CREDIT RISK ANALYSIS

CREDIT RISK EVALUATION AND MEASUREMENT

Credit Risk

- **Credit** is an agreement where one party receives something of value and agrees to pay for the good or service at a later date. The word “credit” is derived from the ancient Latin word *credere*, which means “to believe” or “to entrust.” The creditor must have knowledge of the borrower’s character and reputation as well as his financial condition

Credit Risk

- Generally, there is not a definitive yes or no answer to whether a borrower can and will pay back a loan. As such, the lender must address the question of likelihood. The lender must assess the likelihood that the borrower will pay back the loan in accordance with the terms of the agreement.

Credit Risk

- **NOTE:** Borrower, obligor, counterparty, and issuer are all used to signify the party receiving credit. Lender, creditor, and ***obligee*** are primarily used to signify the party granting credit.

Aspects of Credit Risk

- The concept of **credit risk** encompasses a range of risk measures. Those relating to *default* include default risk, recovery risk, and exposure risk. Those relating to *valuation* include migration risk, spread risk, and liquidity risk. Additional measures include concentration risk and the correlation with pure financial risks (e.g., interest rate, exchange rate, and inflation risks).
- **Default risk**, or counterparty risk, relates to a borrower's inability to make promised payments. **Recovery risk** is the risk that the recovered amount, in the event of default, is less than the full amount that is due. **Exposure risk** measures the risk that a credit exposure at the time of default increases relative to its current exposure

Aspects of Credit Risk

- **Migration risk** looks at the risk that the credit quality and market value of an asset or position could deteriorate over time. To mitigate this risk, a periodic assessment of the credit quality of assets is necessary, and institutions may need to make credit provisions and record gains and losses.
- **Spread risk** is the risk that spreads may change during adverse market conditions as investors require different risk premiums, leading to gains and losses. **Liquidity risk** is the risk that asset liquidity and values deteriorate during adverse market conditions, lowering their market value.

Aspects of Credit Risk

- **Credit default risk** is the probability that a borrower will not pay back a loan in accordance with the terms of the credit agreement. The risk can result from:

-Default on a financial obligation.
-An increased probability of default on a financial obligation
-A more severe loss than expected due to a greater than expected exposure at the time of a default.
-A more severe loss than expected due to a lower than expected recovery at the time of a default.

Aspects of Credit Risk

- Credit events include:

  -Bankruptcy.

  -Failure to pay.

  -Restructuring.

  -Repudiation.

  -Moratorium.

  -Obligation default

Credit Risk Evaluation

- **-The borrower's (or obligor's) capacity and willingness to repay the loan**
- **-The external environment and its effect on the borrower's capacity and willingness to repay the borrowed funds**
- **-The characteristics of the credit instrument**
- **-The quality and adequacy of risk mitigants such as collateral, credit enhancements, and loan guarantees.**

Credit Risk Evaluation

- **The borrower's (or obligor's) capacity and willingness to repay the loan.** Questions the lender must consider include:

-What is the financial capacity to pay?
-Is it likely the borrower can fulfill its financial obligations through the maturity of the loan?

-Are there outside forces that affect the borrower's capacity and/or willingness to pay? For example, does the ownership structure of the firm, relationships within and outside the firm, and other obligations of the firm affect the borrower's ability to pay?
-How does the business itself affect the borrower's capacity to pay? Are there credit risk characteristics tied to this particular industry or sector?

Does the firm have a niche within the industry or sector?

Credit Risk Evaluation

- **The external environment and its effect on the borrower's capacity and willingness to repay the borrowed funds.** Factors such as the business climate, country risk, and operating conditions are relevant to the lender.
- Are there cyclical changes that will affect the level of credit risk? Will political risks affect the likelihood of repayment?

Credit Risk Evaluation

- **The characteristics of the credit instrument.** The credit instrument might be a bond issue, a bank loan, a loan from a finance company, trade credit, or other type of debt agreement/security. Concerns include:
- Risk characteristics that are inherent in the credit instrument, including legal risks and obligations that are specific to the instrument.
- The maturity (also called “tenor”) of the instrument.
- Is the debt secured or unsecured? Is there collateral backing the loan? Are there loan guarantors?
- Is the debt subordinated or senior to other obligations? What is the priority assigned to the creditor?
- How do loan/bond covenants increase or decrease the credit risk for each party?
- Can the borrower repay the loan early without penalty? Can the lender call the loan? Can the security be converted to another form (e.g., a convertible bond)?
  What is the denominated currency of the obligation?
- Are there any contingent risks?

Credit Risk Evaluation

- **The quality and adequacy of risk mitigants** such as collateral, credit enhancements, and loan guarantees. Secured lending (i.e., using risk mitigants in the lending process) is generally the preferred method of lending. If there is collateral, a bank or other lender may not have to force a delinquent borrower into bankruptcy but may instead sell the collateral to satisfy the financial obligation. Secured lenders are also generally in a better position than unsecured lenders in the event of bankruptcy.

Credit Risk Evaluation

- The use of collateral not only mitigates losses in the event of default, but also lowers the probability of default because the obligor typically does not want to lose the collateral. Historically, banks have substituted collateral for analysis of the borrower's ability to pay. In some sense, the use of collateral eliminates the need for **credit analysis**, or at the very least makes the credit decision simpler. A lender can normally put a market value on collateral and determine if it is sufficient to cover potential losses. Three issues regarding risk mitigants include:

Credit Risk Evaluation

- Is the collateral pledged to, or likely to be pledged to, another loan?
- Has there been an estimation of the value of the collateral?
- If there is a loan guarantor, has there been sufficient credit analysis of the third party's willingness and ability to pay in the event the borrower does not pay? A guarantor accepts liability for debt if the primary borrower defaults. The bank is able to substitute analysis of the guarantor's creditworthiness for that of the primary borrower. Typically, the guarantor has a greater ability to pay than the
  primary borrower (e.g., a parent guaranteeing a child's car loan or a parent company guaranteeing a loan to a subsidiary)

Credit Risk Evaluation

- The willingness to repay a loan is a subjective attribute. Lenders must make unverifiable judgments about the borrower. In some cases, intuition, or "gut feelings," are necessary to conclude whether a borrower is willing to repay a loan. As such, **qualitative credit analysis techniques** are largely used to evaluate the borrower's willingness to repay.

Credit Risk Evaluation

- Qualitative techniques include:
- **Face-to-face meetings** with the potential borrower to assess the borrower's character are routine in evaluating willingness to pay.
- **"Name lending"** involves lending to an individual based on the perceived status of the individual in the business community.

Credit Risk Evaluation

- **Gather information** from a variety of sources about the character and reputation of the potential borrower.
  Old-fashioned lending relied on first-hand knowledge of the people
  and businesses in a town. In this case, lenders knew (or thought they knew) potential borrowers. It is more difficult in the modern world, where lending decisions are centralized, to know customers personally.

Credit Risk Evaluation

- **Extrapolating past performance into the future.** Lenders often assume that a pattern of borrowing and repaying in the past (e.g., a credit record compiled from past history with the borrower and data garnered from credit bureaus) will continue in the future.
- Historical lending norms relied on the *moral obligation* of borrowers who could pay to repay their debts. Thus, gauging the borrower's willingness to pay was a critical component of credit analysis.

Credit Risk Evaluation

- However, in modern society, the moral obligation to pay if one is capable of paying has been replaced by the **legal obligation** to pay.
- In other words, in terms of credit analysis, determining the **capacity to pay is more important** than determining the **willingness to pay** because the legal system will force those who can pay to honor their commitment.
- Courts can seize the assets of those who will not fulfill their financial obligations.

Credit Risk Evaluation

- In corrupt or ineffective states, a borrower will not suffer, even if able to pay but not doing so.
- The willingness to pay is more important in countries with less-developed financial markets and legal systems. Creditors must evaluate the legal system and the strength of creditors' rights in emerging markets, along with the prospective borrower's ability and willingness to repay the obligation.
- The creditor must also consider the costs associated with taking legal action against a delinquent borrower. If costs are high, the creditor may be unwilling to take action regardless of the strength of the enforcement of creditor rights. As such, the willingness to pay should never be completely ignored in credit analysis.

Credit Risk Evaluation

- The ability of a borrower to repay a loan is an objective attribute. **Quantitative credit analysis techniques** are largely used to evaluate the borrower's ability to repay. The primary quantitative technique used in financial analysis is examining the **past, current, and forecasted financial statements** of the prospective borrower. This forms the core of the quantitative credit analysis used to determine a borrower's capacity to meet its financial obligations.

Credit Risk Evaluation

- There are **limitations** associated with quantitative data, which include:
  Limitations on the Historical nature of the data. Financial data is typically historical and thus may not be up-to-date or representative of the future. Also, forecasted financial data is notoriously unreliable and susceptible to miscalculations and/or misrepresentations.

Credit Risk Evaluation

- **Difficult to make accurate projections using historical data.** Financial statements attempt to represent the economic reality of a firm in a highly abbreviated report. As such, some information is lost in translation that is critical to the loan decision. The rules guiding financial reporting are created by a diverse group with varying interests and are often decided by compromise.

Credit Risk Evaluation

- Firms may **use the latitude in financial reporting to deceive interested parties**. Even if the reports are accurate, **financial data is subject to interpretation**. There can be a range of **conclusions drawn from the same data** due to the variety of needs, perspectives, and experiences of the various analysts. This means there is a subjective, qualitative component to an objective, quantitative exercise.
- Given the shortcomings of financial reporting, lenders should not ignore **qualitative analysis**. The **quality of management**, the **motivation of the firm's management**, and the incentives of management are relevant for both nonfinancial and financial firms.

- **Qualitative skills** are necessary to assist in determining the **willingness** of the entity to repay debt (e.g., reputation, repayment track record).
- It is critical for analysts to **think beyond numbers** and apply considerable judgment, reasoning, and experience in determining which factors are relevant for making decisions (e.g., management competence, bank's credit culture, and the robustness of credit review process).
- The ability to analyze the quality, reliability, and consistency of reported earnings is also necessary. In addition, an understanding of the **regulatory environment** of banks and the impact(s) of any regulatory changes is important (e.g., central bank given more authority to regulate banks)

- **Quantitative skills** are necessary to assist in determining the ability of the entity to repay debt. A banking credit analyst must be able to read and interpret **financial statements** in order to perform a wide range of ratio analysis.
- The ratios to be analyzed depend on which measures of financial performance are relevant (i.e., liquidity, solvency, profitability). For example, **return on equity (ROE**) is a commonly used measure because it considers efficiency and leverage in addition to profitability.
- Analysts must also understand **statistical concepts** (e.g., **sampling, confidence intervals, correlation**) in order to properly interpret data to arrive at reasonable conclusions under uncertainty. Analysts should have an understanding of monetary policy and an ability to compute and interpret **macroeconomic data** (e.g., GDP growth rates), both of which impact the general banking industry.

Credit Risk Evaluation

- Credit quality analysis from an **experts-based approach** will apply frameworks such as the four Cs of credit **(Character, Capital, Coverage, Collateral)** proposed by Altman/NYU,
- LAPS (**Liquidity, Activity, Profitability, Structure**) from Goldman Sachs, and
- CAMELS (**Capital Adequacy, Asset Quality, Management, Earnings, Liquidity, Sensitivity**) from JP Morgan. As Porter (1980, 1985) emphasized, qualitative features need to be factored into any analysis along with quantitative components.

Credit Risk Evaluation

- The types of qualitative items that may be found in a credit analysis questionnaire include things like corporate structure (incorporation date, group members), business information (competitive forces within the industry, growth forecasts),
- Management quality (degree of involvement, experience), strategy (business plans, nonrecurring transactions such as mergers and transfers),
- Financial position sustainability (liquidity risk, debt maturity concentration), quality of information given to the bank by the company (availability of financial projections, relationship history), and other risks (geographic focus, client base quality). Due to the enormous breadth of qualitative factors, a best practice would be to only collect qualitative information that cannot be quantified.

Credit Analysis Comparison for Different Customers

- **Consumers**
- **Capacity:** *Wealth (i.e., net worth), salary, or incoming cash per period, expenses per period, assets such as houses and cars, amount of debt (e.g., credit card debt), net cash available to service debt (i.e., cash flow minus household and mortgage expenses)*
- **Willingness:** *Reputation of individual, payment history*
- **Methods of evaluation:** *Credit scoring models that consider income, duration of employment, and amount of debt for unsecured debt like credit cards. Credit scoring and some manual input and review for large exposures such as mortgage loans or automobile loans*
- **Loan size/type:** *Large exposures are typically secured (e.g., mortgage loans). Smaller exposures are unsecured (e.g., credit card loans)*

Credit Analysis Comparison for Different Customers

- **<u>Corporations:</u>**
- **Capacity:** *Liquidity, cash flow combined with earnings capacity and profitability, capital position (solvency), state of the economy, strength of the industry.*
- **Willingness:** *Quality of management, historical debt service*
- **Methods of Evaluation:** *Detailed manual analysis including financial statement analysis, interviews with management. More complex than consumer analysis because companies are so diverse in terms of assets, cash flow, financial structure, etc.*
- **Loan Size/Type:** *Typically larger exposures (sometimes considerably larger) than loans to consumers. Debt may be secured or unsecured*

Credit Analysis Comparison for Different Customers

- ***Financial Institutions***
- **Capacity:** *Similar to nonfinancial firms but bank specific. Liquidity (the bank's access to cash to meet obligations), capital position historical performance including earnings capacity over time (and ability to withstand financial stress), asset quality (affects the bank's likelihood of being paid back and by extension the bank's lender's likelihood of being paid back), state of the economy, strength of the industry.*
- **Willingness:** *Quality of management; qualitative analysis is even more important for financial firms than for nonfinancial firms*
- **Methods of evaluation:** *Similar to nonfinancial firms*
- **Loan Size/Type:** *Similar to nonfinancial firms (i.e., large).*

Credit Analysis Comparison for Different Customers

- ***Sovereigns***
- **Capacity:** *Financial factors including the country's external debt load and debt relative to the overall economy; tax receipts are important*
- **Willingness:** *Credit analysis for sovereigns is often more subjective than for financial and nonfinancial firms because the legal system and the enforcement of creditor rights is critical to the analysis. Sovereign legal risk ratings are often considered in the analysis.*
- **Methods of evaluation:** *Similar to financial and nonfinancial firms but with increased subjective analysis of the political environment*
- **Loan Size/Type:** *Similar to nonfinancial and financial firms (i.e., large).*

Credit Risk Measurement

Credit risk measurement requires Modelling of its drivers:

- – Distribution of default probabilities
- – Loss given default
- – Credit exposures

Drivers of Credit Risk

- Probability of Default (PD)
- Credit Exposure (CE) or Exposure at default (EAD)
- Loss given default (LGD)

Modelling Default Risk

- Heuristics/Expert Systems - These methods are designed to mirror human decision-making processes and procedures. These methods are also known as “expert systems,” with a goal of reproducing high frequency standardized decisions at the highest level of quality at a low cost. The fundamental idea is to learn from both successes and errors.

Modelling Default Risk

- An expert system may also incorporate “fuzzy logic” applications. This logic applies “rules of thumb” based on feelings and uses approximate as opposed to precise reasoning. A fuzzy logic variable will not be confined to the extremes of zero and one; rather, they can assume any value that exists between the two extreme values.

Modelling Default Risk

- **Numerical methods**. The objective of these methods is to derive optimal solutions using "trained" algorithms and incorporate decisions based on relatively weak information in very complex environments. An example of this is a "neural network", which is able to continuously update itself in order to incorporate modifications to the environment

Modelling Default Risk

- **Logistic regression models** (also known as **LOGIT models**), which are from the Generalized Linear Model (GLM) family, are statistical tools that are also used to predict default. These types of models are based on analyzing the dependencies of one or multiple dependent variables from one or more independent variables.
- GLMs typically have three common elements:
  A *systematic component*, which specifies the variables used in a linear predictor function.
  A *random component*, which identifies both the target variable and its associated probability function.
  A *link function*, which is a function of the target variable mean that the model ties to the systematic component.

Modelling Default Risk

- Assume that π represents the probability that a default event takes place. The link function represents the logarithm of the ratio between the default probability and the probability that the firm continues to be a performing borrower (the ratio is known as *odds*). The LOGIT (i.e., logarithm of odds) equation is therefore:

$$LOGIT\ (\pi_i) = log\ \frac{\pi_i}{1 - \pi_i}$$

- The LOGIT function associates the expected value for the dependent variable to the *linear* combination of independent variables, whereas the relationship between the probability of default (π) and the independent variables is *nonlinear*.

In the event that there is only one explanatory variable, the LOGIT function becomes:

$$\frac{\pi_i}{1 - \pi_i} = e^{b_0 + b_1 x_1}$$

Modelling Default Risk

- **Cluster analysis** looks to identify groups of similar cases in a data set. Groups represent observation subsets that exhibit homogeneity (i.e., similarities) due to variables' profiles that allow them to be distinguished from those found in other groups. In the context of a database with variables in columns and observations in rows, cluster analysis serves to aggregate borrowers based on the profile of their variables. The end result is a top-down, statistically based segmentation of borrowers. An empirical default rate can be calculated for each segment, which serves as the default probability for the borrower at each segment
- **Market-price methods:** infer risk-neutral measurements from traded prices (including a risk premium) of debt, equity or credit derivatives.

Modelling Default Risk

- Determining default probability can be based on (1) analysis of historical default frequencies of a borrower's homogenous asset classes, (2) mathematical and statistical tools, (3) a hybrid approach that combines mathematical and judgmental analyses, and (4) implicit default probabilities from market prices of publicly listed counterparties.
  Default risk is typically measured over one year. However, cumulative default rates extending beyond one year are important. Shorter exposures, such as overnight lending, are also exposed to default risk.

Modelling Default Risk

1) Analyzing historical default frequencies of a borrower's homogenous asset classes.
Historically, credit analysis was based on subjective analysis, and rating agencies assigned ratings and historical default rates on past observations on an ex post basis (i.e., after an event).
2)*Using mathematical and statistical tools*. Statistical models are typically used for large portfolios with hundreds or even thousands of positions, which allows for segmentation into different risk classes, measuring risk on an ex ante basis (i.e., before an event).
3) *Using a hybrid approach that combines mathematical and judgmental analyses*. The mathematical results are generated automatically, which are then corrected using qualitative analysis.

Modelling Default Risk

- Logistic regression: Logistic regression is a statistical method used to model the relationship between a binary dependent variable (e.g., default or no default) and one or more independent variables (e.g., borrower's characteristics, credit history, macroeconomic factors). The model estimates the probability of default based on the input features.
- Linear probability models: Linear probability models use ordinary least squares (OLS) regression to model the relationship between the probability of default and the independent variables. Although less commonly used than logistic regression due to its limitations, linear probability models can still provide valuable insights.
- Survival analysis: Survival analysis models the time until a borrower defaults on their loan. Techniques such as the Cox proportional hazards model or the Kaplan-Meier estimator can be used to estimate the hazard rates and the probability of default over time.

Modelling Default Risk

- Decision trees: Decision trees are a machine learning technique that involves recursively splitting the dataset into subsets based on the values of the input features. The final output is the probability of default for each group of borrowers. Decision trees can be easily visualized and are simple to interpret.
- Support vector machines: Support vector machines (SVM) are a machine learning technique used for classification tasks, including binary classification like default prediction. SVMs can model complex relationships between input features and the probability of default by using kernel functions.
- Neural networks: Neural networks are a class of machine learning models that can approximate complex non-linear relationships between input features and the probability of default. These models consist of multiple layers of interconnected neurons, which are trained using backpropagation algorithms.
- Bayesian networks: Bayesian networks are graphical models that represent the probabilistic relationships among a set of variables. They can be used to estimate the probability of default by considering the joint probability distributions of the variables involved.

Modelling Default Risk

- Recovery risk is a conditional metric assuming that default has already occurred. The amount of recovery depends on (1) the type of credit contracts used and the relevant legal system, (2) general economic conditions, and (3) covenants. Estimating the recovery rate on ex ante basis is challenging due to the difficulty in collecting recovery rate data, uniformity of information, and challenges in creating a comprehensive model. Exposure risk is easily determined for term loans. For revolving credit facilities, exposure depends on borrower behavior and external events.

Measuring Credit Loss

- The distribution of expected losses due to credit risk from a portfolio of N instruments can be

described as:

$$ECL = \sum_{i=1}^{N} b_i \, X \, CE_i \, X \, p \, X \, (1 - f_i)$$

- Where bi is a Bernoulli random variable (1=default, 0=No default), CEi is credit exposure at the time of default. P is the probability of default and f_i is the credit recovery rate.

Recovery Rates -Recovery rates tend to be lower when the economy is in a recession. Suppose that default is accompanied by a declaration of bankruptcy. The bankruptcy process creates a pecking order for a company's creditors. The recovery rate will vary by the position in the pecking order (status or seniority of the debtor) and the value left after liquidation of the firm's assets.

Measuring Credit Loss

- Exposure risk measures the amount of risk a firm is exposed to in the event of a default. For term loans, exposure is easily determined. For revolving credit facilities, determining exposure is more challenging since it depends on borrower behavior and external events. In this situation, exposure risk [i.e., **exposure at default** (EAD)]

- Recovery risk measures the risk that the amount recovered, in the event of a default, is less than the full amount that is due. The recovery rate is a conditional metric expressed as a percentage which assumes that default has already occurred. It is the complement to **loss given default** (LGD) such that the recovery rate equals 1 - LGD. The amount of recovery depends on the following factors:
  -*The type of credit contracts used and the relevant legal system*.
  -*General economic conditions*. Firms operating in more volatile sectors may see larger swings in asset values.
  -*Covenants*. Negative covenants restricting the sale of assets that are important to the borrower should be considered in LGD estimations

- Alternatively then Expected Credit Loss can be calculated as:
  - ECL = PD X LGD X EAD

Example

- An analyst's credit management desk is involved with 3 classes of borrower's namely: students, small businesses and financial institutions. The analyst estimates that the expected credit losses from each borrower class would be 9%, 16%, 6% and that the aggregate credit loss would be $60M. The analyst assumes a Gaussian distribution function for loss distributions of the categories. They estimated the annual default correlations naively by a Pearson correlation coefficient across the categories and found this to be zero, although the analyst insisted in the report that this did not strictly imply probabilistic independence. He further reported that 99% VaR for the portfolio was 12.5% and that the total credit desk portfolio amounted to $600M. He however failed to provide the credit exposure for each borrower class. Determine the credit exposures for each class of borrower. (10 Marks)

- 99% VaR = 12.5%
- Aggregate Desk Loss = 10%
- Individual Category Loss = 9%, 16%, 6%

- **10%=w1*9% + w2*16% + w3*6%**
- **W1+w2+w3=1**
- **12.5%=w1*9% + w2*16% + w3*6%**
- **- 2.33*sqrt(variance(9%,16%,6%))**

- **TO FIND THE REQUIRED EXPOSURES WE NEED TO SOLVE FOR THE WEIGHTS.**

- **12.5%=mean - (quantile intervale*SD)**

- In portfolio, could be a combination of assets or individual desks
- For either Returns or Losses (X OR X),
  - $Y=w1*A+w2*B+w2*C$
  - $E(Y)=w1*E(A)+w2*E(B)+w2*E(C)$
  - $VAR(Y)=w1^2*Var(A)+w2^2*Var(B)+w2^2*Var(C)$
    $+ 2w1*w2*Cov(A,B)$
    $+2w2*w2*Cov(B,C)$
    $+2w1*w3*Cov(A,C)$

- $E(X)=w1*E(Ind1) +w2*E(Ind2) + w3*E(Ind3)$
- $VAR (X) =w1^2*Var(Ind1)+w2^2*Var(Ind2)+w2^2*Var(Ind3)$
  $+ 2w1*w2*Cov(Ind1,Ind2)$
  $+2w2*w2*Cov(Ind2,Ind3)$
  $+2w1*w3*Cov(Ind1,Ind3)$

Determine the 99% VaR, 95% VaR, 99% ES, 95% ES for the Portfolio.

	Assets 1	Asset 2	Asset 3
Mean	10%	15%	8%
Std. Deviation	13%	20%	15%
Portfolio Weighting	30%	45%	25%
Correlation Relationship (\rho)	0.6	0.8	-0.8

Hint: *Cov(A,C)=\rho * std.dev(A)* std. dev(C)*

Consider 2 contexts – first a MARKET RISK CONTEXT, & CREDIT RISK

- Credit loss is the amount of money a lender loses when a borrower fails to repay a loan or meet their financial obligations. It is a crucial aspect of risk management in the financial industry. Measuring credit loss involves estimating the likelihood and magnitude of potential losses.

- Probability of Default (PD): This is the likelihood that a borrower will default on their loan within a specific time horizon, typically expressed as a percentage. PD can be estimated using historical data, credit scoring models, and macroeconomic factors.
- Exposure at Default (EAD): EAD represents the total outstanding balance a lender is exposed to at the time of default. It includes principal, interest, and any fees that the borrower owes when they default on their loan. EAD can be estimated by analyzing a borrower's credit limit, outstanding balance, and repayment behavior.
- Loss Given Default (LGD): LGD is the proportion of the outstanding balance that the lender expects to lose after the borrower defaults, considering any recoveries from collateral, legal actions, or debt sales. LGD is expressed as a percentage and can be estimated using historical loss data, collateral values, and recovery rates.
- Expected Credit Loss (ECL): ECL is the product of PD, EAD, and LGD, representing the average loss a lender expects to incur over a given time horizon. ECL helps lenders estimate the total credit loss across their loan portfolio and set aside appropriate provisions for potential losses. ECL can be calculated as follows:

$$ECL = PD * EAD * LGD$$

Measuring Credit Loss

- Concentration was traditionally mitigated by minimizing exposure to a single borrower. Portfolio credit risk models specifically factor in a borrower's risk contribution to concentration, and allow for segmentation of portfolio risk or viewing the portfolio risk profile as a whole.
- Concentration risk arises in credit portfolios where borrowers all face common risk factors, including interest rates, exchange rates, and changes in technology. Facing common risks is problematic since they simultaneously affect a borrower's willingness and ability to repay their obligations.

Measuring Credit Loss

- However, actual losses may be different from expectations, resulting in **unexpected losses** (ULs). ULs are problematic because they can jeopardize the viability of a bank as a going concern. Banks can prepare for ULs by holding sufficient equity capital to cover all risks, not just credit risks. Capital can be replenished from profits in good times, which can absorb ULs. Credit risk models and credit ratings are important in determining the overall credit contributions needed by banks

Measuring Credit Loss

- Stress testing: To account for potential changes in economic conditions, lenders may perform stress testing on their loan portfolio. Stress testing involves simulating various adverse economic scenarios to assess their impact on credit losses and the financial stability of the lender.
- Credit loss reserves and provisions: Lenders set aside a portion of their income as credit loss reserves or provisions to cover expected and unexpected losses from their loan portfolio. These reserves act as a financial buffer and help maintain the lender's financial stability in case of increased defaults or economic downturns

Credit Scoring Process

- Data collection: The first step in credit scoring is gathering relevant data on the borrower. This typically includes personal information, credit history, employment details, income, and current financial obligations.
- Data preprocessing: The collected data is cleaned and transformed to ensure it is accurate and consistent. This process includes handling missing data, converting categorical variables into numerical values, and normalizing or scaling data.
- Feature selection: In this step, important variables, or features, are identified that have a significant impact on the borrower's creditworthiness. Feature selection helps in reducing the complexity of the model and improving its performance.
- Model development: Various statistical and machine learning models are used to analyze the relationship between the selected features and the borrower's creditworthiness. Common models include logistic regression, decision trees, random forests, support vector machines, and neural networks.

Credit Scoring Process

- Model validation and calibration: The developed model is validated using a portion of the dataset that was not used during model development. This helps in assessing the model's performance and ensuring that it is not overfitted to the training data. The model may also be calibrated to align the predicted probabilities with the observed probabilities.
- Credit score calculation: Based on the developed model, a numerical credit score is calculated for each borrower. This score typically ranges from 300 to 850, with a higher score indicating a lower risk of default.
- Score interpretation: Lenders use the calculated credit score to make decisions about extending credit, setting interest rates, or determining credit limits. Generally, a higher credit score indicates a more creditworthy borrower, resulting in more favorable loan terms.
- Regular updates and monitoring: Credit scores are not static and should be updated regularly to account for changes in the borrower's financial situation or behavior. Lenders and credit bureaus should also monitor the performance of the credit scoring model to ensure its accuracy and relevance over time.

- End.