CPT > PV = 113.61

Hence the value of bond is $113.61. Please note this is theoretical value of the bond and not the market value.

Semiannual rates

In the previous section we discussed Treasury bonds pays semiannual compounding. Assume same Treasury bond with semiannual compounding. To calculate present value of bond we need semiannual risk-free rate,

- Risk free rate (Semiannual) = 5% = 2.5% per period.
- Coupon rate (semiannual) = 10% = 5% per period.
- Time period = 3 years = 6 periods (3 years X 2 Periods per year)

$$P_0 = 5\frac{1}{(1+0.025)^1} + 5\frac{1}{(1+0.025)^2} + 5\frac{1}{(1+0.025)^3} + 5\frac{1}{(1+0.025)^4} + 5\frac{1}{(1+0.025)^5} + 105\frac{1}{(1+0.025)^6}$$

$P_0 = \$113.77$

Using TI BA II Plus calculator,

Step: Clr > TVM , 100 > FV, 2.5 > I/Y , 5 > PMT , 6 > N , CPT > PV = $113.77

Similarly, we can calculate present value of bond, for quarterly coupons by taking

- N = 3 X 4 = 12
- I/Y = 5/4 = 1.25*
- PMT = 10/4 = 2.5

*I/Y can be converted into effective rate of quarter only if the rate which is given is quarterly compounded rate. If rate is given in some other compounding say annual rate or semiannual rate then we need to follow different procedure to convert it into quarterly compounded rate. To learn more about this part please check free calculator course available on falconedufin.com.

Note: In discounting and compounding we assumed interest is reinvested. However, in case of bonds coupons are paid to investors and hence reinvestment is not considered while calculating present value of the bond.

16.2.a Bonds Yield (Short introduction)

Yield is the discount rate applied for discounting of the cash flow. We can also say, yield is the expected return produced by the bond. Yield to maturity is the annual yield produced by the bond during its life. While using calculator we inserted risk free rate of 5% in I/Y, where I/Y is effective periodic yield which is used for discounting of the bonds cash flows.

Illustration:

Bond paying annual coupon at 10% with face value of 100 has 5 years maturity left is currently priced at case 1: $102 , Case 2 : 100 , Case 3: 98. Calculate effective annual yield of the bond for all three cases and interpret it.

Case 1: Clr > TVM, FV = 100, 10 > PMT , 5 > N , 102 > PV, CPT > I/Y = 9.479%

Case 2: Clr > TVM, FV = 100, 10 > PMT , 5 > N , 100 > PV, CPT > I/Y = 10%

Case 3: Clr > TVM, FV = 100, 10 > PMT , 5 > N , 98 > PV, CPT > I/Y = 10.535%

Interpretation:

General observation is as the price of the bond decreasing, yield is increasing. When the bond price is above face value yield is less than coupon rate and when bond price is below face value yield is more than face value and when bond price is exactly equal to face value. This is not mere coincidence. There are two ways to explain this, one is mathematical and other one is conceptual. If you are good with mathematics, you don't need my explanation and if you are not good with mathematics my explanation won't work for you (also not important for exam). Hence, will prefer conceptual explanation.

We know yield of bond is represents return produced on the bond. When bonds price is high which is indicative of high initial investment value for same benefits of coupon and maturity value, yield produced by bond is lower, and when initial investment is low because of lower bond price, it will increase yield of bond because benefits (coupon and face value) are same.

In case 2 we can see price of the bond is equal to face value of the bond. This is because, the coupon paid is 10% and it is discounted at the same rate it creates overall nullifying effect and hence present value and face value is equal. To understand this in layman's language think of coupon as gain and discount rate is reduction in value because gain and reduction is at same rate, face value is equal to present value. Now consider case 2 in which coupon is paid at 10% and discounting applied at 9.47%, hence present value of coupons is higher (due to less discounting) compared to case 2. This increases the present value of the bond. You can also think of it as gain is 10% and reduction is at 9.47% and hence price of the bond is more than face value. In case 3 the bond is trading below face value, because discount rate is more than the coupon rate and hence the present value of the coupon is lesser compared to case 2. Which makes price of the bond below the face value.

Case 2 is the example of bond trading at par, meaning value is same as face value. Bond can trade at par only if the yield and coupon rate are exactly same.

We will discuss yield in detail in Readings from Book 4.

16.3 Spot rate

Spot rate is the discount rate applied for the bonds cash flow discounting. It can be same for all the periods or different for different periods. In the previous discussion, we used yield for discounting which is analogous sport rate (same for all time periods). Spot rate however is derived using different methods. Spot rate corresponds to the yield of zero-coupon bond. Please note, zero coupon bonds do not pay any coupons, hence the yield of the zero-coupon bond is nothing, but the annual rate of discount applied on face value to arrive at price of zero-coupon bond.

Assume 10-year ZCB (zero coupon bond) currently trading at 98. To calculate the yield on zero coupon bond we need to - Clr > TVM , 10 > N, -98 > PV and 100 > FV which gives yield CPT >I/Y = 0.20%.

16.3.a Spot rate term structure

Spot rates are time duration dependent i.e. spot rate for 6 months may be different from the 5 years. This is indicative of the effective annual returns produced on investment for 6 months and 5 years. If we assume 6 months spot rate equal to 5% and 5-years spot rate equal to 8%, in simple

terms it means if you invest funds today for 6 months the effective annual return produced is 5% and if funds are invested for 5 years, then effective annual return produced is 8%. Please give special attention to the word annual which indicates irrespective of time duration of investment returns/yields are quoted in annual terms only event if the investment is made only for one day.

The series of spot rates quoted for different time periods is known as term structure of spot rates. We can calculate these spot rates from the respective zero-coupon bond maturing at specific time duration.

Following table provides the list of zero-coupon bond maturing at different time periods and spot rates derived from respective zero-coupon bond.

Time to Maturity	ZCB Price	Spot Rate
6 months	98.5	3.05%
12 months	97.5	2.55%
18 months	96	2.74%
24 months	95.5	2.32%

To calculate 6 months spot rate using TI BA II Plus calculator, Clr > TVM , 100 > FV , -98.5 > PV, 1>N, CPT > I/Y , which gives the result 1.525% as periodic yield. We have 6 months per period hence semi annual rate is equal to 3.05% (1.525 X 2). In all spot rate calculations, I/Y is for one period only and needs to be multiplied by 2. In case of 24 months spot rate, Clr > TVM , 100 > FV , -95.5 > PV, 4 > N CPT > I/Y = 1.16% per period. Hence semi annual spot rate is equal to 2.32% (1.16 X 2). The rate is semi annual because it is calculated from the period of 6 months. If we have case where period is 1 quarter, then we need to multiply periodic rate by 4 and rate will be called as quarterly rate.

16.3.b Bootstrapping spot rates

Spot rate term structure (spot rate curve) is derived using Treasury bonds. The spot rates are discount rate of ZCB and Treasury Bonds pay coupon, hence we treat Treasury bonds cash flow as series of coupon. Assume a Treasury Bond paying semi annual coupon at 5% and has 1 year time to maturity. We can assume this as package of zero coupon bond by treating 6 months coupon as ZCB with face value of 2.5 and 12 months coupon + face value as ZCB with face value of 102.5 maturing in 12 months.

In bootstrap method spot rates are derived progressively using coupon paying Treasury bonds.

Illustration:

Time To maturity	Coupon annual	Semi	Price	Face Value
Bond A: 6 months	5%		100.5	100
Bond B: 12 months	6%		104.2	100

Solution:

Step 1: First we will use Bond A to derive discount factor for 6 months and then this discount rate will be used in Bond 2 to derive discount factor for 1 year.

Equation A (Bond A): $100.5 = 102.5 \text{ X } (d_{0.5})$

Equation B (Bond B): $104 = 3 \text{ X } (d_{0.5}) + 103 \text{ x } (d_1)$

Where, d0.5 is discount factor of 6 months and d1 is discount factor of 1 year. First we will use equation A to calculate d0.5, then we will use this d0.5 in equation B to calculate d1.

Equation A : d0.5 = 100.5 / 102.5 = 0.9804

Equation B: 104 = 3 X 0.9804 + 103 X (d1)

D1 = 0.9811

Step 2: Converting discount rate into spot rate.

We know discount rate is calculated as $\frac{1}{(1+\frac{r}{m})^{nxm}}$, where m is 2 (semi annual). Hence 6 month spot rate is calculated as

$0.9804 = \frac{1}{(1+\frac{r}{2})^{0.5*2}}$

Hence 6 months spot rate r_{6m} = 4%.

If you want to avoid the trouble of using formula simply follow these steps

1/0.9804 = 1.01999 >(1.01999 – 1) X 2 = 4% (6 months semi annual spot rate)

To get the 1 year spot rate (semi annual)

1/0.9811 = 1.0192 > 1.0191 – 1 > 2% is 1 year annual spot rate

To convert into semi annual rate

0.02 + 1 > 1.02 press Ln > 0.0198 /2 > 0.0099 2nd Ln > (1.0099 -1) X 2 > 0.0199 = 1.99%

Note: In exam always check the if the question requires semi annual or annual compounding. Depending on the question you need to treat the calculated rate.

Assume you got the discounting factor of 1.5 years is equal to 0.8638 in exam and you supposed to answer **Case1:** Annual spot rate, **Case 2:** Semi Annual compounded spot rate. Follow these steps to get

Case 1: Annual Spot Rate

1/0.8638 = 1.15762580 > Ln = 0.14637119 /1.5 = 0.097580 2nd Ln > 1.1025 -1 > 10.25% Annual Rate

Case 2: Semi Annual Spot Rate

1/0.8638 = 1.157625 > ln = 0.146370 / 3 = 0.0487 2nd Ln > 1.0500 – 1 >5% X 2 > 10% Semi Annual Rate

Semi annual and Annual rates are method of quotations. In both the cases above investor will get exactly same return.

16.4 Forward Rate and Forward rate agreement

Assume you need funds for 1 year after 1 year from now. The question is at what rate you will be able to borrow funds at the end of 1 year? The answer to this question is at forward rate which is theoretical rate implied by spot rate in future. Assume current spot rate is 5% for 1 year and 6% for 2 years.

Forward rate (1 year from now for 1 year) = $R_{forward} = \frac{R2T2-R1T1}{T2-T1}$

This formula assumes rate given are effective periodic rates. If the rates are continuously compounded rates then we need, different formula. However, we can still use the above formula in even if the rates are continuously compounded because answer given by above formula is still very close to forward rate calculated using formula for continuously compounded rates. The answer calculated using above formula is slightly higher (negligible) compared to answer given by continuously compounded formula

Where, R1 and R2 is spot rate applicable for short and long duration respectively

T1 and T2 is spot rate time of short and long duration.

$R_{forward} = \frac{6*2-5*1}{2-1} = 7\%$.

Forward rate of 7% implies that the rate of borrowing for one year after one year from now is 7%.

Similarly, assuming R2 = 6%, R1 = 5%, T2 = 1.5 years and T1 = 0.5 years. To calculate forward rate of 1 year 6 months from now, we can calculate it by,

$R_{forward} = \frac{6*1.5-5*0.5}{1.5-0.5} = 6.5\ \%$

16.4.a Forward Rate Agreement

Forward rate agreement is the contract to exchange interest for fixed rate with actual rate. In FRA one party agrees to pay fixed rate against actual rate (time period in forward) on notional value and other party agrees to receive fixed against actual rate.

Illustration:

A company enters an FRA that ensure it will receive a fixed rate of 5% on a principal of $1million for a 3-month period starting in 3 years. The FRA is an exchange where LIBOR is paid and 5% is received for the 3-month period. If 3-month LIBOR proves to be 5.5% for the 3-month period, the cash flow to the company will be (assuming rates are quarterly compounded),

Cash flow = 1,000,000 X (0.050 – 0.055) X 0.25 = - $1250

$1250 is negative cash flow (paid by party) because rate received is 5% and paid is 5.5%.

Deciding the cash flow is positive or negative can be confusing in exam if you try it by mugging up the formula. The simplest approach to decide positive or negative cash flow is to check the rate received and paid by company.

The cash flow of $1250 is at the end of 3.25 years. Because interest rate in FRA is already set at the start of forward rate agreement period, payment settlement can also be done at the beginning i.e. end of 3 years. To calculate cash flow at end of 3 years, we can

Cash flow = $\frac{1250}{(1+\frac{0.055}{4})} = 1233.045$

16.4.b Valuation of FRA

At the inception the value of FRA is zero if the agreed fixed rate R_k is equal to implied forward rate R_f. However, with time reference rate changes which changes the forward rate affecting the value of FRA. The value of the FRA (or any derivative) at a point in time is referred to as mark to market. Valuation of the derivative is done to estimate the gain or loss on the derivative position and for accounting purpose (if needed).

Illustration:

Time T0: Party A needs (borrow) $1,000,000 for 1 year, 6 months from now. Party A is worried about interest rate rise at the end of 6 months. Hence, he decides to enter into FRA with Party B where he will pay fixed rate of forward rate 6.5% implied by spot rate (Check working given below) against reference rate Libor. At time T0 the value of FRA is zero, because FRA is implied and should materialize if spot rates stays the same.

Time	Spot Rate
6 months	5%
12 months	5.5%
18 months	6%
24 months	6.5%

$FRA_{(6X18)} = \frac{6*1.5-5*0.5}{1.5-0.5} = 6.5\%$

Time T2 (2months after T0 i.e. 4 months before settlement date):

Spot rate term structure at time T2.

Time	Spot Rate
4 months	5.5%
10 months	5.8%
16 months	6.5%
22 months	6.7%

$FRA_{(4X16)} = \frac{6.5*1.33-5.5*0.33}{1.33-0.33} = 6.8\%$, Where 1.33 = 16 months / 12 months in year.

Lets assume T3(4 months from now) is the settlement date and T4 is the interest payment date. Please note FRAs are settled at T3 by interest differential payment which is discounted cash flow at paid at T3 of cash flow supposed to be paid at T4 (As discussed in previous section).

Value of FRA= Cash flow at T4 X Discount factor (T4 to T2)

Value of FRA = 1,000,000 (0.068 – 0.065) x (1.33 – 0.33) x $e^{-0.065x1}$

Value of FRA = $2811

To evaluate if the value of FRA is positive or negative, we can use simple logic. Party A agreed to pay fixed at 6.5% and is expected to receive (implied by FRA) 6.8% of interest rate. This means the value of FRA is positive.

16.5 Risk Free rates

In the previous sections we used risk free rate in our calculation. Risk free rate is the rate at which investor can invest without taking any risk of default. Risk free rate is not directly observed in the market. Generally, it is reference rate calculated or reported using various methodologies using different sources. Following are the sources of reference rates (for majority of the reference rates given below we have detailed discussion in FRM Part II, in FRM Part I you are only expected to know the basic concept).

Treasury rates: These are the rates on Treasury bonds which corresponds to borrowing rate of the government. These rates are considered risk free because it is very unlikely that government will default on its own currency.

LIBOR: London interbank offered rate is the at which big size banks are ready to borrow from other bank. Libor rates is not based on actual transaction. It is based on the report submitted by large banks operating in London. Libor is quoted for various currencies and time periods. Due to the size of the bank which are less likely to fail, Libor rate quoted by these banks is considered as risk free. Please note, Libor is just reported rate and banks are not required to trade (lend or borrow) using these rates. This resulted in Libor scandal. Hence Libor was phased out in start of 2022 and replaced by SOFR for dollar currency and SONIA sterling currency.

SOFR: The secured overnight financing rate (SOFR) is overnight (one day), repo rate derived from actual transactions. The calculation methodology is difficult to understand in FRM Part I. We will discuss SOFR in more details in FRM Part II.

- Overnight rate is the rate at which big banks borrow funds from each other in overnight market. This rate is also called as federal fund rate in USA.

Repo rate: Repo is repurchase agreement where party sells securities to another party and agrees to buy these securities at higher rate in future. The first part is borrowing of funds where party transfers the securities in order to borrow funds which is then repaid when borrows buy back his securities. The form of repo is sale and purchase but substance is borrowing and repayment of loan. The difference between the sale price(say $1000) of the securities and repurchase price(say $1025) of the securities is interest paid ($25). Repo transactions are similar to collateralized loan transaction except in repo lender gets complete ownership of the securities whereas for collateral lender is just custodian of the securities. Repo transactions do carry credit risk if the party defaults but this risk is very low.

Criticism of Treasury rate treated as risk free rate

We discussed the Treasury rates are considered as risk free rate but critics says that it is lower compared to risk free rates. This is because the government with the regulations or tax benefits pushes investors to invest into Treasury rates. These considerations allow governments to offer rates lower than the ideal risk free rate.

16.6 Term Structure Theories

In this section we will discuss few theories which tries to answer the question, what moves term structure of interest rates?

Market segmentation theory: This suggests that different sorts of traders are drawn to short, medium, and long-maturity products. While the activities of traders who are only interested in short-maturity investments would affect short-maturity rates, medium- and long-maturity instruments would only attract traders who are interested in those investments. Market segmentation theory may be unrealistic because market participants do not focus on any one segment of interest rate term structure.

Expectations Theory: This suggests that the interest rate term structure reflects market expectations for future interest rates. The term structure of interest rates will be upward-sloping if the market expects interest rates to rise (with long-maturity rates being higher than short-maturity interest rates). The term structure will be downward-sloping if the market expects interest rates to fall (with long-maturity rates being lower than short-maturity rates). According

to expectations theory, advance rates should equal expected future spot rates. If the market expectations theory is to be believed, then interest rates should keep increasing because most of the times the term structure is upward sloping.

Liquidity Preference Theory: Provides the explanations to above criticisms of term structure theories. As per liquidity preference theory says, if the investors have to choose, they will always prefer short term investment over long term investment because short term investment are liquidated early. From the borrowers perspective, borrowing for short term means borrower needs to roll over loan till life of borrowing. If the markets view of the financial stability of borrower declines, it may not be possible for company to roll over short term borrowing at a competitive interest rate.

As a result of liquidity concerns, lenders prefer to lend for short periods of time, whereas borrowers want to borrow for extended periods of time. Financial intermediaries (such as banks) must raise long-term rates relative to market expectations for future short-term rates in order to match borrowers and lenders. As they do so, they should:

- Because short-term rates are more appealing to borrowers, long-term borrowing becomes less appealing.
- Because long-term rates are more appealing to lenders, short-term financing becomes less appealing.

According to liquidity preference theory, the process of matching borrowers and lenders results in long rates that are higher than market expectations.

17 Corporate Bonds

17 Corporate Bonds

TOPIC COVERAGE

This chapter examines bond market structure and trading conventions, explaining yield behaviour and pricing dynamics. It outlines the key provisions of a bond indenture and the role of the corporate trustee. The chapter defines high-yield bonds, describes typical issuers and unique payment features, and distinguishes credit default risk from credit spread risk, including event risk in corporate bonds. It classifies bonds by issuer, maturity, coupon structure, and collateral, and explains mechanisms for early retirement. Finally, it analyses default and recovery rates—distinguishing issue and dollar default rates—and evaluates the components of a bond's expected return.

17.1 Bond's introduction

Bond is the fixed income security sold by an issuer. From issuer's perspective bond is borrowing in the form of securities. Bond issuer agrees to make the coupon payment on the periodic basis and the principle (face value) at the maturity. Few things to note about bond issue price,

- Bond may be issued at premium if issuer is very creditworthy, and coupon paid is more than market rate. Hence investors may be willing to pay more than the face value received at the maturity.
- Bonds may be issued at the discount i.e. by issuing bond below par rate of bond. This is usually done by issuers to make bond issue more lucrative.
- Bonds may be issued at par rate which is the face value of the bond received at the maturity.

For the riskier bonds, bond issuers pay higher coupon compared to normal. This additional coupon rate is risk premium paid to investor. In US coupons are paid every six months however, coupon payment frequency depends on norms followed in respective countries. Face value of the bond in US is USD 1000 but price is quoted in USD 100 of principal. The global bond markets are larger than the global equity markets.

17.1.a Bond Issuance

Bond issue can be private or public issue. In private placement, bonds are issued to few institutional investors and in public issue it is issued to public at large. For the private issues, issuers pay higher coupon rates compared to public issues; however, there are some advantages of private placement.

- Fewer registration and regulatory requirements. In US private placements are not required to register with SEC.
- No requirement of rating agency which is required in case of public issue.
- Issuance cost is lower, can be completed quickly and issue can be relatively small.

In case of public issue investment banks acts as underwriter in which bank first buys issue from issuer and then sells to public at higher rate. The profit for underwriter is the difference of buy and sell price. In case of public issue, credit rating is important. For underwriter, there is risk of interest rate increase and hence bond price decline which might lower profit or generate loss.

17.1.b Bond Trading

Publicly issued bonds are traded in OTC markets. This is different from publicly issued securities which trades in an exchange. OTC market of bonds is the network of bond dealers who quotes bid and ask rates for bonds which makes them market maker. The bond price is decided by demand and supply for a bond. When there is higher demand for a bond than supply, the price of bond increases and yield on the bond decreases.

Bond yield which we will learn in coming discussions in Book 4 is the return of the investors assuming the bond pays the principal and coupon as per the agreement. Bond's yield consists risk free return and credit spread (return earned for risk taken). As the maturity of the bond increases the credit spread of the bond with good credit rating increases. This is because, with the increasing maturity issuers probability of default increases.

The fluctuation in the yield of the bond may increase or decrease the bond price. For a bond dealer, who maintains the bond inventory for trading, may lose money on their inventory if bond price declines.

Some bonds trade only few times in a year and other trade frequently. The bonds yield also compensate for the liquidity risk. As the bonds liquidity decline investors require more yield for liquidity risk. For bonds with high liquidity i.e. trading volume is high for a bond tends to have low bid ask spread. Reverse is true for the bond with low liquidity. The bid ask spread is adjusted for the liquidity risk related to the bond. The Volker rule restricts the extent to which banks can trade in bonds, which might reduce bond liquidity because Volker rule puts the restriction on inventory of the bank which they need for market making.

17.2 Bond indentures

Bond indenture is a legal contract between the bond issuer and bondholder which specifies the important features of the bond. The features include,

- Maturity date of the bond
- Amount and time remaining for coupon payment.
- Callable and convertible features
- Rights of the bond holder in case of any violation.

Bond indenture may also include some covenants for issuer,

- Negative covenants: limit on the issuer's ability to engage in further debt financing, asset sales, dividend payouts and share buybacks.
- Positive covenants: Which requires issuer to produce regular financial statements, carry insurance and use money raised by bond issue for the stated purpose.
- Financial covenants: Which may require the issuer to maintain certain financial ratios.

Bonds issued by highly creditworthy firms generally contain few covenants, while bonds issued by riskier firms contains extensive list of covenants.

17.2.a Corporate Bond Trustee

In case of public bond issues, it is not practical for individual bond holder to review and ensure that the issuer follows the bond indenture. Hence, issuer appoints a corporate bond trustee. This is a financial institution that looks after the interests of the bondholders and ensure that the issuer complies with the bond indentures.

The trustee periodically reports to the bondholders and will act on behalf of the bondholders. Trustees duties are well defined and he is under no obligation to exceed those duties.

17.3 Credit ratings

Rating agencies provide opinions on the credit worthiness of bond issuers. The bonds with AAA ratings or equivalent (from other rating agencies) is considered safest and virtually impossible to default. We will discuss more on rating and structure by various rating agencies in topic on Credit Rating from Book 4 Valuation and Risk Models.

Public bond issuers pay rating agencies to rate their bonds which is conflict of interest, because rating agencies have incentive to provide positive ratings. In practice, rating agencies want to maintain reputation which might suffer in case of biased rating provided to client.

17.4 High Yield bond (Junk bonds)

Bonds rating below certain threshold are considered below investment grade and generally called as High yield bonds, non-investment bonds, speculative grade or junk.

There are several factors which give rise to junk bonds.

- Bonds which are sold by new companies who have promising prospects but not track record might want to sell junk bonds.
- Investment grade bonds may also become junk if the issuers condition deteriorates. These junks are called fallen angels.
- A company with stable cash flow increases its debt burden to benefit shareholders.

Some unique features of junk bond

- A deferred coupon bond: These bonds pay no interest in the for specified period.
- Step up bonds: Coupon increases with time.
- Payment in kind: Issuer has the option of providing the holder with additional bonds in lieu of interest.
- An extendable reset bond: Coupon is reset annually to maintain the price of the bond a some level.
- The issuer may have right to recall the bond from the proceeds of an equity issue.

17.4 Bond Risk

Credit ratings by rating agencies are the measure of default risk of a bond. Rating agencies also provide probability of default for various ratings and probability of default when bond moves from one rating to another. We will discuss this in more details in Book 4. Another risk for bond holders arises from the change in credit spread pricing by market. The credit spread pricing changes in stress periods. The measure of credit spread used by analyst is spread duration. Spread duration is the percentage change in the bond price for 100 bps pints increase in credit spread.

17.4.a Event Risk

Event risk is the risk of major events affecting the bond prices. One such event risk is significant increase in leverage. Firms can increase leverage through leverage buyouts, share buybacks etc. Increase in leverage might deteriorate firms' capital structure. Bond indenture may include a maintenance of net worth clause to ensure healthy capital structure. If firm fails to maintain this clause, it must begin to retire its debt at par until the equity moves above prescribed levels.

17.4.b Defaults

Default on the bond occurs when a bond issuer fails to pay coupon or principal to bondholders. Bondholders in case of default have claim over issuers assets. In the US bankruptcy laws facilitate reorganizations where company gets the time to negotiate with bondholders and other creditors by reorganizing. The reorganization may involve the sale all or part of the business, a reduction in the amount owed on loans and reduction in interest rate charged on the loans.

An important consideration in case of default is the ranking of claimants. Bondholders or creditors are always ranked above equity. However, some category of creditors or bondholders may be ranked above others.

17.5 Classification of Bonds

Corporate bonds can be classified based on

17.5.a Issuer

Issuers can be put into five broad categories:

1. **Utilities**: Examples include electric, gas, water, and communications companies,
2. **Transportation** companies: Examples include airlines, railroads, and trucking companies,
3. **Industrials**: Examples include manufacturing, retailing, mining, and service companies,
4. **Financial institutions:** Examples include banks, insurance companies, brokerage firms, and asset management firms, and
5. **Internationals:** Examples include supranational organizations such as the European Investment Bank, foreign governments, and other non-domestic entities. The bonds that they issue are referred to as Yankee Bonds in the U.S.

17.5.b Maturity

The initial maturity of corporate bonds is at least a year. Commercial paper is an asset class with an original maturity of less than one year. Short-term notes are bonds with maturities of less than five years; medium-term notes are bonds with maturities of five to twelve years; and long-term bonds are bonds with maturities of more than twelve years. There are some circumstances where the bond principal is repaid in full (or in part) before maturity, as will be discussed further.

17.5.c Interest Rates

Bonds can also be categorized by how they structure their interest rates.

The interest rate on fixed-rate bonds remains constant for their entire life. The interest may occasionally be paid in a foreign currency. For instance, foreign organizations occasionally issue bonds denominated in US dollars. Bonds with a coupon equal to a floating reference rate (such as Libor) plus a spread are referred to as floating-rate bonds, floating-rate notes (FRNs), or variable rate bonds.

Consider a bond that pays a coupon every six months with interest equal to the six-month Libor plus 20 basis points to understand how a floating-rate bond might operate. The magnitude of the coupon paid at the conclusion of the six-month period would thus depend on the Libor rate at the start of the period, with the 20-point spread remaining constant. Some bonds with floating rates have maximum, minimum, or both levels specified for their coupons.

A fixed-rate bond and an interest rate swap can be combined to form a floating-rate bond. Bonds with zero coupons give their holders no coupons, as their name suggests. Instead, they offer a reduction from the main sum when selling. In the event of bankruptcy, the holder of a coupon-bearing bond in the United States often has a claim to the principal. A zero-coupon bond, on the other hand, entitles the bearer to the initial purchase price plus any accumulated interest. The ability of zero-coupon bonds to change one form of income into another under specific tax laws is one of their charms. The investor will have essentially changed what would usually be interest income into capital gain income if the USD 200 difference between the price at which the bond in the previous example is bought and the ultimate repayment of its par value is viewed as a capital gain. 15 If capital gains are taxed at a lower rate, this is advantageous.

The absence of reinvestment risk is another benefit of zero-coupon bonds. A coupon-bearing bond, however, requires that the coupons that are received be reinvested. A coupon-bearing bond will perform worse (better) than a zero-coupon bond if interest rates decrease (raise) because investors will be forced to reinvest at a comparatively low (high) interest rate.

17.5.d Collateral

The offered collateral can also be used to classify bonds, which is important if a company doesn't meet its debt payments. As was already noted, a default may lead to reorganization or asset liquidation. In either case, a bondholder with collateral should do better than one without. In the event of a liquidation, bonds with collateral will be paid first from the sale proceeds of the collateral, and in the event of a reorganization, bonds with collateral will have a stronger bargaining position than bonds without collateral.

A mortgage bond offers specific assets, like homes and commercial property, as collateral. In the event of a default, bondholders have the option to sell the assets to cover outstanding debts (although it is usually necessary to get permission of the courts first). The mortgage bond holder typically seeks assurance that future bonding issues won't worsen their predicament. The amount of future asset purchases that can be used as collateral for future bond issuance could thus be limited, as well as future bond issuance itself.

The use of property obtained after the bonds are issued as collateral for the bonds is occasionally mandated by an after-acquired provision. As a result, the collateral cannot be effectively used to support the issuance of additional mortgage bonds.

Bonds that include shares, bonds, or other assets issued by another firm pledged as collateral are known as collateral trust bonds. The other business is typically a division of the issuer. When significant decisions are taken at shareholder meetings, a corporation that has pledged shares of a subsidiary as collateral would prefer to be able to vote the shares. As a result, if there hasn't been a default, the issuer has the ability to vote shares in the subsidiary. The corporate bond trustee, however, casts a vote for the shares if there has been a default.

It should be noted that the corporate bond trustee will act in the best interests of the bondholders, not always the shareholders of the corporation. There are clauses that, if the appraised value of the collateral drops below a specific level, call for the provision of further collateral.

A debt instrument used to fund the acquisition of an asset is called an equipment trust certificate (ETC). (They are frequently used to finance the acquisition of aircraft.) The trustee receives ownership to the property, who then leases it to the borrower for a sum adequate to pay the lenders the promised return. Borrower receives title to the asset following complete repayment of the debt. The fact that the asset is already owned by the trustee gives an ETC to the lender a benefit. Therefore, in the case of a default, no legal action is required to seize the asset. The trustee may simply lease the asset to another business, working in the best interests of the stockholders.

Unsecured bonds known as debentures (i.e., bonds where no collateral has been posted by the issuer). They are likely to have a higher interest rate and rank below mortgage bonds and bonds issued by collateral trusts. The indenture of a debenture bond frequently contains clauses that restrict the extent to which the issuing firm may issue additional debentures in the future. These clauses are necessary because a new debenture issue makes existing debenture holders less secure. A negative pledge clause, which prevents the issuer from using assets as collateral for further bond issues if doing so will make the debenture holder's position weaker, is sometimes included in debentures.

In the case of insolvency, a subordinated debenture has priority over other debentures and general creditors, as its name suggests (which means that other debentures get paid first from available funds). In order to make up for the holders' inferior position in the case of an issuer default, subordinated debentures require a higher rate of interest than unsubordinated debentures.

Sometimes another firm, such as the company's parent, will guarantee a bond issued by one of its subsidiaries. The promised interest and principal should then be given to the bondholder (unless both the issuer and the guarantor default). The relationship between the issuer's and guarantor's financial results determines the value of the guarantee. The guarantee loses value as the correlation goes up.

17.6 Debt Retirement

Bonds are frequently retired with the money from a new bond issuance once they reach their designated maturity date. An issuer would want to replace an older bond issuance with a new one before maturity if interest rates fall during the bond's lifespan. The bond issuer will benefit because its interest payments will be reduced as a result. However, because the early retirement proceeds must be reinvested at a reduced rate, the bondholder really loses out.

Bond covenants may also force an issuer to reissue a bond that has already matured. Bond covenants may become needlessly onerous if the issuer's business changes or its financial situation gets better (even if those covenants were reasonable at the time the bond was issued). Highly restrictive covenants can be removed by paying back bonds early.

17.6.a Call Provision

The bond issuer may occasionally be permitted by the bond indenture to "call" the bond, or purchase it back from the bondholder, at a specific price and at a specific period. The bond indenture's schedule specifically lays out when and how much bonds can be called. The call price is the price at which the issuer must purchase the bond. When a bond is issued, the call price is often higher than par. As the bond gets closer to maturity, the call price drops to par. A bond's initial few years of existence are often not callable; this provides bondholders with some security from the likelihood of early interest rate decreases.

On predetermined terms, some bonds are convertible into equity. Typically, the call feature is included along with the conversion option. It is probably best for bondholders to put off conversion as long as they can if there is no call feature. The issuer often calls the bond as soon as (or shortly after) the price of its equity has increased to the point where it is preferable for a bondholder to convert the bond rather than sell it back to the issuer (so that bonds become equity and fresh debt can be raised).

A make-whole call provision is created when the call fee is calculated rather than predetermined. The call price is frequently calculated as the present value of the remaining interest and principal payments to the bondholder. The discount rate is frequently the risk-free rate plus a preset margin.

In a sinking fund arrangement, periodic bond retirements before to maturity are agreed upon. The bond trustee may receive payments from the issuer in order for the trustee to retire the bonds (usually at par value). A different option is for the issuer to purchase bonds on the open market and hand them over to the trustee. When bonds are selling below par, the latter is probably more appealing to the issuer. The issuer may retire more bonds than what is allowed by the sinking fund's acceleration provisions.

Sinking fund obligations may occasionally be achieved by acquiring additional assets held as collateral rather than retiring bonds. Typically, the property added is worth more than the required collateral, which strengthens the security behind the debt. Utilizing maintenance and replacement funds is an alternative strategy that calls for the issuer to keep the value of the collateral up through property expansions. If no property improvements are performed, debt can be paid off using cash. While adding property to satisfy sinking fund requirements will typically increase the collateral supporting the associated loan, maintenance and replacement funds are typically intended to preserve the collateral's value.

Occasionally, a business will desire to sell assets that were used as collateral. Normally, a corporation can do this in accordance with the bond indenture as long as the money from the sale is used to pay down the bonds. Therefore, selling real estate may be a means to pay off debt earlier.

Bonds can also be redeemed early by the corporation making a tender offer to bondholders as a final option. An offer to buy the bonds is all that a tender offer entails. The offer may be made at a set price or as the discounted present value of a series of future cash flows. The discount rate is the risk-free rate plus a predetermined spread, just like in the case of a make-whole call price.

17.7 Default Rat end Recovery Rate

The two important statistics published by rating companies are the default rate and recovery rate. The default rate for a year can be measured in two ways.

1) $Issuer\ default\ rate = \frac{Number\ of\ bonds\ defaulted\ in\ a\ given\ year}{number\ of\ issues\ outstanding}$
2) $Dollar\ default\ rate = \frac{Total\ par\ value\ of\ bonds\ defaulted\ in\ a\ given\ year}{Total\ par\ value\ outstanding\ of\ all\ bonds}$

Issuer default rate does not consider the size of the default whereas dollar default rate does. When the bond defaults bond holder is able to recover some principal amount. However, it is difficult to track for default rate calculation, hence calculations are made at par value default.

17.8 Expected Return from bond investment

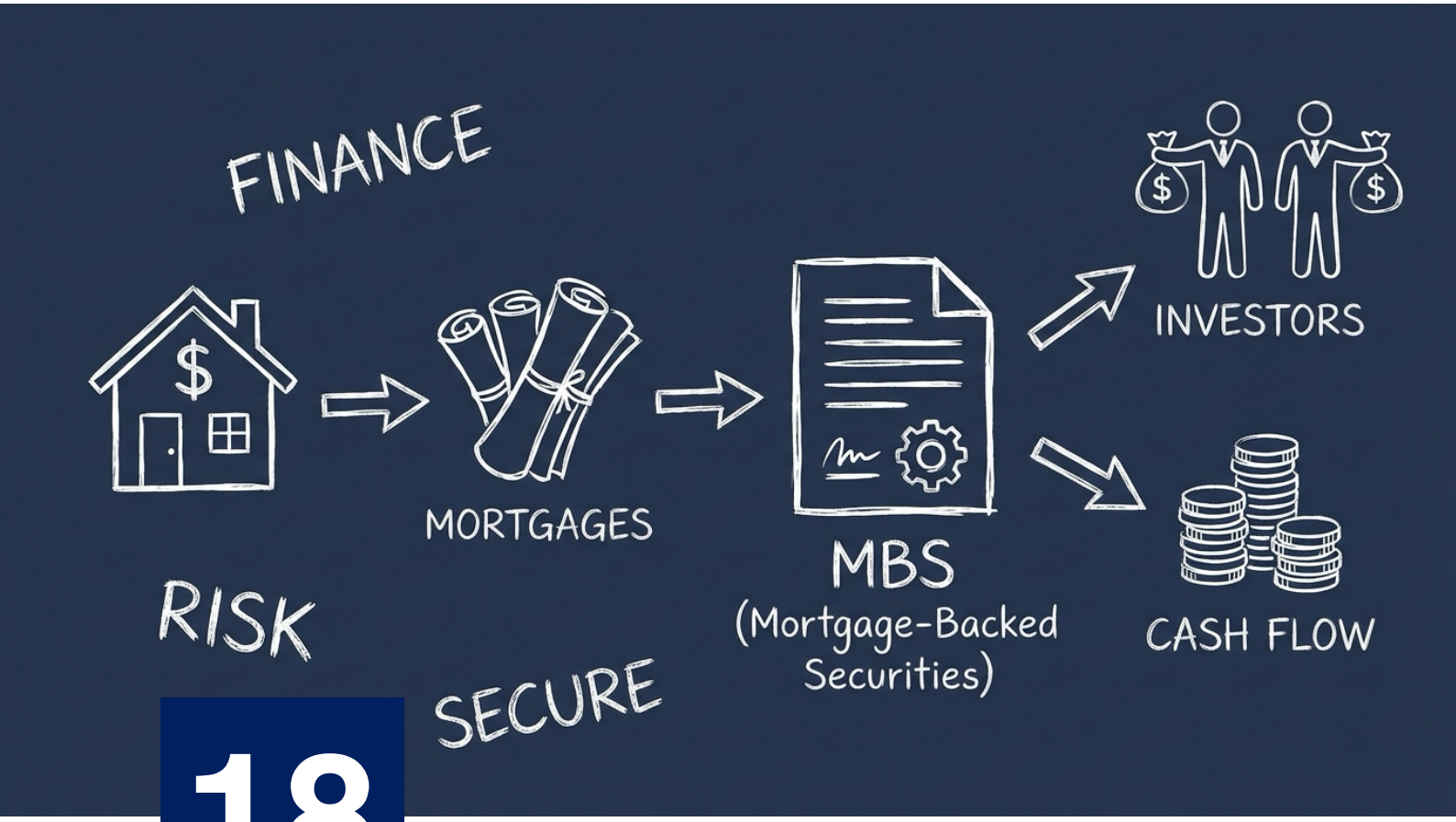
Expected return of the bond is calculated as

Risk free rate + Credit spread – Expected loss rate

Where expected loss rate = Probability of default X Loss rate given default

Expected loss rate is usually lower than the credit spread. It is also observed that, the excess of the spread over the loss rate tends to increase as the credit quality of the issuer decreases.

18 Mortgages and Mortgage-Backed Securities



18 Mortgage-Backed Securities

TOPIC COVERAGE

This chapter examines residential mortgage products and develops the mechanics of mortgage cash flows, including calculation of fixed-rate payments and their principal–interest decomposition. It analyses the embedded prepayment option and the drivers of borrower prepayments. The chapter explains the securitization process of mortgage-backed securities (MBS), including pool formation, TBAs, and trading of pass-through agency MBS. It develops key pool metrics such as weighted average coupon, weighted average maturity, SMM, and CPR, and explains structured agency products such as CMOs, IOs, and POs. It also covers dollar roll transactions and valuation, prepayment modelling components, Monte Carlo valuation of MBS, and the interpretation and limitations of option-adjusted spread (OAS).

18.1 Introduction to Mortgage Backed Securities

In Reading number 1 we discussed about the conventional model of banking, where banks take deposits and provides loans to borrowers. In the same reading we also discussed originate to distribute model in detail. In this reading we will discuss Mortgage-backed securities which is the result of originate to distribute model.

Mortgage: Mortgage is the loan on real estate like house, in which house is collateralized for the loan. In case of default, bank have right to take the ownership of the house and sell it to recover the loan money. In short mortgage is the loan collateralized by real estate. In the traditional banking model, bank provides the mortgage to homeowners. Residential mortgage in the US typically last 15 to 30 years. Mortgage can be fixed rate or adjustable rate.

- Fixed rate mortgage: Interest remains the constant across the life of mortgage. Fixed rate mortgage is risky because borrower can prepay loan if interest rate falls substantially. Generally there is no penalty for prepayment of mortgage which makes the prepayment useful for borrowers.
- Variable or Adjustable rate mortgage: Interest is fixed for some years and for later years it is interest is variable linked with some index like One year treasury rate or LIBOR. ARMs are less risky than fixed rate mortgage for lenders and riskier for borrowers. ARMs are set at lower rate in the beginning compared to fixed rate mortgage.

MBS (mortgage backed securities): In reading 1 we discussed originate to distribute model. MBS are special form of securities in which only mortgages are pooled by SPV to create securities in originate to distribute model. MBS can be in form of pass through securities in which interest and principle is directly transferred to the investors in MBS. Banks provide the guarantee to the investors in case of default in mortgage.

18.2 Loan amortization schedule

Loan amortization for fully amortized mortgage loans is simple concept. In this case, monthly payment is utilized to pay for the interest and principle. In the starting payments interest portion is very high and principle payment is very low, however, with time, monthly payments fully repay the principle and interest.

Illustration:

To keep things simple, we will take 1 year fully amortized mortgage of $100,000 with fixed rate of 12% compounded monthly. To calculate the monthly payment we can take the help of TI BA II plus calculator by following these steps

N= 12, I/y = 1% (12% / 12), PV = -100,000, FV = 0 CPT > PMT

Monthly payment is equal to = 8884.87= 8885 approx.

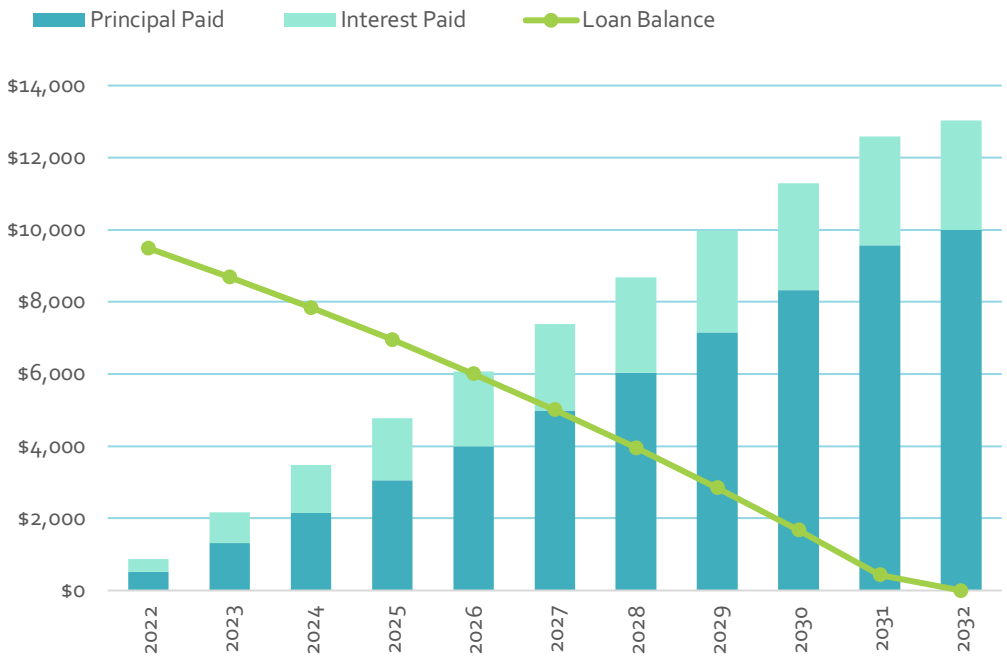
Using this information we can construct the loan amortization table as given below –

(Please note: We are using excel sheet for loan amortization table which is available with all excel packages)

Loan start data is assumed – 1 Jan 2022

1	2/1/2022	$100,000.00	$8,884.88	$7,884.88	$1,000.00	$92,115.12
2	3/1/2022	$92,115.12	$8,884.88	$7,963.73	$921.15	$84,151.39
3	4/1/2022	$84,151.39	$8,884.88	$8,043.36	$841.51	$76,108.03
4	5/1/2022	$76,108.03	$8,884.88	$8,123.80	$761.08	$67,984.23
5	6/1/2022	$67,984.23	$8,884.88	$8,205.04	$679.84	$59,779.19
6	7/1/2022	$59,779.19	$8,884.88	$8,287.09	$597.79	$51,492.11
7	8/1/2022	$51,492.11	$8,884.88	$8,369.96	$514.92	$43,122.15
8	9/1/2022	$43,122.15	$8,884.88	$8,453.66	$431.22	$34,668.49
9	10/1/2022	$34,668.49	$8,884.88	$8,538.19	$346.68	$26,130.30
10	11/1/2022	$26,130.30	$8,884.88	$8,623.58	$261.30	$17,506.72
11	12/1/2022	$17,506.72	$8,884.88	$8,709.81	$175.07	$8,796.91
12	1/1/2023	$8,796.91	$8,884.88	$8,796.91	$87.97	$0.00

We can see in this table, the interest payment keeps decreasing every month because with monthly payments some portion of principle is prepaid. When bank receives monthly payment, first interest is charged to this payment and remaining amount is then considered as interest recovery. Change in interest and principle is provided in the following graph.



18.3 Mortgage prepayment options and factors affecting prepayment

Above table provides the standard payment model by borrower. However, borrower might repay loan earlier than required is known as prepayment of loan. Prepayment happens mainly due to two reasons –

- Borrower might prepay loan because property is sold.
- Property can be refinanced at lower rate.

This creates a risk for lender, because-

- Loss of interest: Interest income is lost on principle prepaid by borrower
- Reinvestment risk: When borrower repays loan due to lower interest rate in the market, this means lender have to reinvest this loan at lower rate which creates reinvestment risk.

The prepayment is accounted for in mortgage rate charged to borrower in advance.

18.4 Mortgage-backed securities and pass-through securities

The mortgage pools are created for investment purpose. The mortgages in a pool are generally similar in terms of loan type, interest rate and origination date. These pools constitute mortgages from different financial institutions to create diversification.

Pass Through Securities: Pass through securities are created from the pool of mortgage in which payment collected from mortgages is transferred to investors after deducting commission. Pool can consist different mortgage hence weighted average coupon rate and weighted average maturity is important statistic for investors.

18.4.a WAC and WAM and other statistics

The WAC (Weighted average coupon) is the weighted average interest rate on the mortgage in the pool. Consider a pool of $5,00,000 mortgage, consists of $200000 mortgage at 5% and $300000 mortgage at 6%.

$$\text{WAC} = \frac{200000}{500000} X\ 5\% \ + \ \frac{300000}{500000} X\ 6\% = 5.6\%$$

The WAM (weighted average maturity) is the weighted average of number of months to mature, based on proportional outstanding. Consider same example as mentioned above with maturity left of 300 months for 5% mortgage and 450 months for 6% mortgage.

$$\text{WAM} = \frac{200000}{500000} X\ 300 \ + \ \frac{300000}{500000} X\ 450 = 390 \text{ months.}$$

Other statistics

In addition to WAC and WAM, investors can also use the following statistics of interest-

1. The average loan balance: $\frac{Total\ outstanding\ loan}{Total\ number\ of\ mortgages}$
2. The pools factor: $\frac{Current\ outstanding}{Original\ pool\ value}$
3. Weighted average FICO score: It works in similar manner as WAC and WAM. Instead of percentage or maturity we use FICO score. FICO score measures the creditworthiness of borrowers ranging from 300 to 850, and more than 650 is considered acceptable.

4. LTV ratio: Is the weighted average loan to value ratio = $\frac{Principle\ amount\ of\ the\ laon}{Assessed\ value\ of\ mortgage\ property}$

18.4.b Conditional Prepayment Rate (CPR) and Single Monthly Mortality Rate (MMR)

Mortgages are always subject to prepayment risk and hence the pass-through securities generated from mortgage pool. Prepayment risk must be taken into consideration while valuing pass through securities.

The single monthly mortality rate SMM is percentage of the outstanding principal that was prepaid (excluding regular principal payments) during a given month. The SMM is annualized into what is known as Conditional Prepayment Rate (CPR).

CPR = $1 - (1 - SMM)^{12}$

Same equation can be restructured to calculate SMM

SMM = $1 - (1 - CPR)^{1/12}$

Assuming the SMM of 5%, it means 5% of the pool outstanding in the beginning of the month is repaid (less scheduled payments).

PSA Benchmarking for prepayment

For the purposes of analysing American MBSs, increasing prepayment rates are assumed for the first 30 months after mortgage origination, and constant prepayment rates are assumed thereafter, according to the Public Securitisation Association Standard Prepayment model (PSA). The annualised prepayment rate in month one is 0.2 percent under the standard model (also known as the 100 percent PSA). It then rises by 0.2 percent every month until it reaches 6% in month 30. After month 30, the percentage stays the same at 6%. These figures are 50 percent higher in the 150 percent PSA model, resulting in an annualised prepayment rate of 0.3 percent in the first month and 9 percent in month 30.

Illustrations:

I18.1 CPR to SMM

Assume CPR of 8% for a mortgage pool. Calculate the Single Monthly Mortality Rate.

SMM = 1 – (1-0.08)^1/12

SMM = 0.00692 =0.007 = 0.7%

I18.2 SMM to CPR

Assume SMM of 0.2% for a mortgage pool. Calculate the Conditional Prepayment Rate.

CPR = 1 – (1-0.002)^12

CPR = 2.37%

I18.3 CPR and SMM with PSA

Assume the CPR for a mortgage pool for specific month is 3%. Calculate SMM in the given cases Case 1: 50 PSA, Case 2: 100 PSA and Case 3: 150 PSA.

Case 1: 50PSA

CPR = 0.5 X 3 = 1.5%

SMM = 1- (1-0.015)^1/12 =

Case 2: 100PSA

CPR = 1 X 3 = 3

SMM = 1-(1-0.015)^1/12 =

Case 3: 150 PSA

CPR = 1.5 X 3 = 4.5

SMM = 1-(1-0.045)^1/12 =

I18.4 PSA only question

Assume 150 PSA prepayment speed for mortgage pool. Calculate the CPR and SMM in the month 10.

The CPR in month 10 = 0.2% * 10 months = 2%

CPR at 150 PSA = 2% x 1.5 = 3%

SMM = 1-(1-0.03)^1/12 =

I18.5 Estimated prepayment using SMM CPR

Assume SMM of 0.35% in 10th month for a mortgage pool. Principle outstanding balance at the beginning of 10th Month is $100000 and scheduled principle payment for this month is $100. Calculate the estimated prepayment.

Prepayment = SMM (Outstanding at the start of the month – Schedule principle payment)

Prepayment = 0.0035 (100000-100) = $349.6

18.5 Modelling Prepayment Risk

Calculating the cost of the prepayment option to investors is more complicated than valuing an interest rate option. This is because prepayment behaviour depends on more than just interest rates. There are generally four reasons for prepayments:

Refinancing:

A borrower prepays a mortgage to refinance the underlying property. The most probable cause is a drop in interest rates. A borrower can minimise monthly payments by refinancing in such a situation. But there are other reasons. Decreased rates may be obtained because the borrower's credit rating has improved even while interest rates have not changed. A greater loan can be negotiated if the property value has grown.

Turnover:

These occur when a borrower sells their home. Summer turnover is higher than winter turnover. It is also lower in early time of mortgage's life because homeowners rarely move shortly after taking out a loan.

Curtailment:

Curtailments are prepayments. These arise when loans are old and balances are low. Curtailment prepayments can reach 5% when a mortgage pool's loans are only one or two years old.

Defaults:

If the mortgage is part of an agency pool, the agency pays the defaulted mortgage. Despite agency guarantees, this is viewed as a prepayment and defaults are significant to the computation. During the 2007-2008 crisis, defaults increased prepayments for mortgage pools. Prepayment defaults are predicted using typical FICO scores, LTVs, and historical property price changes.

18.6 Agency MBS

US government setup (directly or indirectly) three agencies to promote mortgage-backed securities market. These agencies buy mortgages from banks and create mortgage pools for securitization. These agencies perform useful function because agencies keep banks always funded and hence banks can provide loans to new home buyers. Following table summarizes the key feature of these agencies-

	GNMA	FNMA	FHLMC
Full form	Government National Mortgage Association	Federal National Mortgage Association	Federal Home Loan Mortgage corporation
Govt Support	Government Agency	Private company but support by Govt is implied (not explicit)	Private company but support by Govt implied

These agencies guarantee mortgages to investors for fees. This provides investors protection from default in mortgage. But agencies does not offer any guarantee against the prepayment risk. The simplest MBS are pass throughs in which payments from the borrowers are transferred to investors.

18.6.a Trading of Pass Through and TBAs

Issuer decides the specifications of Pass throughs like coupons and maturity. Pass throughs are subject to prepayment risks. Prepayment depends on factors such as interest rates and value of asset mortgaged.

Pass through agency securities trade as specified pools or to be announced (TBAs). Specified pools market in where certain amount of specified pool is traded at certain price. TBA on the other hand is a forward market. Similar to forwards market, in TBA buyer and seller agree to certain terms like issuer, maturity, coupon etc. In TBA seller enters into contract with buyer to deliver mortgages with pre decided specifications. Like bonds futures, TBA seller gets cheapest to deliver option.

18.6.b Dollar Roll

A trade known as a *dollar roll* involves selling a TBA for one settlement month and buying a similar TBA for the following settlement month. For example, a trader could sell a USD 50 million 30-year FNMA pool with a 4.5% coupon for Jan settlement and buy a USD 50 million 30-year FNMA pool with a 4.5% coupon for Feb settlement.

Dollar roll trade is similar to Repo trade we discussed in previous reading. We know in repo trade party sells a security and then buys back at the later date. Party entering this trade is mainly borrowing funds and the security sold acts as collateral provided to counterparty. When the transaction is reversed buying similar security its repurchase and it is at slightly higher price

compared to the price at which the security was sold. This difference in price represents the interest rate. Dollar roll is similar but with some differences as follows.

- The securities purchased may not be the same as the securities provided. The party on the other side of the transaction can sell back the same securities, but it may also deliver securities with worse prepayment properties.
- No interest is added to the price at which the securities are repurchased. The dollar roll transaction involves the initiating party losing one month of interest payments from a pool with the specified coupon, while the party on the other side gains one month of interest.

Defining terms:

- A: The price at which the pool is sold during the first month (including accrued interest),
- *B:* The price at which the pool is purchased during the second month (including accrued interest),
- C: The interest earned on the proceeds of the sale for one month, and
- D: The coupon and the principal repayment that would have been received on the pool sold during the first month.

What is termed the value of the roll is thus calculated as:

$A - B + C - D$

Illustration (source GARP)

For example, suppose that a USD 1 million par value of a 4.5% pool is sold for USD 102.50 in March and repurchased for USD 102.00 in April. We suppose that the payment date is the twelfth of the month for both months. This means that the accrued interest is USD 1,500 (= (12/30) X (0.045/12) X 1,000,000) in total for both transactions. It follows that A = USD 1,026,500 and B = USD 1,021,500.

Now assume that the proceeds of the sale in the first month can be invested at 0.1% for the month so that C = USD 1,026.5. In calculating D, we assume that if the pool had been sold, interest and principal payments on the pool during the month of the roll would have amounted to 0.45% of the par value. This means that D = USD 4,500.0.

In this case, the value of the roll (USD) is

1,026,500 - 1,021,500 + 1,026.5 - 4,500 = 1,526.50

18.7 Other agency MBS products

18.7.a CMO – Collateralized Mortgage Obligation

CMOs are securities structured using pass through securities in which cash flows are distributed according to the category of securities called tranche. Tranches have different claims on cash flows of pool. CMO helps investors to take the different risk exposure using the security created from the same pool.

PAC (Planned amortization class) is the type of CMOs. PAC provides the prepayment risk protection with the help of support tranche which is packed with PAC at issue. If the prepayment rate is faster than the set limit, support tranche absorbs excess prepayment and hence PAC receives principles according to schedule.

18.7.b Principal-only and interest only securities

Principal-only strip: Investors of PO receives principal portion from the mortgage pool. In PO security, cashflow streams are low in the beginning and gradually increases with time. POs are extremely sensitive to prepayment rate. PO price increases when interest rate fall.

Interest only strip: Investor of IO receives interest portion from the mortgage pool. IO security cash flow starts big and gets smaller in with the time. Hence IO have shorter effective life than PO.

18.8 Valuation of an MBS Pool

The first step in valuing an MBS pool is to develop a prepayment model. The previous section indicates (in a general way) what the different components of such a model might be. Two variables that future prepayments may depend on are as follows.

- **Level of interest rates**: The burnout phenomenon shows that the complete pattern of interest rates because mortgage origination is relevant to determining prepayments in a given month.
- **Housing prices:** The history of housing prices since the mortgage origination may also be relevant. Sharp increases in housing prices may lead mortgage holders to refinance (i.e., use cash-out refinancing). Sharp decreases in housing prices may lead to defaults. Both are liable to increase prepayments.

It is necessary to develop models describing the uncertain future behaviour of these variables in order to calculate future prepayment behaviour.

In addition, there are several relevant parameters describing the mortgage pool. The following are examples.

- The prepayment rate tends to increase as the average loan size increases.
- The geographical distribution of the loans may affect the model used to project housing prices and expected turnover.
- Average FICO scores and average LTVs affect default predictions.
- Average loan age affects curtailment estimates.

18.8.a Monte Carlo Simulation for MBS valuation

Once a prepayment model has been specified, a technique known as Monte Carlo simulation is used to value an MBS. This involves the following steps.

1. Randomly sample from probability distributions to determine a hypothetical month-by-month path for risk-free interest rates and housing prices. The interest rate path will be accompanied by estimates of the spread of the mortgage rate over the risk-free rate. The housing price path may depend on interest rates and will reflect the geographical distribution of the mortgage holders.

2. For each month, determine prepayment rates using the specified prepayment model, the path for interest rates, and housing prices up to that month, as well as relevant parameters describing the mortgage pool.

3. Use the prepayment rates to calculate month-by-month cash flows from the MBS.

4. Starting at the end of the life of the MBS, discount cash flows month-by-month back to today. The discount rate for a month is the risk-free interest rate sampled for that month.

5. Repeat steps 1 to 4 many times.

6. Calculate the value of the MBS pool as the average of the calculated present values.

18.9 Option adjusted spread

The option-adjusted spread (OAS) is the excess of a fixed-income instrument's expected return over the risk-free return, adjusted to account for embedded options. The return on a mortgage-backed security is modified for prepayment alternatives as follows.

OAS = Expected MBS Return - Return on Treasury Instruments

We have outlined a procedure involving Monte Carlo simulation for determining the value of an MBS. This procedure can be adjusted to determine the OAS provided by the MBS. The procedure is as follows.

1. Make an initial estimate of the OAS.
2. Carry out a Monte Carlo Simulation as described in the previous section but using discount rates equal to the Treasury rate plus the current estimate of the OAS.
3. Compare the price obtained with the market price. If the market price is higher than the simulated price, the OAS estimate is reduced. If the market price is lower than the simulated price, the OAS estimate is increased.
4. Continue changing the OAS estimate until the simulated price equals the market price.

A workable algorithm can be created using the successive bisection method. Initial high and low OAS estimates are created first. This can be accomplished by lowering OAS until the simulated price exceeds the market price, then increasing OAS until the simulated price falls below the market price. The simulation then uses the average of the high and low costs. It becomes the new high OAS if it proves to be excessively high. It becomes the new low OAS if it proves to be too low. The technique is then carried out once more. On each repetition, the ranges between the high and low OAS are halved.

Assume that the pool in the previous example sells for USD 98.00. The OAS is therefore the spread that must be added to the discount rates to give a present value of USD 98,000 per USD 100,000 of par value. This turns out to be 24.67 basis points. If we discount at 5.7467% and 1.7467% (instead of 5.5% and 1.5%) in these two scenarios (respectively), the value of the pool changes from USD 99.12 to USD 98.00.

The OAS method can be used to determine the relative value of multiple MBS pools. An MBS with an OAS of 80 basis points (i.e., a return of 0.8 percent above the Treasury rate) should, for example, be a better investment than one with an OAS of 40 basis points (i.e., with a return of 40 basis points over the Treasury rate). Of course, the amount of OAS calculated is dependent on how well the underlying model compensates for prepayments. The results cannot be trusted if the model is wrong or has not been calibrated adequately. When an analyst discovers a pool with a high OAS, he or she should seek for institutional or technical reasons why it trades differently than the rest of the market. It's possible that the analyst can uncover a flaw in the model that's causing the high OAS. The veracity of that assumption should next be rigorously examined.

The prepayment model's reliance on interest rates is crucial. If an analyst believes the model accurately describes prepayments, hedging the interest rate exposure (at least roughly) to lock in an expected profit should be doable. Treasuries are the most obvious vehicles for hedging interest rate risk. Even if an analyst has a faultless prepayment model based solely on interest rates, there will always be some residual interest rate risk when Treasury instruments are utilised as hedges.

19 Interest Rate Futures

19 Interest Rate Futures

Topic Coverage

This chapter develops fixed income market conventions and futures pricing mechanics. It covers major day-count conventions and their application across markets, pricing of Treasury bills from discount rates, and the distinction between clean and dirty bond prices including accrued interest. The chapter explains Treasury bond futures, including conversion factors, delivery cost, cheapest-to-deliver selection, and theoretical pricing. It analyzes Eurodollar futures pricing, convexity adjustment, and their use in extending the LIBOR zero curve. Finally, it constructs duration-based hedge ratios using interest rate futures and evaluates the limitations of duration-based hedging strategies.

19.1 Basic terms we need to understand this topic

Accrued interest: When we invest funds at given interest rate for say 1 year and interest is to be paid at the end of 1 year. If you consider any time period between investment date and maturity date what is the value of our investment? The answer is funds investment + accrued interest. Accrued interest is the interest earned but not yet received by investor. Assume you invest $1000 at the rate of 10% due to receive at the end of 1 year. Accrued interest at the end of 2 months is

Accrued interest = 1000 X 10% X 60 / 360 = $16.67

Accrued interest of $16.67 is not received by you but earned by investing.

Here, we assumed 30 days in one month and 360 days in a year. The way we count days for accrued interest calculations will be discussed in same chapter in day count conventions section.

Bond price quotations: Price quotations are not straight forward for bonds. For example, T-Bond price is quoted relative to $100 par amount. Bond price quoted as 95-6 is 95. 6/32 = 95.1875. The advantage of 32nd quotation is it allows more price change for example 1/32 = 0.03125 , 2/32 = 0.06250, etc. Quoted price of the bond excludes accrued interest. Hence to buy bond the price paid is quoted price + accrued interest. The corporate bonds on the other hand are quoted 1/8 increments instead of 1/32. We will talk more about this in coming section.

Eurodollar: Eurodollars are the dollars held outside the USA which are not subject to jurisdiction applicable in USA. The word Euro comes from the history. After world war II US provided dollars to Europe under Marshall plan to come out of devastations caused by war. Due to this the large amount of US dollar banknotes were in custody of foreign banks outside the USA. Because the regulations are not applicable, banks can pay more interest on Eurodollar compared to Dollars in USA.

19.2 Day Count conventions

Day count conventions are used to count days for the calculation of accrued interest. The day count depends on the type of securities. Days count may be actual which means actual days in a month are counted for accrued interest calculations. Convention of 360 assumes 360 days in a year irrespective of actual number of days in year. The conventions also assumes 30 days in a month. In united states three commonly used day count conventions are

- 30/360 – US Corporate bonds and municipal bonds
- Actual / Actual – US Treasury bonds
- Actual / 360 – US Money market instruments T-Bills

Assume bond paying semi annual interest at the rate of 5% with $10000 par value. Coupon is due to receive in 1st Jan and 1st July. Current date is 1st March 2022. Calculate the accrued interest rate assuming Bond is

A: Corporate Bond

Accrued interest = 10000 X 2.5% X 60/180 = $83.33

B: US Treasury Bond

Accrued interest = 10000 X 2.5% X 59/181 = $81.49

C: T-Bills

Accrued Interest = 10000 X 2.5% X 59/180 = $81.94

19.3 Clean price and dirty price - Bonds

US Treasury bills and treasury bonds are commonly referred as bonds. Treasury bills are issued with original maturity with 10 years of less and T bonds are issued with the maturity more than 10 years. In the following section we will discuss T bond and T bills one by one.

19.3.a Treasury Bonds: Are issued with maturity more than 10 years.

As we discussed these bonds are issued in dollar as 32nd part of dollar. Bond currently quoted at 102 – 05, the face value of USD 100,000 is equal to 102.15625% X 100,000 = 102156.25.

The quoted price is also known as clean price of the bond. The cash price at which bond can be bought is also known as dirty price and calculated as

Cash price = Clean price + accrued interest.

Assume, T Bond paying semiannual coupon at 3% is currently quoted at 102-05. Last coupon date was 1st of Jan 2022. Cash price of the bond assuming todays date 1st March 2022, is calculated as

Clean price = 102 – 05 = 102.15625

Accrued interest = 1.5 X 59 / 181 = 0.48895

Cash price = 102.15625 + 0.48895 = $102.6452

Cash price is the price paid by trader to buy bond which is 102.6452 in this case.

19.3.b Treasury Bills: Are issued with original maturities of 10 years of less.

Treasury bills are quoted on the discount basis. The discount price quotation is also applicable for some other type of money market instruments. Accrued interest on US Treasury bills calculated using an actual/360 convention. For example, 120-day Treasury bill with face value of USD 100,000 quoted as 4.50. If Q is quoted price and C is the corresponding cash price of USD 100 face value

$$Q = \frac{360}{n}(100 - C)$$

Hence $4.50 = \frac{360}{120}(100 - C)$

Upon solving this equation we get, C = 98.5, which is cash price of the bond paid by investor is 98.5 for the bond quoted at 4.50.

The quoted rate of 4.50 is also semiannual interest rate 4.5% earned by bond holder.

For exam purpose, know how to get quoted price if the cash price is given and cash price if the quoted price is given. GARP might ask question on realized interest rate, which can be calculated as

$Interest\ earned\ \% = \frac{2.25}{(100-2.25)} = 2.30\%$ in 6 months assuming 4.5% annual interest rate.

19.4 Treasury Bonds futures

Treasury bond futures contract are among the most popular long term interest rate futures in CME exchange. Under the Treasury bonds futures, any government bonds maturing between 15 and 25 years to maturity left on the first day of the delivery month can be delivered. Because there is wide range of bonds which can be delivered in settlement, CBOT developed a procedure for adjusting the price received by short.

Quotation of Treasury bond futures

Treasury bond futures are quoted in same manner as Treasury bonds which is 32nd quotation.

19.4.a Cheapest To Deliver Bond

CBOT developed a procedure using conversion factors(CF) for adjusting the price received by short position holder. The cash received for each $100 face value of the bond delivered is

(Most recent settlement price X CF) + Accrued Interest

We will discuss the calculation of conversion factor in next section, first we will see use of conversion factor in deciding cheapest to deliver bond.

Assume a bond with face value of $100,000 with recent settlement price of 96-5. Conversion factor of the bond chosen for delivery is 1.25 and accrued interest at the time of delivery is $5 per $100. The cash price received by short position holder is

(settlement price X CF) + AI = (1.25 X 95.15625) + 5 = 123.945

The chosen bond needs to be purchased, assuming the chosen bond costs $125, the cost of bond purchase is

Quoted price of bond + AI = 125 + 5 = 125

The difference between cash received and cost of bond purchase is delivery cost for short position holder. A short position holder gets multiple options of bonds to choose from, and hence short position holder will always choose bond which is cheapest to delivery,

Cheapest to deliver is the lowest value offered by bond = Cost of purchase – cash received

= *Quoted price of bond + AI - (settlement price X CF) + AI*

= Quoted price of bond – (settlement price X CF)

Illustration: Consider following options of bonds available for delivery in a Treasury bond futures contract settled at $115.

Option	Quoted price of bond	CF	Cost of delivery (quoted price – cash received)
Bond A	98	0.8325	98 – 115X0.8325 = 2.2625
Bond B	117	0.9855	117 – 115 x 0.9855 = 3.66
Bond C	145	1.2330	145 – 115 X 1.2330 = 3.205

Bond A has lowest cost of delivery of $2.2625 among all the options available and hence is the cheapest to deliver bond.

19.4.b Calculation of conversion factor (As per CBOT)

CF is calculated as = $\frac{Quoted\ price\ of\ the\ bond}{100}$

When we use TI BA II Plus calculator for bond price calculation, the value is dirty price and hence accrued interest should be reduced from the dirty price to arrive at clean price.

CF is price of the bond per dollar, hence CF for bond with clean price of $101.55 and $98.50 is 1.0155 and 0.9850 (i.e. clean price / 100).

We already understand the pricing of the bond, however, the bond pricing for conversion factor of Treasury Bond futures is calculated using certain assumptions –

- **Time to Maturity**: Is calculated from the 1st day of the month of delivery (as per bond future) and to maturity of the bond with rounding down as follows-
    - Bond with **maturity more than 10 years – Rounded down to the nearest quarter** (i.e. by 3 months). Example, time to maturity is say 20 years and 8.5 months is rounded down to 20 years and 6 months and time to maturity say 20 years and 5.5 months is rounded down to 20 years and 3 months.
    - Bonds with **less than 10 years maturity – Rounded down to nearest month**. For example, time to maturity is say 5 years and 1.5 months is rounded down to 5 years and 1 month.
- **Yield to Maturity:** Bond price is calculated assuming **6%** yield **with semi annual** compounding.

Illustration 1:

Consider the Treasury bond futures September 2022 contract having 5% coupon rate maturing on May 15th 2037. To calculate CF,

Time to maturity = 1st Sept 2022 to 15th May 2037 is 14 years and 8.5 months which should be rounded down to nearest quarter hence time to maturity is taken as 14 years 6 months.

Bond price(Using TI BA II Plus calc):

N = 29 periods (14 years x 2 + 1 period of 6 months)

I/Y = 3% (6% semi annual rate assumed)

PMT = 2.5

FV = 100

CPT > PV = 90.4057

Hence the dirty price of the bond is 90.4057. The clean price is also same because price is calculated at settlement date.

CF calculation

CF = $\frac{90.4057}{100}$ = 0.904057

Illustration 2:

Consider the Treasury bond futures December 2022 contract having 5% coupon rate maturing on May 15th 2037. To calculate CF,

Time to maturity = 1st December 2022 to 15th May 2037 is 14 years and 5.5 months which should be rounded down to nearest quarter hence time to maturity is taken as 14 years 3 months.

Bond price(Using TI BA II Plus calc):

Note: Because time to maturity is left is 14 years and 3 months which is not in 6 months cycle of bonds coupon, we will first calculate the bond price at 14 years time to maturity and then the price from this calculation is discounted by 3 months.

N = 28 periods (14 years x 2)

I/Y = 3% (6% semi annual rate assumed)

PMT = 2.5

FV = 100

CPT > PV = 90.618

Hence the dirty price of the bond is 90.618 three months from now. However, 3 months from today bond will pay 2.5 coupon which should be added in this price and hence price 3 months from now is $93.12 (90.618 + 2.5). To calculate the present value this price should be discounted by three months. For the sake of simplicity, we will use ¼ X 6% for discounting-

Dirty price of bond = 93.12/1.015 = 91.7538

Hence Clean price of the bond = 91.74 – 1.5 Accrued interest = 90.24

CF calculation

CF = $\frac{0.9024}{100}$ = 0.0.9024

19.4.c General guidelines for selecting cheapest to deliver bond (CTD)

To find the cheapest to deliver bond one can take the support of following guidelines (very important for exam).

- If the bonds yield is > 6%, low coupon longer maturity bonds tends to be CTD
- If the bonds yield is < 6%, high coupon short maturity bond tends to be the CTD.
- In case of upward sloping yield curve long maturity bond tends to be CTD.
- In case of downward sloping yield curve short maturity bond tends to be CTD.

19.4.d Wild card play

Wild card play is done by short position holder in order to reduce the cost of delivery. The settlement price is decided at which the futures contract trades at 2 PM Chicago time. The notice of intention to deliver can be issued at later time in a day. Hence short can wait for a day when bond price decline after 2 PM and therefore reduce the delivery cost. Please note, short can deliver bond on any day of settlement price.

Wild card play and CTD makes the futures contract more attractive to short.

19.5 Treasury bond futures price calculation

Treasury bond futures contract is futures on fixed income security which eases the pricing of which is similar to what we studied in Reading on Futures pricing. We know,

$F_0 = (S_0 - I)X\ (1 + r)^T$,When the rates is effective rate and

$F_0 = (S_0 - I)X\ e^{rT}$ when the rate is continuously compounded.

S_0 in this equation is dirty price of Treasury bond.

Illustration

Consider a Treasury bond paying 6% coupon on semiannual with conversion factor of 1.10 (for CTD). Time to maturity of the futures on this bond has 270 days left. Last coupon date was 60 days ago and next coupon is in 120 days (180 days gap in two coupon date). The next coupon after the immediate coupon (120 days) will be received 180 days after the immediate coupon. The term structure is flat with internet rate of 4% per annum continuously compounded. Assume the currently quoted bond price is $110. To price the Bond futures which has maturity in 270 days, we need to follow steps.

Step 1: Calculate the **dirty price of the Treasury Bond**.

Dirty price / cash price = Quoted price + AI (from the last coupon)

Dirty price / cash price = $110 + $\frac{60}{180}$ X 3(6% semiannual) = $111

Step 2: Cash price of futures contract using $F_0 = (S_0 - I)X\ e^{rT}$

First we need to calculate I i.e. present value of next coupon due 120 days from now.

$I = 3\ e^{-0.04\ X120/360}$ = $2.960

$F_0 = (111 - 2.96)X\ e^{0.04X270/360}$= 111.330

Hence the cash price of the bond futures is $111.330.

Please note, in exam if you get question which requires you to calculate cash price of the Treasury bond futures, you don't need to proceed further. Next part of this illustration is to calculate clean price of the bond futures which is done by adjusting AI and CF.

Step 3: Calculation of **clean price of futures contract**.

First we will remove interest accrued at the time of maturity of futures to get the clean price of the bond. Total number of days from the date of coupon just before maturity to maturity are 150 (i.e. next coupon in 120 days – time left to maturity of contract 270 days)

AI = $\frac{150}{180}$ X 3(6% semi annual) = $2.5

Clean price of bond futures = 111.330 – 2.5 = 108.33

Clean price should be adjusted for conversion factor, hence

Quoted price of the Treasury bond futures = 108.330 / 1.10 = 98.93636 = $99 approx.

Professors note(Important for Exam): Because it is lengthy and cannot be answered in the allotted time, it is highly doubtful that the whole question on the quoted price of Treasury bond

futures will be asked in exam. If you get a full question on this area, it is best to skip it. This part is most likely to be tested in the following manner by GARP (all the above information is given).

- Cash price of bond futures using quoted or dirty price of bond.
- Cash price might be given and you have to calculate quoted price of the bond.
- Clean/ quoted without CF adjustment and you have to calculate the clean price after CF adjustment.

19.6 Eurodollar Futures

As we discussed in the first section of this reading, Eurodollar is the dollar parked outside USA which might offer higher interest rate compared to interest rates on USD in USA. Eurodollar interest rate is the interest rate earned on Eurodollar deposited by one bank with another bank. Eurodollar futures contract is the 3 months futures contract on Eurodollar interest rate traded by the CME Group. Due to the standardization in Eurodollar contract, future price calculation methodology is very unique to this derivative only. The standardizations (for 3 months futures) are,

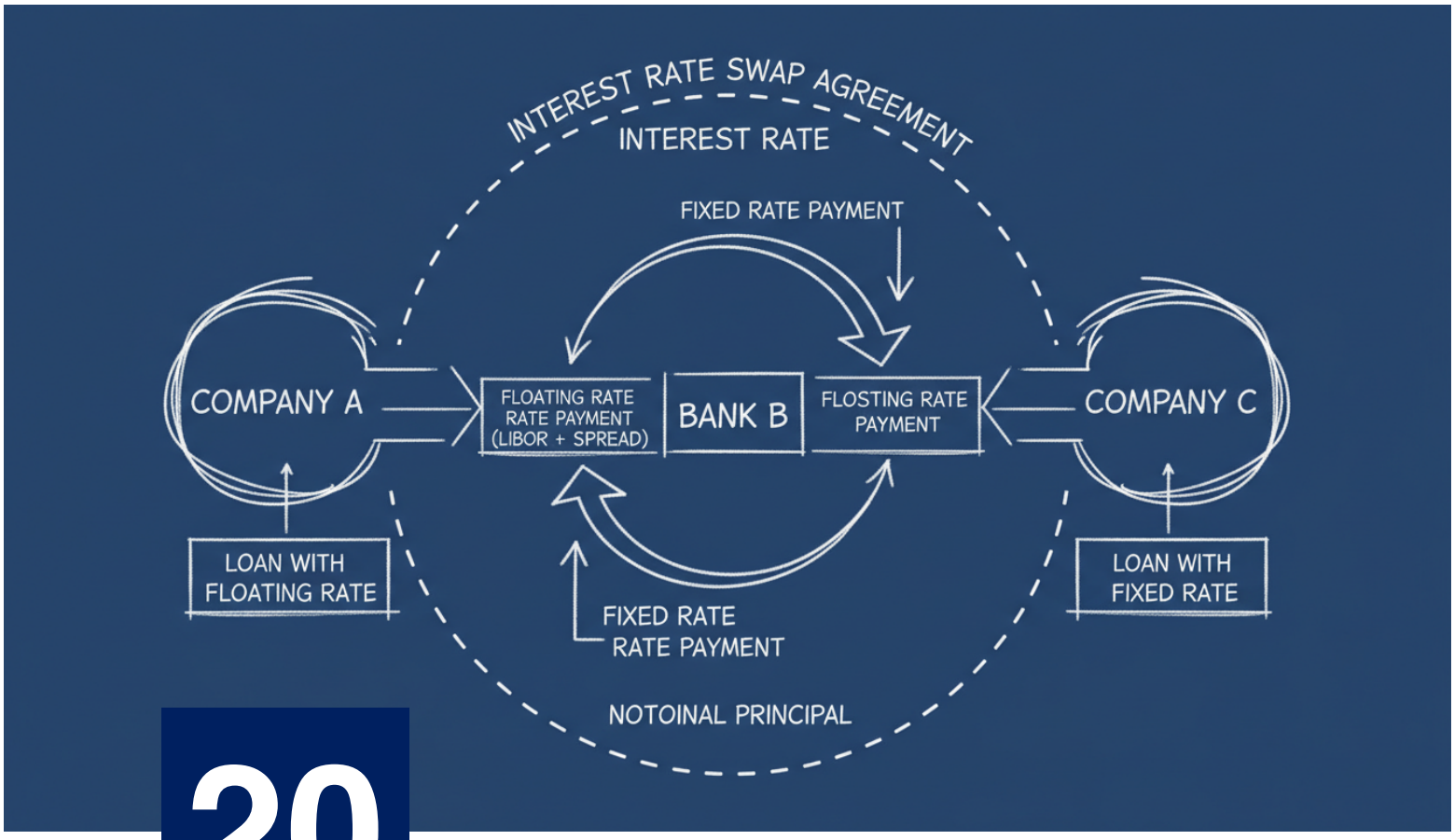
- Notional value of Eurodollar futures is $1,000,000.
- Maturity months are March, June, September, and December.
- The price change is one tick (0.01% or 1 basis point) which results in corresponding gain or loss on contract by $25 per tick. This $25 is the outcome of 0.01% X ¼ X 1,000,000 = 25. Hence for every one basis point increase, long position of one contract gains by $25 and short position of one contract lose by $25.
- The quotation of Eurodollar futures is 100 – futures interest rate.

Illustration:

Consider quoted price Q of the bond is 99.725 for June 2022 contract. Then the contract price is calculated as

10,000 x [100-(0.25 X(100 – Q)] = 10,000 x [100-(0.25 X(100 – 99.725)] = $999,312.5

Professors note: In exam you might see question on gain or loss for long or short party on Eurodollar futures position given the basis point change. To calculate gain or loss simply use Basis points X 25. If the basis points are increasing then for long it is gain and for short it is loss. Reverse is true for basis point decrease.



20 Swaps

TOPIC COVERAGE

This chapter explains the structure and cash flow mechanics of plain vanilla interest rate swaps and currency swaps, and shows how they can be used to transform the nature of assets and liabilities. It discusses the role of financial intermediaries, swap confirmations, and the comparative advantage argument along with its limitations. The chapter develops swap valuation using bond replication and forward rate agreements for interest rate swaps, and bond and forward exchange rate approaches for currency swaps. It also introduces other swap types—such as commodity, volatility, credit default, and exotic swaps—and analyzes the credit risk exposure inherent in swap positions.

20.1 Swaps Introduction

The literal meaning of swap is exchange. In financial markets swap is the transaction where one party agrees to exchange cash flows based on interest rate or currency for another form on interest rate or currency. The value of swap is derived from the underlying asset (which we will discuss in this section) which makes swap contract a derivative. In this reading we will discuss 3 types of swaps

- Currency swaps
- Interest rate swaps
- Credit risk swaps

In the previous readings we discussed forward contracts like FRAs where interest rate is exchanged for fixed with floating. Interest rate Swaps is forward contract similar FRA except in FRA the settlement is one time whereas in swap transaction settlement can happen for multiple periods. In the other words, interest rate swap is series of FRAs.

20.1.a Interest rate swaps

The most common form of interest rate swap is exchange of floating rate (usually LIBOR +) for fixed rate for several periods. This is called as plain vanilla interest rate swap. The floating rate used in the swap is based on some reference rate like Libor + x basis points (E.g. Libor + 50bps) which obviously keeps changing from one period to another. In the following illustration to build the understanding of swap we will assume direct swap transaction between two parties however in real life swaps are made with the help of intermediaries. We will discuss the role of intermediaries in coming section.

Party X agrees to pay Party B a fixed rate of 5% per year on notional principle of USD 1,000,000 for next 5 years in return for Libor rate on same notional. In this case, interest would be exchanged every year. Assume swap starts from today (lets call it T0) and 1 year Libor today is 6%.

Particulars	Computation	Amount$
Payment by Part A to Party B at fixed rate of 5%	5% X 1000000	50,000
Payment by Party B to Party A at 1 year Libor of 6%.	6% X 1000000	60,000
Net payment by Party B to Party A	60,000 – 50,000	10,000

Points to note

- In the above illustration, the word notional principle indicates that the $1000000 is never exchanged between parties. It is used just to calculate interest rate payment by one party to another.
- The cash flow of interest rate is made on the net basis. In the above illustration, we can see party A owes party B $50,000 and party B owes party A $60,000. Instead of both the parties paying cash to each other, it is more sensible to make net payment by party B(who owes more) to party A.
- We know interest rate declared at T0 is applicable for next 1 year (lets call it T1). If the cash settlement is made at T1 then the net payment is $10,000. However, rates are already known at T0 and both the parties know the amount of settlement at T1. Hence parties can also decide to make the settlement at T0 itself, but the payment made by party B to party A would be present value of $10,000 to adjust for the time value.

- Reference rate/ floating rate is observed on every settlement date which is then used to calculate the cashflow for next period. Assume at T1 Libor is 4%, which is then used to calculate the cash flow from T1 to T2.

Note on Day count convention: Day count convention as we know can be actual/ 360, 30/360 or actual/actual. GARP generally provides the information on day counting method which is to be used for question. If question asks to perform calculations based on actual days, then actual days will be provided in the question. Mostly GARP prefers 360/360 convention in order to ease the calculation process.

Illustration

Assume party A and Party B agrees to enter into 2 year swap arrangement to exchange Libor +1% for fixed rate of 5% on the notional principle of $1000,000. Pay A is fixed payer and swap is settled semiannually. Following table provides the periodic cash settlements between Party A and Party B based on following Libor Rate at the start of the period.

Term	Libor (Semi annual)	Applicable rate (+1%)
T0 Years	5%	6%
T0.5 years	4.5%	5.5%
T1 yea	3.5%	4.5%
T1.5 year	4%	5%
T2 year	4.25%	5.25%

Please note, the cash flow at time T0.5 is based on Libor declared at T0 and so on. Swap ends at the time T2 and hence 4.25% Libor rate declared at T2 is of no use in our calculation.

Term	A =Floating Rate used for cash flow calculation	Floating amount (USD). Notional X A/2	Fixed amount (USD) 5%/2	Net payment	Cash flow to Party A Paying fixed.	Cash flow to party B paying floating
T0.5	6%	30000	25000	5000	5000	(5000)
T1	5.5%	27500	25000	2500	2500	(2500)
T1.5	4.5%	22500	25000	2500	(2500)	2500
T2	5%	25000	25000	0	0	0

Business day convention: The payment dates are affected by weekends and holidays. When the settlement day is holiday/ weekend the payment can either be made on next business day or preceding business day based on which convention is applicable. For sake of simplicity, we will ignore these conventions in calculation unless otherwise specified.

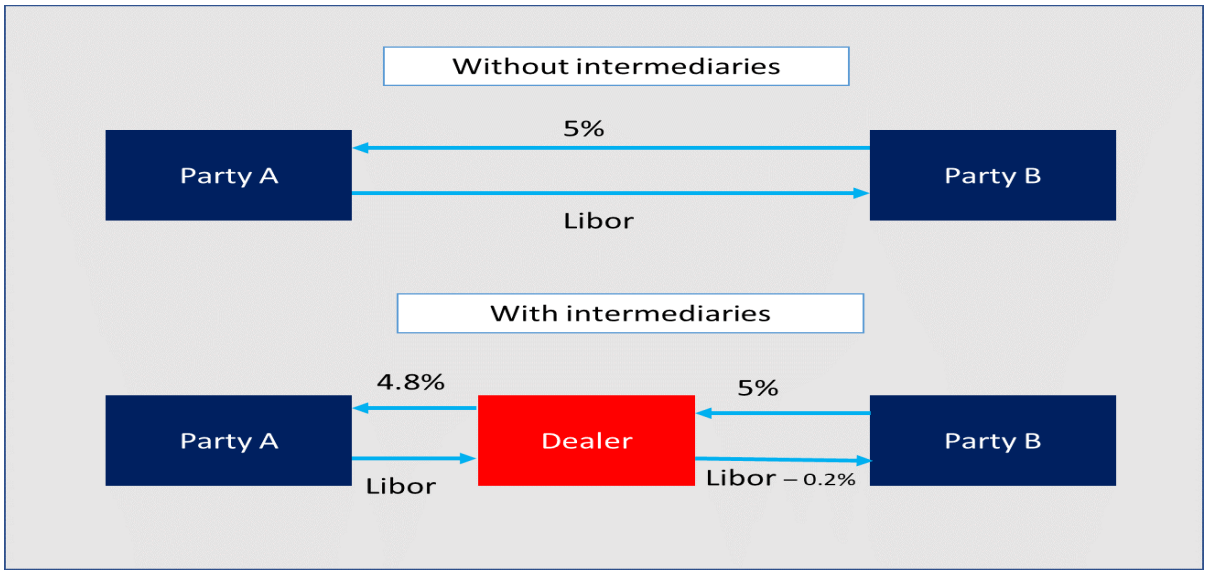
Confirmations: Confirmation is the agreement in an OTC derivative transaction which specifies the date of payment, method of cashflow calculation, day count convention to use and applicability of holidays, etc. Plain vanilla interest rate swaps between two parties are cleared through CCPs. Each party pays initial margin. Clearing of swap through CCPs is only applicable for swaps between the two financial institutions. If one of the parties in swap transaction is not financial institution, such swap is cleared bilaterally.

Quotations: Market makers are large financial institutions which quotes bid and ask rates for swaps that takes place. The bid quote is the fixed rate the institution is willing to pay to receive Libor and ask is to pay Libor.

20.1.b Financial Intermediaries

The financial intermediaries provide platform for parties to search and enter into desired swaps arrangements. Financial intermediaries can large banks or swap dealers. Intermediaries charge

commission to facilitate the swap transaction. Following diagram shows the swap with and without intermediaries in which we can see dealer collects 5% from the Party B but transfers only 4.8% to party A and Libor is transferred to B is Libor -0.2%. In this case 0.2% is the commission of dealer to facilitate swap transaction which is charged from each party.



20.2 Asset Liability transformation using Swap

The party with existing liability with fixed rate willing to convert the liability with floating rate can do so by entering into the swap arrangement.

Consider Party A issued bond paying 6% fixed on annual basis willing to convert it into floating rate equal to Libor. Party B issued floating rate bonds which has reference rate equal to Libor is willing to convert this liability into fixed payment liability. If both the parties decide to enter into swap where party A pays Libor rate to Party B and party B pays fixed 6% to party A their liability can be changed from floating to fixed or fixed to floating. Assuming the notional value of $1000000,

Particulars	Party A Payment	Party B Payment
	Without Swap	
Payments to bond holders	Party A makes the payment of $60000 to bond holders.	Party B makes the payment of $50,000 (assuming Libor 5%) to bond holders.
	With Swap	
A Payment to bond holders (same as above)	$60,000	$50,000
B Payment made in swap to counterparty	Party A is floating payer, hence the payment made to Party B is $50000	Party B is fixed payer, hence payment made to party A is $60,000
C Payment received in swap from counterparty	Party A receives fixed rate of 6% from Party B ($60,000)	Party B receives floating rate of 5% Libor from Party A. ($50,000)
Net Payment (A+B-C)	$50,000	$60,000

Above illustration shows how the initial fixed liability of Party A of $60,000 is converted floating liability of 5% Libor Payment of $50,000.

20.3 Comparative advantage

Before we see the comparative advantage in swaps, lets first see how swap is beneficial for both the parties involved in swap. Assume that Party A wants to borrow $1M at a fixed rate while Party B wants to borrow $1M at a fluctuating rate. Following table shows the lending rates (floating and fixed) quoted to both the parties by their respective banks.

Party	Fixed Quoted rate	Floating Quoted rate
Party A	6% PA	1% + Libor
Party B	5% PA	2% + Libor

In this example Party A is interest in fixed rate borrowing and rate quoted by bank to party A is 6% which is expensive compared to fixed rate quoted to Party B. However, the cheaper rate quoted to Party B is of no use because he is interested in floating rate borrowing which is 2%+Libor which is expensive compared to floating rate quoted to Party B. If both the parties decide to take the loan at rates quoted, both would end up paying interest at expensive rates. However, both the parties can enjoy the cheaper rate of interest on their loan amount while keeping the desired type of rate (floating or fixed) with the help of swap.

Interest payment without Swap

- **Party A: Amount borrowed $1M at Fixed rate of 6% PA**: Total interest paid by Party A (assuming annual interest payment) is $60,000.
- **Party B: Amount borrowed $1M at Floating rate of 2%+ Libor.** Assuming Libor is 5%, total interest paid at 7% (2%+5%) by Party B is $70,000.

Interest payment with Swap:

Steps in Swap

- **Party A** will borrow funds at the rate which is cheaper when compared with other parties. In this case, fixed rate quoted is expensive for Party A (compared to fixed quoted to B) and floating rate is cheaper for party B (compared to floating rate quoted to B). Hence Party A borrows $1M at floating rate. Please note, Party A wants fixed rate loan and not floating rate. This mismatch will be fixed with the help of swap.
- **Party B** will borrow funds at the rate which is cheaper when compared to other party. In this case fixed rate is quoted at cheaper rate hence, Party B will borrow at fixed rate. Please note, Party B wants floating rate loan and not fixed rate. This mismatch will be fixed with the help of swap.

Swap: Party A will enter swap agreeing to pay fixed rate of 5% to Part B and Party B will agree to pay floating rate of 1% + Libor to Party B. With this swap arrangement, Party A becomes net fixed rate payer and party B becomes the net floating rate payer(as mentioned below).

- Party A: Amount borrowed $1M at floating rate Libor +1%: Party A pays interest of $60,000 to bank and same amount is received from the Party B from swap. The net cash flow for party A at floating rate is zero. Party A agreed to pay fixed rate in swap transaction, hence will pay $50,000 to party B which make the party A fixed rate payer.
- Party B: Amount borrowed $1M at fixed rate of 5%: Party B pays interest of $50,000 to bank and same amount is received from the party A. The net cash flow for Party B at fixed rate is zero. Party B agreed to pay floating rate of 1% + Libor to Party B in swap transaction, hence will pay $60000 to Party A which makes the Party B floating rate payer.

If we compare the interest expense for both the parties with and without swap, both the parties are getting their desired type of rate but at lower rate. For example, Party A is liable to pay $60,000 without swap and $50,000 with swap. Both the payments are based on fixed rate only but with swap arrangement, it is cheaper. Similarly, party B is liable to pay $60,000 at floating rate with swap instead of $70,000 without swap. Hence entering into swap is beneficial for both the parties.

20.3.a Comparative advantage in swap

In the above example, lets assume the rate quoted by bank to both the parties are as follows,

Party	Fixed Quoted rate	Floating Quoted rate
Party A	7% PA	2.5% + Libor
Party B	5% PA	2% + Libor

In this case, party B is quoted lower rates for both fixed and floating rate and party A is quoted higher rates. One can say that there is no advantage for Party B in entering into swap arrangement with Party A because Party B who wants floating rate, is already getting cheaper floating rate compared to B. However, this is not true. There is comparative advantage which can be enjoyed by both the parties by entering into swap arrangement and both the parties can enjoy their desired and lower rate. First, we will learn process to calculate floating and fixed rate calculation for swap with comparative advantage. Then we will see shortcut to calculate these rates.

Note: This swap arrangement will be beneficial for both he parties, if the difference of any one rate fixed or floating is higher than the difference of other rate. In this case, the difference of fixed rate quoted to both the parties is 2% (7%-5%) and floating rate is 0.5% (2.5% - 2%). The difference of fixed rate is more than difference of fixed rate.

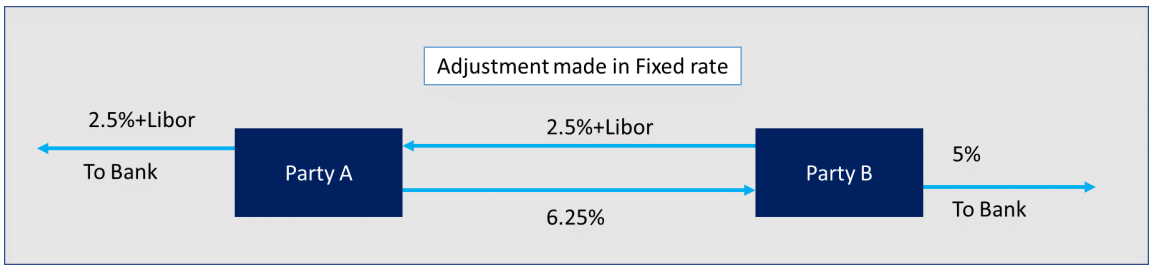
Swap arrangement in comparative advantage:

- **Party A** borrows funds at floating rate of 2.5% + Libor. We already know that the party A wants fixed rate borrowing and this mismatch is fixed in swap.
- **Party B** borrows fund at fixed rate of 5%.
- **Swap:** Party A will enter into swap with Party B by paying fixed rate of 6.25% while the Party B paying floating rate at 1.25% + Libor. The question here is how did we got the fixed rate and floating rates exchanged in swap.

Calculating swap rates in comparative advantage:

- **Step 1: Calculate Net Advantage:** Net advantage is the difference between the difference of floating rate and difference of fixed rate. Hence
- Net Advantage = (7%-5%) – (2.5% + Libor – 2% Libor)
- Net advantage = 1.5%
- **Step 2: Distribution of advantage:** In real life how this net advantage is distributed may be negotiated by both the parties. From the exam perspective, question will specifically provide the distribution of advantage, like 75% for Party A and 25% for Party B. If nothing is given, advantage should be distributed equally among the parties, which we did in our calculation to arrive at Party A fixed rate of 6.25% in swap. We are assuming equal distribution of advantage of 0.75% (1.5%/2) among the parties.
- **Step 3 Calculation of swap rate:** To calculate fixed rate on swap paid by party A, simply subtract advantage from the fixed rate quoted to Party A, which gives us the result of 6.25% (7% - 0.75%). In this case party B would pay quoted floating rate applicable to Party A without any adjustment to compensate in full for floating rate loan borrowed by Party A. This will automatically adjust the advantage for Party B. Check the following

diagram. Please note adjustment can also be done from swap floating rate payer (Party B) side which will see in this section.



Position of Party A (wants fixed rate loan):

- **Without Swap:** The quoted fixed rate for Party A is **7%,** hence without swap party A would end up paying 7% fixed rate on loan.
- **With Swap:** Party A borrows loan at floating rate of 2.5% + Libor which is compensated by Party B, by paying 2.5% + Libor in swap. Hence net fixed rate payment liability for Party A is **6.25%,** which accounts for the comparative advantage gain for this party.

Position of Party B (Wants floating rate loan):

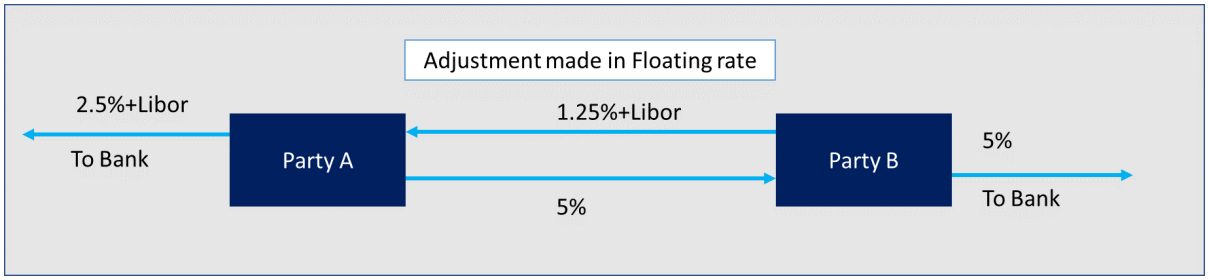
- **Without Swap**: The quoted floating rate for Party B is 2% + Libor, hence without swap party B would end up paying 2%+Libor floating rate on loan.
- **With Swap:** Party B borrows fixed rate loan at 5%. Party A pays party B 6.25% under swap agreement and hence party B gains 1.25% fixed on swap. Party B pays 2.5% + Libor to Party A. If we adjust gain of 1.25% gain generated from the swap in floating rate paid by Party B, the net floating rate applicable for party B is 1.25% + Libor (i.e. 2.5% Libor – 1.25%). Party B was originally quoted with floating rate of 2% + Libor and after swap the **floating rate is reduced to 1.25% + Libor** which accounts for 0.75% comparative advantage gain.

Table showing cash flows for Party A and Party B (Loan amount $1M and Libor is 4%).

Particulars	Party A	Party B
Original Loan borrow rate	2.5% + Libor	5%
A: Interest paid (for a year)	$65000 (2.5% + 4% X 1,000,000)	$50,000
Swap payment rate	6.25%	2.5% + Libor
B: Payment made in swap	$62500	$65000
C: Payment received in swap	$65000	$62500
Net payment (A+B – C)	$62500	$52500

Please note: Party B after swap is liable to pay 1.25% + Libor which gives the effective rate of 5.25% (1.25% + 4%). Hence the total floating liability of Party B is 52500 which is 1.25% + Libor of loan amount. We know swaps payments are netted by parties, and hence only Party A will make $10,000 (62500 – 52500) payment to Party B instead of both the parties exchanging cash flows.

Adjustment in swap floating rate: Party B is liable to pay 2% + Libor without swap and advantage in swap is 0.75%. Hence, Party B will pay 1.25% + Libor in swap to Party A and Party A will pay fixed rate to fully compensate party B on his fixed loan. Check the diagram.



Party A: Party A is paying 2.5%+Libor to bank and getting compensated by Party B only up to 1.25% + Libor in swap. Hence, Party A is paying extra 1.25% in this transaction. Party A is paying only 5% in fixed to fully compensate party B for fixed loan. Hence the total fixed payment to party A is 6.25% (5% to party B + 1.25% extra pay on loan) which is same as rate applicable to Party A after adjusting for comparative advantage.

Party B: Party B is getting fully compensated on fixed loan payment and hence becomes the net 1.25%+Libor floating rate payer.

Exam Shortcut: Assume the same question is given in exam and you are supposed to calculate net payment. To calculate the payment, find the difference of differences in quoted rates, which is 1.5% in our case. Assuming advantage is to be distributed equally, adjust this gain in both the parties desired rates. In our case Party A is fixed rate payer and is quoted at the rate of 7% which after adjusting for the comparative advantage gain becomes 6.25%. Party B is floating rate payer and is quoted at 2% + Libor which after adjustment becomes 1.25%+Libor. Assuming the Libor is 4%, the floating rate payment equals 5.25%. Hence payment of $10,000 which is 1% (6.25% - 5.25%) of loan amount $1M will be made by Party A to party B. This amount is exactly same as we did in above calculation.

20.4 Currency Swap

In currency swap principal and interest rate both are exchanged, however in interest rate swap, only interest differential is exchanged. Currency swap is simple to understand with example,

Example:

India company A Inc from needs USD 1,00,000 to invest in USA. B Inc from USA needs Rs 7500000 to invest in India for the same as A Inc. The first option is both the companies borrow from their country and invest in other country. However, this will increase currency exchange risk. The currency risk will source from principle and interest payments. Another option is the currency swap. To enter into currency swap,

Party A will borrow funds in Indian rupees Rs 7500000 at 10% (INR borrowing rate) and lend to B Inc. B Inc invests this amount into India. Please note B Inc is liable to pay interest on rupees.

Party B will borrow funds in USD 100000 at 4% (USD Borrowing rate) and lend to A Inc. A Inc will invests these funds in USA. A Inc is liable to pay interest on USD.

Assuming 3-year swap term the settlement at the end of 1st year if exchange rate is 1USD = Rs 80

Interest payment by A Inc (In USD): $100000 X 4% = $4000

Interest payment by B Inc (In INR): Rs 7500000 X 10% = Rs 750000

Interest payment by B Inc (In USD) = Rs 750000/80 = $ 9375

Net payment by B Inc = $9375 - $4000 = $5375

The net payment received by A Inc in INR = $5375 X 80 = Rs 430,000

20.4.a Valuation of currency swap

As we know valuation of swap is different from the actual payment at the settlement date. In the above example, assume three years are left for Swap and interest rate term structure is 5% flat for USD and 9% flat for INR. For valuation we need to calculate the value of each leg using method of bond valuation.

USD leg = $\frac{4000}{1.05} + \frac{4000}{(1.05)^2} + \frac{104000}{(1.05)^3}$ = $97276.75

INR Leg = $\frac{750000}{1.09} + \frac{750000}{(1.09)^2} + \frac{82,50,000}{(1.09)^3}$ = Rs 76,89,847

Value of swap in USD (for Party A) = 7689847 / 80 – 97276 = 96123 – 97276 = -1153.66

The negative sign shows net payable for party A.

20.4.b Valuation of swap with forward exchange rate

In the above example we used flat rate of 1USD = Rs 80. However, it is possible to calculation the value of swap using series of forward rates. Assume the forward rates are

1 year USD = Rs 75, 2 year USD = Rs 80 and 3 year USD = Rs 85

Valuation of swap in dollar terms							
Time	**Cash flow in USD**	**Cash Flow in Rs**	**Applicable forex rate**	**$ value of Rs**	**Net Cash flow**	**PV factor**	**PV of cash flow**
1	4000	750000	75	10000.00	6000.00	0.9524	5714.28
2	4000	750000	80	9375.00	5375.00	0.9070	4875.28
3	4000	750000	85	8823.53	4823.53	0.8638	4166.74
3	100000	7500000	85	88235.29	-11764.71	0.8638	-10162.79
Total							4593.51

Hence the value of swap is $4593 in Dollar terms.