Credit Risk Basics

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Outline

Main Learning Goals of the lecture:

- Understand what constitutes Credit Risk and how it is different from other types of risk (market)
- Introduce you to the basic derivatives subject to Credit Risk : loans, bonds, basic knowledge on CDS
- Know the main components of Credit Risk: Exposure at Default, Probability of Default, and Loss Given Default
- Credit Scoring

Topics:

1. Categories of Risk
2. Components of Credit Risk
3. PD, EAD, LGD
4. Basic Credit Instruments
5. Credit Risk at current times

Categories of risk

The risks faced by financial institutions largely fall into the following broad categories:

- Market risk:Market risk is the risk or loss in a financial instrument due to adverse changes of the market price of that instrument
  - Interest rate risk
  - Exchange rate
  - Stock (equity)
  - Commodity prices

- Liquidity risk: the risk that the costs of adjusting financial positions will increase substantially or that a firm will lose access to financing.

- Operational risk: the risk of fraud, system failures, trading errors (e.g., deal mispricing), and many other internal organizational risks.

Credit and risk , and what is different from market risk

Credit Risk

1. Credit risk is a form of performance risk in a contractual obligation: involves default risk and downgrade risk.
2. Counterparty credit risk, inherent to trading: relates to the risk that the counterparty will default prior to the expiration of the contract.
3. Credit derivatives, such as credit default swaps, in which financial institutions are active players.
4. It is also high relevant to insurance companies.

Differences between market and credit risks:

- Credit risk is a form of performance risk in a contractual obligation whereas market risk derives from changes in the value of traded securities or held contracts
- There is a difference in time horizon: market risk typically measured over short time periods (daily), credit risk is typically measured over longer periods (annually)

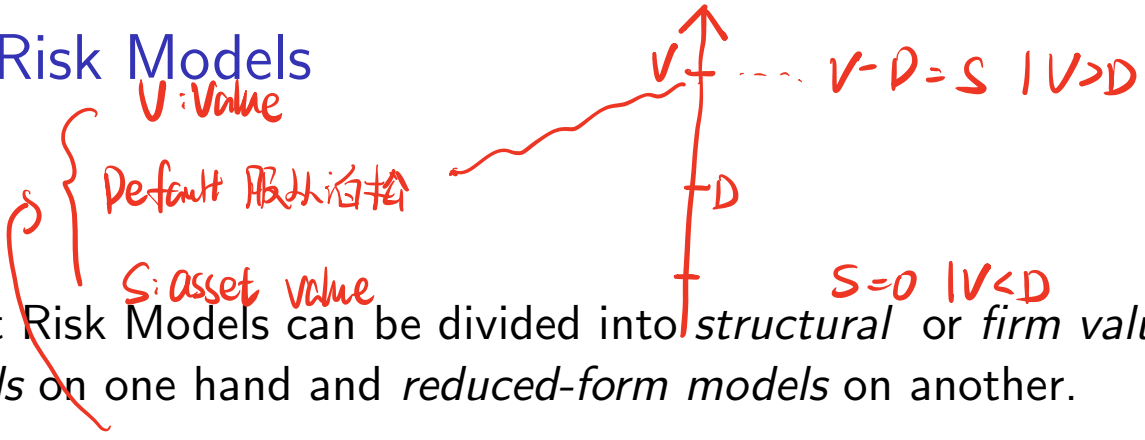
Management of Credit Risk

1. Determine the capital it should hold to absorb losses due to credit risks, for both regulatory and economic principles
2. Manage Credit Risk on a balance sheet: portfolios of credit-risky instruments are well diversified and optimizes according to risk-return considerations
3. Hedging risk concentrations with credit derivatives
4. Manage portfolios of traded credit securities : pricing, hedging and managing collateral
5. Counterparty Credit Risk in their trades and contracts with other institutions . Now becoming even more important

BS assumption: P is positive

In 2008: adverse , P negative

Credit Risk Models



Credit Risk Models can be divided into *structural* or *firm value models* on one hand and *reduced-form models* on another.

1. In a structural model default occurs when a stochastic variable, generally representing an asset value, falls below a threshold, generally representing liabilities.
2. In reduced form model the precise mechanism leading to default is left unspecified and the default time of a firm is modeled as a non-negative random variable (r.v.) whose distribution typically depends on economic covariables.

Credit Risk

Definition(s)

- **Credit Risk** *is the risk that an obligor does not honor his payment obligations.*
- **Credit Risk** *is the possibility of a loss resulting from a borrower's failure to repay a loan or meet contractual obligations. Traditionally, it refers to the risk that a lender may not receive the owed principal and interest.*

Example of obligor

- A company that has borrowed money from a bank.
- A company that has issued bonds.
- A household that has borrowed money from a bank, to buy a house.
- A financial institution that has entered into a bilateral financial contract (e.g. a forward, an interest rate swap) with another bank.

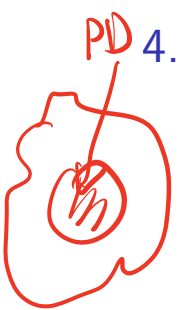
Example of default

- A company goes bankrupt.
- As company fails to pay a coupon on time, for some of its issued bonds.
- A household fails to pay amortization or interests on their loan.
- A financial institution fails to meet the contractual obligations on a swap payment date.

Expected Loss (EL)

EAD: 暴露在risk下的value
LGD: Default下的loss
PD: default prob

1. The basic idea of any insurance is that one calculates the expected cost of protection.
2. For bank loans, the arguments are the same: they charge the appropriate risk premium for every loan and collect those in an internal bank account, creating expected loss reserve as a cushion for covering losses arising from defaulted loans.
3. Bank assigns to every customer a *probability of default* **PD**, a loss fraction called the *loss given default* **LGD**, and the exposure at default **EAD** subject to be lost in the considered time period.



4. The loss of any obligator is then defined by a *loss variable*

$$\tilde{L} = EAD \times LGD \times L, \text{ with } L = \mathbb{1}_D, \mathbb{P}(D) = PD \qquad (1)$$

PD: $\mathbb{E}[I_D] = \mathbb{P}(D=1)$
I_D { 1 default, 0 else }

where D denotes the event that the obligator defaults in a certain period of time, and $\mathbb{P}(D)$ stands for the probability of D.

Calculation of expected loss

- As usual, the underlying model is a probability space $(\Omega, \mathcal{F}, \mathbb{P})$, sample space Ω (events), σ-algebra $\mathcal{F}$ and probability measure $\mathbb{P}$.
- The quantities PD, LGD, EAD are measured w.r.t. specific time horizon.
- Given loss variable its expectation call the *expected loss* of the underlying credit-risky asset.

$$EL = \mathbb{E}_{\mathbb{P}}[\tilde{L}]$$

- If the constituents of $\tilde{L}$ in 1 are independent than the expected loss can be written as

$$EL = \mathbb{E}[EAD] \times \mathbb{E}[LGD] \times PD$$

R.V R.V Const

Recovery rate

RR = 1 - LGD

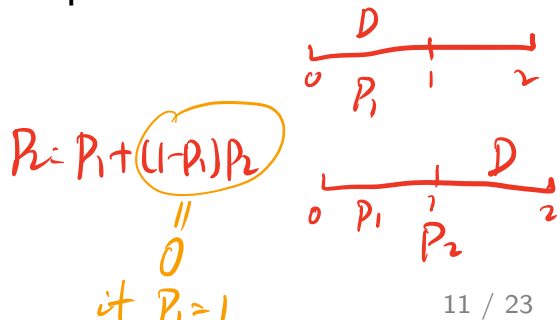
PD always in Basic point.

Probability of Default, **PD**

1. Probabilities of default (PD) are very important for credit analytics.
2. It is not sufficient to know probabilities w.r.t. one particular time horizon. We need a whole *term structure*

$$p(t)_{t\geq 0}$$

of default probabilities where t denotes time and for each t we are looking at default probability in the interval $[0, t]$.
3. There are different methods to come up with PD.



How to estimate PD's

In measuring the risk of losses over a fixed time horizon, we are particularly concerned with estimating the probability that obligator default by the the time horizon.

(a.) Casual models seek to identify the causes of default.

(b.) Historical frequencies models assign an obligator to a class based on the risk characteristics of the borrower at the time of the origination of the loan, and estimate of PD based on historical default rate of the members of the class. Typical class choices for corporations include the industry, size, etc

(c) Credit scoring models resemble historical, but they include a wider class of comparables, using firm-specific and market information, including statistical information for firms of different industries and sizes to calibrate PD for a particular company.

(d). Credit rating agency models are used in markets where credit ratings are issued by credit rating agencies , such s Moody's, Standard& Poor (S&P), and Fitch Ratings.

Credit rating (for "big" borrowers)

Credit assessment and evaluation for companies and governments is generally done by a recognized credit rating agencies such as:

1. **Moody's**, Moody's : Aaa, Aa, A, Baa, Ba, B, Caa, Ca, C ; link Moodys
2. **Standard & Poor's (S&P)** , S&P : AAA, AA, A, BBB, BB, B, CCC, CC, C; link S&P
3. **Fitch**, link Fitch

Aaa/AAA is the best rating all the way to C. Only bonds with ratings of Baa/BBB or above are considered to be **investment grade**, in contrast to **speculative/non-investment/high-yield grade**.

S&P Ratings Categories

General summary of the opinions reflected by our ratings

Investment Grade	**AAA**	Extremely strong capacity to meet financial commitments. Highest rating
	AA	Very strong capacity to meet financial commitments
	A	Strong capacity to meet financial commitments, but somewhat susceptible to adverse economic conditions and changes in circumstances
	BBB	Adequate capacity to meet financial commitments, but more subject to adverse economic conditions
	BBB-	Considered lowest investment-grade by market participants
Speculative Grade	**BB+**	Considered highest speculative-grade by market participants
	BB	Less vulnerable in the near-term but faces major ongoing uncertainties to adverse business, financial and economic conditions
	B	More vulnerable to adverse business, financial and economic conditions but currently has the capacity to meet financial commitments
	CCC	Currently vulnerable and dependent on favorable business, financial and economic conditions to meet financial commitments
	CC	Highly vulnerable; default has not yet occurred, but is expected to be a virtual certainty
	C	Currently highly vulnerable to non-payment, and ultimate recovery is expected to be lower than that of higher rated obligations
	D	Payment default on a financial commitment or breach of an imputed promise; also used when a bankruptcy petition has been filed or similar action taken

Balance Sheet Scorings

- In some situations the casual approach is difficult to follow, and many companies do not have external rating (assigned by a rating agency)
- In such cases, balance sheet scoring model is the usual approach to assign a bank-internal rating to such companies.
- It is done by the credit analyst based on various qualitative and quantitative drivers of the economic future of the firm, such as
  1. Future earnings and cashflows
  2. Debt, short and long term liabilities, and financial obligations
  3. Capital structure
  4. Liquidity of the firm assets
  5. Particular market (industry) where company has the main activities
  6. Management quality

Calibration of Default Probabilities to Ratings

- The process of assigning a default probability to a rating grade is called *calibration*

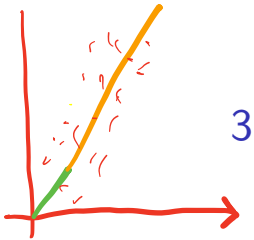
$$R \mapsto PD(R)$$

historical (R) R: rate
1990 today
Calculate mean(R) and std(R)

- Moodys' has a huge database of historic default frequencies of corporate bonds. With use of that information, the calibration steps are as follows:
  1. Calculate the historic default frequencies $h(R_i)$ of rating class R for different years i. Compute the mean $m(R)$ and standard deviation $s(R)$
  2. Plot the mean values $m(R)$ vs rating class converted to numbers. The empirical evidence shows that default frequencies grow exponentially with decreasing credit score. For that reason, one has to choose a logarithmic scale, i.e fit $\ln(PD(x))$ vs rather than probabilities
  3. The last step is to perform a regression, and calculated the probabilities based on that regression. Based on that regression, even the best rating Aaa has a small but positive default probability

AAA
B

$\ln(m_i) \to i$



Exposure at Default, **EAD**

Stochastic

The risk of a credit loss is affected by three, generally related quantities: the *exposure at default* (EAD) ; the *probability of default*. (PD), and the *loss given default*, (LGD)
We start with EAD. In some cases, easy to determine (for example, for a loan, it would be a principal). However, there might be complications such as

(a.) Uncertainty of the lost interest payments.

has maximum

(b.) Further source of uncertainty is due to use of credit lines (draw credit at time of financial difficulty)

(c) Counterparty Risk Exposure could be a stochastic variable depending on a market risk factors

(d) Use of collateral can reduce EAD.

Loss Given Default, LGD

1. In case of default, it is unlikely that the entire exposure is lost. For example, when a mortgage holder defaults, the lender can sell the property. Similarly, bondholders could be recompensed for a loss by the sale of the firms assets.
2. Practitioners use the term LGD to describe the proportion of the exposure that is lost in the event of default, or its converse, the recovery, to describe the amount of the exposure that can be recovered through debt restructuring and asset sales. To come up with LGD, several factors can be taken into account
   (a) Debt maturity and seniority
   (b) Macroeconomic environment
   (c) Industry
   (d) Firm specific capital structure

Loans

Loans are the oldest credit- risky instruments and come in a myriad of forms. It is common to categorize them according to the type of obligator.

1. Retail Loans, to individual and small to medium-sized companies
2. Corporate Loans , to larger companies
3. Interbank Loans; Sovereign loans, to governments

The common feature of most loans are the following:

- A sum of money, known as a *principal*, is advances to the borrower for a particular term in exchange for a series of defined interest payments, which can be fixed or floating interest rates
- at the end of the term the borrower is required to pay back the principal
- There are *secured* and *unsecured* lending. If a loan secured, the borrower has pledged an asset as a collateral for the loan;
- Unlike bonds, loans are private arrangements between borrower and the lender, with a wide variety of legal features

Bonds

- Bonds are publicly traded securities issued by companies and governments that allow the issuer to raise funding on financial markets. Bonds issued by companies are called *corporate* bonds, and bonds issued by governments are known as *treasuries*, *sovereign bonds*.
- The structure of the payoff is akin to that of a loan. The security commits the bond issuer (borrower) to make a series of interest payments to the bond buyer (lender) and pay back the principal at a fixed maturity. IR payments, or coupons can be fixed, or floating. The reference for the floating rate is often LIBOR (the London Interbank Offered Rate).
- There are also *convertible* bonds which allow the purchaser to convert them into shares of the issuing company at predetermined times.
- A bondholder is subject to a number of risks: IR risk, spread risk and default risk.
- Spread risk is a form of market risk that refers to changes in credit spreads, it will be discussed in details later in the course.

Credit Default Swaps and Related Credit Derivatives

- Credit Derivatives are securities that primarily used for the hedging and trading of credit risk. The pay-off of a credit derivative is related to credit event affecting one or more firms.
- Major participants in the market for credit derivatives are banks, insurance companies and investment funds. Retail banks are typically net buyers of protection .
- *Credit Default Swaps*, or CDSs are the workhorses of the credit derivatives markets. The market for CDSs written on larger corporation is fairly liquid. A CDS is a contract between two parties: the *protection buyer* and the *protection seller.* The pay-offs are related to the default of a reference entity.
- There are a number of technical and legal issues in the specification of a CDS: the precise definition of a default event and on a procedure to determine the size of the default payment. Some standardization are due to the efforts of International Swaps and Derivatives Association (ISDA).
- Main reason to enter into CDS contracts is hedging against losses in case of default; also traded for speculative reasons.

Managing and Monitoring Credit Risk in the current times

- **The credit downturn caused by COVID-19 has been abrupt and severe, with a tremendous variance of impact across different corporate sectors**.

- *The conditions that the COVID-19 crisis triggered have specific implications for managing and mitigating credit risk*: In the past three months, banks have been adjusting to the new dynamics and exploring potential new approaches to the challenges. The analyses gauge the impact of the crisis on national or regional economies as a whole, the impact by sector and subsector and specific credit-risk problems requiring real-time monitoring.

Toward real-time, data-driven analysis and decision making

- The conventional sources of data typically used in credit-risk assessments became obsolete overnight. The crisis presented itself as a powerful exogenous shock at the end of a largely benign global credit cycle. Both supply and demand were equally suppressed, suddenly. Also suddenly, the six- or 12-month-old data on which lenders relied in the past were no longer useful in evaluating the resilience of individual borrowers. Creative approaches to acquire and utilize high-frequency data are the order of the day.
- In response to the crisis, leading financial institutions are beginning to approach underwriting and monitoring with a new configuration of sector analysis, borrower resilience, and high-frequency analytics. A key trend we have observed is that leaders are moving relatively quickly from a sector view to a subsector view and finally an obligor view, using real-time data and analytics, which then supports decision making.