

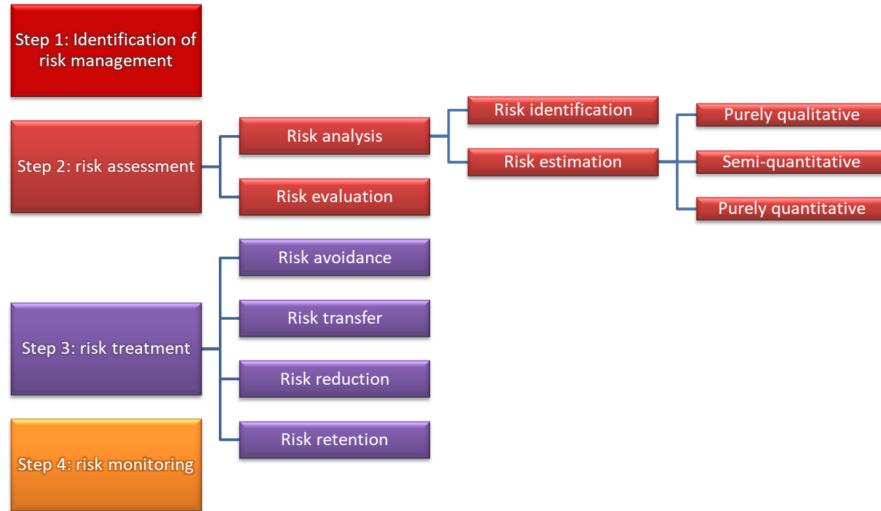
# Applications in Credit Risk\_First Part

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- Credit risk and risk management
  - BASEL and BIS
    - **Basel Committee on Banking Supervision (BCBS) simply Called BASEL**
      - BASEL refers to a **set of international banking regulations developed by BCBS**.
      - The committee develops guidelines and standards to improve banking regulation, supervision, and practices worldwide, promoting stability in the financial system.
    - **Basel Accords:**
      - **Basel I** (1988): Focused on establishing minimum capital requirements for banks.
      - **Basel II** (2004): Introduced more sophisticated risk management standards and addressed credit, market, and operational risk.
        - **Three-pillar approach was introduced: minimum capital requirements, supervisory review, and market discipline.**
          - minimum capital requirements: Capital to Risk Weighted Assets. Credit/ Market/Operational risk are considered.
          - supervisory review: Financial institutions should have a process for assessing their overall capital adequacy and a strategy for maintaining the necessary capital level.
          - market discipline:**Allow participants to obtain key pieces of information on a bank's capital, risk profile, risk assessment process, and capital adequacy through adequate disclosures.**
      - **Basel III** (2010): Created after the 2008 financial crisis, Basel III introduced stricter capital requirements, leverage ratios, and stress testing requirements to further strengthen the resilience of the banking sector.
    - **Bank for International Settlements (BIS)**
      - **BIS** is the institution where central banks collaborate
      - The BIS, based in Basel, Switzerland, is often called the "bank for central banks." It was established in 1930, making it one of the oldest international financial institutions.
      - The **Basel Committee** is hosted by the BIS, but the BIS also hosts other committees and provides a venue for central bank cooperation and the sharing of expertise in financial stability.
  - Risk and risk management
    - Risk: **Anything that threatens or limits the ability** of a community or organization to achieve its mission. It can be unexpected and unpredictable events such as destruction of a building, loss of funds and any other economic and political situations.

- Risk management: A process of thinking systematically about all possible risks, problems or disasters before they happen. This management will avoid the risk, or minimize its impact, or scope of the impact.

- Risk management: Identification, Assessment, Treatment and Monitoring (**remember the 4 steps**)



- **Distinguish Risk avoidance/Risk transfer/ Risk reduction/ Risk retention**

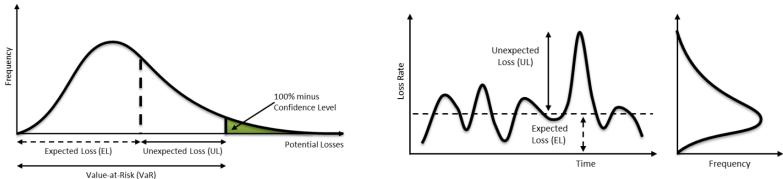
- **Risk Avoidance:** Involves completely avoiding activities that don't align with stated policies. This eliminates any chance of loss, making it the most effective strategy, though it may not always be practical.
- **Risk Transfer(Hedging):** This strategy shifts unwanted risk to another party, typically involving a cost.
- **Risk Reduction:** Often achieved through diversification, this strategy aims to minimize the potential impact of losses.
- **Risk Retention:** Involves accepting certain risks by increasing the organization's capacity to handle potential losses. This approach is suitable for risks deemed manageable or within the organization's risk tolerance.

- **Risk capacity, risk tolerance, risk appetite, risk target**

- **Risk Capacity**
  - Amount and type of risk an organization is able to support in pursuit of business objectives
- **Risk Appetite**
  - Amount and type of risk an organization is willing to accept in pursuit of its business objectives
- **Risk Tolerance**
  - Specific maximum risk that an organization is willing to take regarding each relevant risk
- **Risk Target**

- Optimal level of risk that an organization wants to take in pursuit of a specific business goal
- Uncertainty and types of risk
  - **Uncertainty**
    - Situation where the current state of knowledge is such that the order or nature of things is unknown and limited. Therefore, the consequences, extent, or magnitude of circumstances, conditions, or forthcoming events are unpredictable.
- **Types of Risk (overall in finance)**
  - **Systematic Risk (Market Risk)**
    - Systematic risk is the **volatility or risk affecting all investments in the market**, caused by factors related to the overall economy. **un-diversifiable**
    - Examples include economic downturns, inflation, changes in interest rates, and events like changes in oil prices, which can affect transportation costs and have a ripple effect across industries.
    - also referred to as **market risk, portfolio risk, or un-diversifiable risk**.
  - **Unsystematic risk(Idiosyncratic Risk)**
    - Unsystematic risk is **specific to a particular company or industry**, caused by factors like management decisions, production processes, or legal challenges.
    - Examples include poor management decisions, plant accidents, labor strikes, or company-specific scandals.
    - Unsystematic risk is **diversifiable, meaning it can be minimized or eliminated by holding a well-diversified portfolio**.
    - Also known as **idiosyncratic risk or specific risk**.
- Overview of credit risk and framework
  - How Credit Risk Arises
    - Default on a financial obligation.
    - An increased probability of default on a financial obligation.
    - A more severe loss than expected due to greater/ lower than expected exposure at the time of a default.
    - Default on payment for goods or services already rendered (i.e., settlement risk).
  - **Qualitative Credit Analysis Techniques – Willingness to Repay**
    - Gather information from a variety of sources about the character and reputation of the potential borrower.
    - Face-to-face meetings with the potential borrower to assess the borrower's character are routine in evaluating willingness to pay.
    - Extrapolating past performance into the future. Lenders often assume that a pattern of

borrowing and repaying in the past will continue in the future

- **Quantitative Credit Analysis Techniques – Ability to Repay**
  - Examining the past, current, and forecasted financial statements of the prospective borrower.
- **Expected loss vs Unexpected loss**
  - Expected Loss
    - Expected loss is the average loss that we would expect from an exposure or a portfolio over a given period of time.
  - Unexpected Loss
    - Unexpected loss is the **average total loss over and above the mean loss**. It is calculated as a standard deviation from the mean at a certain confidence level.
- **Loss Distribution**
  - 
  - Probability Of Default(PD)
    - It describes a **probability that a borrower will default** on contractual payments **before the end of a predetermined period**.
  - Exposure Amount(EA)
    - It is a loss exposure of a lender at the time of a loan's default expressed as a dollar amount.
  - Loss Given Default(LGD)
    - It is a **percentage loss incurred if the borrower defaults**. It can also be expressed as:
      - $LGD = 1 - \text{Recovery Rate}$
      - Recovery Rate = recovery / exposure
  - EL and UL for a **single exposure**
    - **Expected Loss for a single exposure.**
      - It is the average credit loss that we would expect from an exposure or a portfolio over a given period.
      - **EL = EA\*PD\*LGD**
        - EA represents the **Exposure Amount** (or Exposure at Default).
        - PD is the **Probability of Default** for this specific exposure.
        - LGD (Loss Given Default) is the proportion of the exposure that would be lost if a default occurs.

- **Unexpected Loss for a single exposure.**

- average total loss over and above the expected loss.
  - Variation over the expected loss.
  - Calculated as the standard deviation from the mean.
- **remember this formula**

$$UL = EA \times \sqrt{PD \times \sigma_{Loss\ Rate}^2 + LR^2 \times \sigma_{PD}^2}$$

- **EA** is the **Exposure Amount** (Exposure at Default).
- **PD** is the **Probability of Default**.
- **LR**: Loss Rate (LGD or Loss Given Default)

- **Example of Calculating UL and EL**

- A bank issued a **\$2 million loan** of which **\$1.6 million is currently outstanding**.
- According to a rating model, the borrower has a **1% chance of defaulting** over the next year.
- In case of that, the estimated **loss rate (LGD) is 30%**.
- The probability of default and the loss rate have **standard deviations of 6% and 20%**, respectively.

Please calculate expected loss and unexpected loss.

**Question:** Calculate the **expected loss (EL)**.

**Answer**

- Expected Loss (EL) = EA x PD x LGD
- EL = \$1,600,000 x 0.01 x 0.3 = \$4,800

**Question:** Calculate the **unexpected loss (UL)**.

$$\begin{aligned} UL &= EA \times \sqrt{PD \times \sigma_{LR}^2 + LR^2 \times \sigma_{PD}^2} \\ &= 1,600,000 \times \sqrt{0.01 \times 0.2^2 + 0.3^2 \times 0.06^2} \\ &= \$43,052 \end{aligned}$$

- EL and UL for a **Portfolio** of exposures.

- **Expected Loss for a Portfolio** of exposures.

- additive

$$EL_p = \sum EA_i \times PD_i \times LR_i$$

- **EA\_i**, **PD\_i**, and **LR\_i** represent the exposure amount, probability of default, and loss rate (or LGD) for each individual exposure *i* in the portfolio.
- The summation **adds up the expected losses** across all exposures in the portfolio.

- **Unexpected Loss for a Portfolio** of exposures.

- Unexpected loss for a portfolio is less than the sum of unexpected individual losses. since standard deviation of the sum will not be the same as the sum of standard deviation unless there is perfect correlation.
- two-asset portfolio

$$UL_p = \sqrt{UL_i^2 + UL_j^2 + 2\rho_{ij}UL_iUL_j}$$

- $UL_i$  and  $UL_j$  represent the unexpected losses for individual exposures or assets within the portfolio.
- $\rho_{ij}$  is the **correlation coefficient** between assets i and j, which accounts for how the risks of different assets are related.
- Due to the effects of diversification, the risk of a portfolio is always less than the total risk of assets held separately.

$$UL_p < \sum UL_i$$

- Credit Rating Agency Method

- Credit rating agencies (CRA, also called a ratings service) **provide investors information about bond and debt instrument issuers**. They provide information about countries' sovereign debt, too. The global credit rating agencies are Moody's, Standard & Poor's, and Fitch.
- A credit rating agency is a company that **assigns credit ratings, which rate a debtor's ability to pay back debt for principal and interest payments on a timely manner including the likelihood of defaults**.
- **investment grade/ speculative grade**

	Descriptions for each rating	S&P	Moody's / Fitch
Investment Grade	Highest grade	AAA	Aaa
	High grade	AA	Aa
	Upper medium grade	A	A
	Medium grade	BBB	Baa
Speculative grade			
	Lower medium grade	BB	Ba
	Speculative	B	B
	Poor standing	CCC	Caa
	Highly speculative	CC	Ca
	Lowest quality	C	C
Modifiers	A+, A, A-, and A1, A2, A3		

**Credit Rating**

- Investment grade securities range from AAA to BBB-.
- Ratings agencies are compensated by bond issuers rather than by sale of their data to investors.
- The ratings assigned by the credit rating agencies reflect the probability of default of entities and debt issues.

- Credit Rating Transition Matrix

- A credit rating transition matrix shows how a statistical **credit rating will migrate from one credit rating category to another over a given time period**.
- **Credit Rating for one year/over the years**

Initial Rating	Rating at year-end (%)							
	AAA	AA	A	BBB	BB	B	CCC	Default
AAA	90.81	8.33	0.68	0.06	0.12	0.00	0.00	0.00
AA	0.70	90.65	7.79	0.64	0.06	0.14	0.02	0.00
A	0.09	2.27	91.05	5.52	0.74	0.26	0.01	0.06
BBB	0.02	0.33	5.95	86.93	5.30	1.17	0.12	0.18
BB	0.03	0.14	0.67	7.73	80.53	8.84	1.00	1.06
B	0.00	0.11	0.24	0.43	6.48	83.46	4.07	5.20
CCC	0.22	0.00	0.22	1.30	2.38	11.24	64.86	19.79

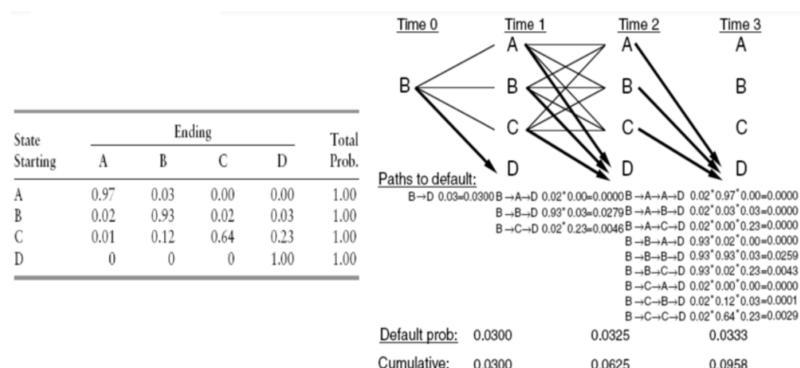
Source: Standard & Poor's CreditWeek, April 15, 1996.

Rating	Year									
	1	2	3	4	5	6	7	8	9	10
Aaa	0.00	0.00	0.02	0.09	0.19	0.29	0.41	0.59	0.78	1.02
Aa	0.07	0.22	0.36	0.54	0.85	1.21	1.60	2.01	2.37	2.78
A	0.08	0.27	0.57	0.92	1.28	1.67	2.09	2.48	2.93	3.42
Baa	0.34	0.99	1.79	2.69	3.59	4.51	5.39	6.25	7.16	7.99
Ba	1.42	3.43	5.60	7.89	10.16	12.28	14.14	15.99	17.63	19.42
B	4.79	10.31	15.59	20.14	23.99	27.12	30.00	32.36	34.37	36.10
Caa-C	14.74	23.95	30.57	35.32	38.83	41.94	44.23	46.44	48.42	50.19
Inv.	0.17	0.50	0.93	1.41	1.93	2.48	3.03	3.57	4.14	4.71
Spec.	3.83	7.75	11.41	14.69	17.58	20.09	22.28	24.30	26.05	27.80
All	1.50	3.09	4.62	6.02	7.28	8.41	9.43	10.38	11.27	12.14

- Credit Rating

- Rating agencies also assess rating migration, or changes in ratings. Probability estimates are summarized in transition matrices, which show the estimated likelihood of a rating change for a company within a specified time period.

- Credit Rating Migration



- on the left: a transition matrix

- For example, an entity with an initial rating of "A" has a 97% probability of remaining at "A" after the period, a 3% chance of being downgraded to "B," and a 0% chance of moving to "C" or "D" within this time frame.

- on the right: Rating Migration Paths

- The calculations at the bottom show the **probability of default (PD)** for each time period, considering all possible paths that lead to a default state (D).
- The **cumulative default probability** is shown over time, representing the total likelihood that a company starting with a given rating will eventually default within

that period.(important for assessing long-term risk and setting appropriate credit limits or provisions.)

- For example, a "B" rating transitioning to "D" could follow multiple paths, such as directly from B to D or through intermediate steps (e.g., B → B → D).

## • **Structured Finance and Securitization**

### • **Structured Finance**

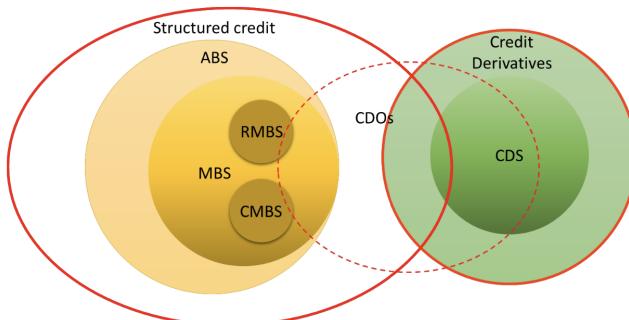
- It involves **repackaging cash flows, legal and corporate restructuring, and various financial instruments**. It is also a secondary financial instrument used for more complex financing needs, which cannot be ordinarily solved with conventional financing.
- **Advantages of structured finance:**
  - **Achieving Financing and Risk Management Objectives:**
    - Involves a financial system for the firm's liabilities to achieve specific financing and/or risk management objectives.
  - **Altering Risk Profile and Lowering Funding Costs:**
    - Allows the firm to alter its risk profile or to raise external capital at funding costs lower than its stand-alone.

### • **Securitization**

- Securitization is a core of structured finance and prompts a liquidation of assets. It involves the process of **pooling various types of financial assets (like loans or receivables) and selling them as securities to investors**.
- process of selling credit-related assets to a third party that subsequently issues securities backed by the pooled cash flows (principal & interest) from the underlying assets.
- **Structured products or structured finance**, are **pre-packaged** structured investment products built from **one single security or a basket of securities**. That includes **bonds, loans, commodities, mortgages and other derivatives**.
  - Components
    - **Bonds:** Often used to provide a steady income component within structured products.
    - **Loans:** Can be pooled or securitized into products like collateralized loan obligations (CLOs).
    - **Commodities:** Used to add diversification and hedge against inflation within structured investments.
    - **Mortgages:** Commonly pooled into mortgage-backed securities (MBS), providing income from mortgage payments.
    - **Derivatives:** Options, futures, or swaps that can add leverage or risk mitigation, shaping the structured product's payoff profile.
  - Purpose

- capital protection, enhanced yield, or tailored risk exposure.
- diversification
- participate in various markets
- Structured products and credit products by assets and legal structures. They are inter connected.

Structured products and credit products by assets and legal structures. They are inter connected.



CDO: collateralized debt obligation & CDS: credit default swap &  
ABS: Asset backed Security & MBS: Mortgage backed security

## • Structured Credit

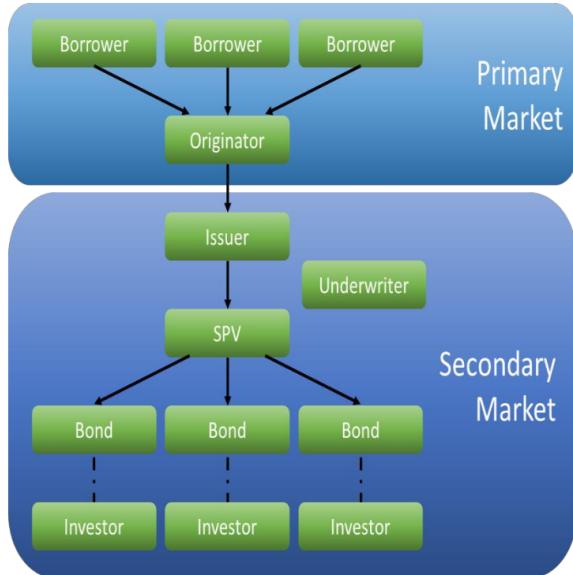
- Structured credit encompasses **Asset-Backed Securities (ABS)** and other credit products designed to redistribute risk and cash flows.
- **Asset-Backed Securities (ABS):** These are financial instruments backed by a pool of assets, such as loans or receivables, and include:
  - **Mortgage-Backed Securities (MBS):**
    - Backed by pools of mortgage loans.
    - Subcategories:
      - **Residential Mortgage-Backed Securities (RMBS):** Focused on residential mortgages.
      - **Commercial Mortgage-Backed Securities (CMBS):** Backed by commercial real estate loans.
  - These structured credit products are designed to allow investors to participate in cash flows from pooled assets.

## • Credit Derivatives

- These are financial instruments used to **transfer credit risk** without transferring the underlying assets.
- **Credit Default Swaps (CDS):** A type of credit derivative where one party transfers the risk of a borrower defaulting on their obligations to another party, in exchange for periodic payments.
- Credit derivatives like CDS are often used to hedge or speculate on credit risk.

## • Collateralized Debt Obligations (CDOs)

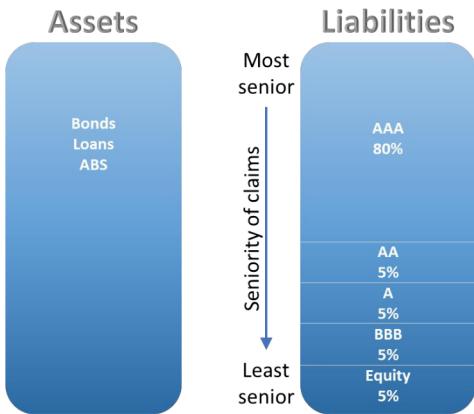
- CDOs are a hybrid product that overlaps between **structured credit** (ABS, MBS) and **credit derivatives**.
- They pool together various types of debt (e.g., bonds, loans) and repackage them into tranches with varying levels of risk and return.
- CDOs are often linked with credit derivatives (e.g., CDS) to manage or transfer risk.
- Interconnections:
  - **Structured Credit** and **Credit Derivatives** are closely related:
    - Products like **CDOs** use underlying assets (e.g., ABS, MBS) and derivatives (e.g., CDS) to create complex financial instruments.
    - **Credit Default Swaps (CDS)** are frequently applied in securitized products like CDOs to hedge against default risks.
    - **ABS and MBS** are foundational building blocks for many structured products, providing the underlying cash flows that are then repackaged into securities or derivatives.
- Special purpose entities (SPE) or vehicles (SPV)[known as trust]
  - Definition:
    - SPE/SPV is a legal entity created to isolate financial risk by holding specific assets and liabilities separate from those of the originator (the entity creating it).
  - Purpose:
    - Asset and Liability Separation:
      - SPE/SPV ensures that the **structured product's assets and liabilities** are independent of the originator's financial health.
      - This separation protects investors from risks associated with the originator's financial instability.
    - Bankruptcy-Remote:
      - If the originator (e.g., a company issuing loans) goes bankrupt, the assets transferred to the SPE/SPV remain unaffected.
      - The SPE/SPV is considered "bankruptcy-remote," meaning it safeguards the underlying assets and ensures continued operations even if the originator defaults.
  - How SPE/SPV Works (Illustrated Process):



SPV with primary and secondary market

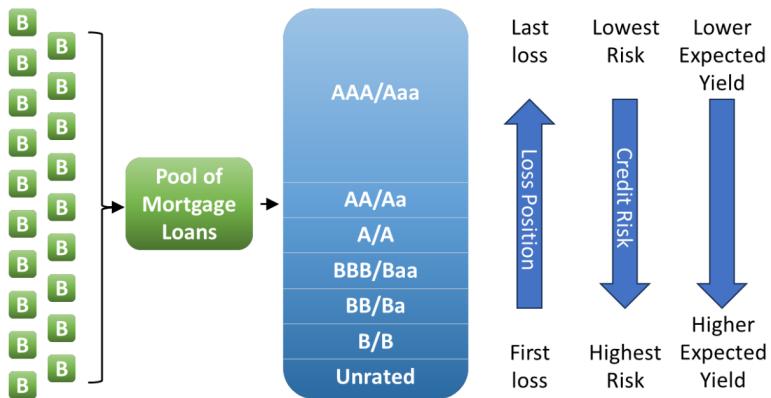
- **Primary Market:**
  - **Borrowers:**
    - Borrowers take loans or mortgages from the **originator** (e.g., a bank or financial institution).
  - **Originator:**
    - The originator pools these assets (e.g., loans, mortgages) and transfers them to the **SPV** to create a structured financial product.
- **Secondary Market:**
  - **SPV:**
    - The SPV packages the pooled assets into bonds or other financial instruments, which are issued to investors.
  - **Issuer and Underwriter:**
    - The issuer helps issue bonds backed by the SPV's assets.
    - Underwriters play a role in selling these bonds to investors in the secondary market.
  - **Bonds and Investors:**
    - The bonds are sold to **investors**, who receive returns from the cash flows (e.g., principal and interest) generated by the underlying assets.
- **Key Features of SPE/SPV:**
  - **Risk Isolation:**
    - Protects the assets within the SPE/SPV from the originator's financial troubles.
  - **Investor Protection:**
    - Investors in bonds issued by the SPE/SPV are protected as the assets are legally separated.
  - **Efficient Funding:**

- Allows the originator to raise capital more efficiently and at potentially lower costs.
- **(Additional Knowledge) Primary Market and Secondary Market**
  - **Primary Market**
    - **Definition:**
      - The primary market is where **new securities** (e.g., stocks, bonds) are **issued and sold for the first time** by companies, governments, or other entities to raise capital.
      - It's also referred to as the "**new issue market**."
    - **Purpose:**
      - **Capital Raising:** Companies use the primary market to raise funds for growth, projects, or other financial needs.
      - Investors purchase securities directly from the issuer.
    - **Examples:**
      - **Initial Public Offering (IPO):** When a private company offers its shares to the public for the first time.
      - **Bond Issuance:** A government or corporation issuing bonds to raise debt capital.
    - **Key Features:**
      - Securities are sold directly by the issuer to investors (e.g., institutions or retail investors).
      - After the initial issuance, securities move to the secondary market for further trading.
  - **Secondary Market**
    - **Definition:**
      - The secondary market is where **previously issued securities** are **traded among investors**.
      - It's also referred to as the "**stock market**" or the "**aftermarket**."
    - **Purpose:**
      - **Liquidity:** Allows investors to buy and sell securities easily, ensuring that investments remain liquid.
      - **Price Discovery:** Enables the determination of the market price for securities based on supply and demand.
    - **Examples:**
      - Stock exchanges like the **New York Stock Exchange (NYSE)** or **NASDAQ**, where shares are bought and sold after an IPO.
      - Bond trading among investors in the secondary bond market.
    - **Key Features:**
      - Securities are not bought directly from the issuer but from other investors.
      - Prices fluctuate based on market conditions, company performance, and investor sentiment.
  - There are two : Asset side and Liability side in the structured finance

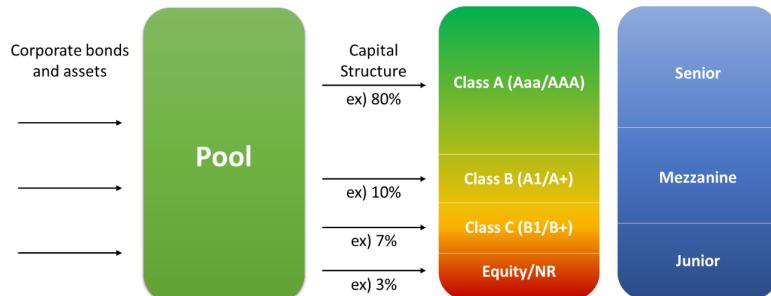


- **Cash flow and tranche levels including risk levels.**

- Loss, risk and yield positions



- Trancing



- Trancing divides the assets' cash flows into a specific ordering or layers.
- The senior tranches have implicit protection from the layer of investors below them.
- The lower (higher) subordinated tranches have the highest (lowest) probability of suffering impairment.
- This process ultimately means a loss distribution.
- Mortgage Pass-through Securities

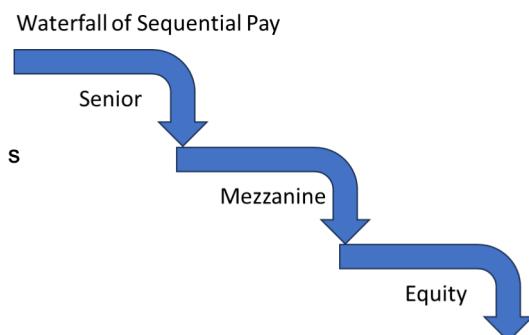


- Investors receive cash flows based entirely on the performance of the pool.

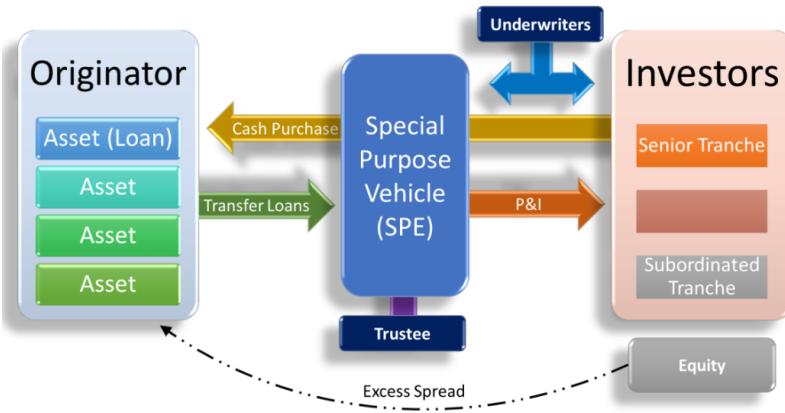
- Mostly, holders are entitled to a pro-rata share of all principal and interest payments made on the pool of mortgage loans.
- Principal and interest on the bonds are passed through from the loans, so the cash flows depend not only on amortization, but also voluntary prepayments by the mortgagor.

## • Collateralized products

- Collateralized Mortgage Obligations
  - Collateralized mortgage obligation (CMO) is a type of security that uses mortgage-backed securities as collateral.
  - CMOs are subdivided into tranches that vary in interest and risk based on the maturity structure of the mortgages.
  - The most common payment structure is the waterfall mechanism (also called sequential pay).
- Waterfall
  - The waterfall refers to the rules about how the cash flows from the collateral are distributed to the various securities in the capital structure
  - the capital structure is paid in a “top down” sequence with the senior debt receiving all of its promised payments before any lower tranche receives any remaining money.

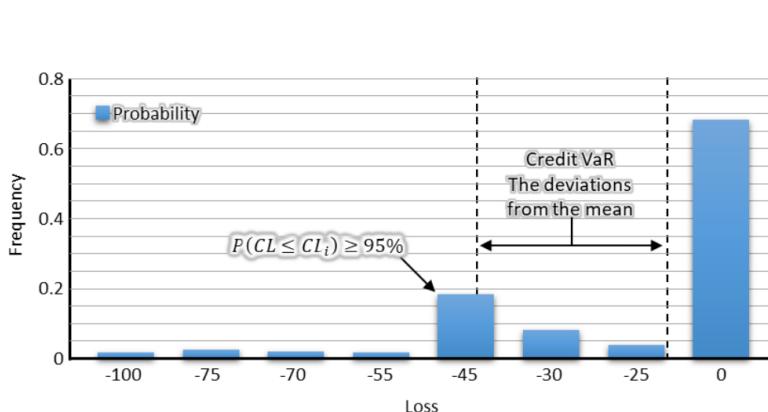


- Collateralized Debt Obligations (CDOs)
  - CDO are securitizations that repackage other securitizations.
  - They may come in form of a bond issued against a collateral pool consisting of ABS, MBS, Loans, or collateralized mortgage obligations (CMOs).
  - CDOs act as a secondary financial structuring with packaging multiple types of debt-backed securities such as MBS, ABS, and CMOs with a single investment product with stratified risk layers. This kind of layering can increase both the complexity and potential unpredicted risk.
  - Collateralized mortgage obligations (CMOs)



- **Value at Risk (VaR)**

- VaR measures **the maximum potential loss** to the value of an asset or portfolio **over a given time period with a given confidence interval that an entity can accept**. [“What loss level is such that we are X% confident it will not be exceeded in N business days?” ]
- Interpretation of VaR:
  - Worst Case Loss: Over given days, and confidence interval: 95% (or 99% or 99.9%) probability that we will not lose more than \$ XYZ
  - Unlikely event: on average, in one out of given period, we should expect to incur a loss greater than or equal to a certain amount.
- **Market Value at Risk (VaR) = Market Value x Risk Variability(Standard Deviation) x Time Horizon(annual & root) x Confidence Level**
  - Example
    - Current market value of stock A: USD 100,000
    - Standard deviation of stock A is 0.1 (10%)
    - Time horizon is 3 months
    - Confidence level is 95%, Z score
    - $VAR = 100,000 \times 0.10 \times \sqrt{\frac{3}{12}} \times 1.96$   
= USD 9,800.00
- **Credit VaR= EL (Expected loss) + UL (Unexpected loss)**



- Credit VaR vs Market VaR

Type	Market Risk	Credit Risk
Distributions	Symmetric	Skewed
Time Horizon	Short Term (Days)	Long Term (Years)

- Credit VaR measures the potential losses that are arising specifically from credit events, such as defaults, credit rating downgrades, or credit spread changes.
- Market VaR measures the potential losses caused by market risk factors such as price changes, interest rates, currency fluctuations, and other economic factors that affect the market value of an asset.

- **Margin Call**

- **Margin account:** Broker requires deposit to reserve your funds for trading.
- **Initial margin:** Must be deposited when contract is initiated.
- **Maintenance margin:** Investor can withdraw funds in the margin account in excess of the initial margin. A maintenance margin guarantees that the balance in the margin account never gets negative (the maintenance margin is lower than the initial margin). **Funds above the initial margin can be withdrawn**
- **Margin call:** When the balance in the **margin account falls below the maintenance margin**, broker executes a margin call. The next day, the investor needs to **"top up" the margin account back to the initial margin level.**