Chapter 17
Types of Credit Structure
Terminologies

- Credit Structure or Credit Facility
  - An agreement between a bank and a customer that creates credit exposure

- EAD (Exposure at Default) or LEQ (Loan Equivalence)
  - The outstanding amount at the time of default

- LIED (Loss in the Event of Default) or LGD (Loss Given Default) or S (Severity)
  - \[ \text{LIED} = \frac{\text{EAD} + \text{Admin} - \text{Recoveries}}{\text{EAD}} \]
• PD (Probability of Default) or EDF (Expected Default Frequency) or Default Rate
• The EAD and LIED are strongly influenced by the type of credit structure
For Company Customers

- Credit exposures to large corporations
  - Commercial loans
    - Secured vs. Unsecured (有無collateral)
    - Collateral: traded securities, inventories, buildings, the rights to a stream of cash flows
    - Unsecured loan: Senior vs. Subordinated (junior)
    - Credit-risk measurement for loans: collateral type, the level of seniority, the maturity, and the scheduled cash flow
    - Syndicated loan (增加secondary trading的可能)
Commercial lines

- A line of credit is also known as a revolver or a commitment
- Historical studies show that companies going into default tend to draw down more than healthy companies
- Three models used for the EAD of a line of credit
  - $EAD = A \times \text{Drawn Amount}, A \geq 1$
  - $EAD = B \times \text{Line}, 1 \geq B \geq 0$
  - $EAD = \text{Drawn Amount} + C \times (\text{Line} - \text{Drawn Amount}), 1 \geq C \geq 0$
- The bank charges the company one rate of interest (cost of debt + cost of capital) for the drawn portion and another lower rate of interest (cost of capital) for the additional amount that the bank has committed to lend
Letters of credit and guarantees

- Trade LCs (for importer) vs. Backup LCs (for credit enhancement)
- The credit risk of backup LCs is considered as a full loan, and the customer is charged for the economic capital the bank set aside in case the customer defaults

Leases

- Leases are a form of collateralized loan
- In terms of credit risk, lease is equivalent to giving the customer a loan, having them buy the equipment, and pledging the equipment as collateral to secure the loan
- The bank may or may not have a further claim on the company if the value of the equipment is less than the amount of the loan
Credit derivatives

- They are designed so their values are determined by credit events, such as a default or a down-grade

Credit derivatives的用處

- It is easy to transfer credit risk without transferring the ownership of a loan
- 容許部份credit risk轉移 (例如只轉移default risk，而不考慮down-grade risk)
- 可只針對某種credit risk (credit event)設計
- **Type 1:** total return swap (all the credit risk is transferred) (很像equity swap，可以很容易的轉移債權)

- **Type 2:** if the corporation defaults, the credit buyer pays a fixed amount to the credit seller and the contract terminates (很像insurance) (In such contract, however, there is the possibility of the bank making a loss or profit if the actual LIED is different from the derivative payment)
For Retail Customers

- Credit exposure to retail customers
  - Personal loans
    - They are typically unsecured
    - They are generally amortizing loans
  - Credit cards
    - The interest-rate is 10%~15% above the floating prime rate
  - Car loans
    - Similar to personal loans, except they are for a specific purpose and have the car as collateral
  - Mortgages
    - Loan-to-value (LTV) is set to be less a level, i.e. 80%
- Leases and Hire-purchase agreements
  - For leases, the customer makes regular payments to cover the interest and the depreciation, and has the option to buy the asset at the end of the lease
  - Hire-purchase agreements are similar to leases except that the payments include the full value of the asset
  - Theses agreements are similar to car loans in that they are secured by the physical asset owned by the bank until finishing all lease payments

- Home-equity lines of credit (HELOC)
  - A HELOC is like a credit card but secured by the customer’s house
  - This ensures a low probability of default
  - HELOCs are generally subordinated to the customer’s primary mortgage
In summary about the retail customers

- Loans to retail customers are relatively small
- The terms of the agreements between a bank and its customer are much more standardized
- Only a small amount of information is known about each customer, but the average behavior of a large number of customers can be predicted well by analyzing the historical data

FICO score model by Fair Isaac Corporation

- Input: age, income, total number of cards, number of delinquencies in the last three years
- Output: score for a retail customer on probability of default, probability of delinquency, or probability of the customer’s actually using a credit card

一般對於640分以下的放款，稱為subprime
Credit exposures in trading operations

- Bonds
  - Changes in value due to the interest rates and spread for a given rating are treated as market risks
  - Changes in value due to the downgrade and actual default are treated as credit risks (一般來說，downgrade的損失小，所以credit risks大多是指真正違約時的損失)
  - 因為在快要破產前，bonds的流動性差，使得此時的bonds很像loans，同時，bonds的credit risk也和loan很像，與其seniority與是否有collateral有關
For Counterparties of Trading Operations

- Asset-backed securities
  - Illustration of an Asset-backed security in Figure 17-1
  - The probability of underpayment depends on the seniority of the tranche, the degree of overcollateralization, and the volatility of the value of the assets
  - 如果銀行順利賣出證券化資產，則不需為此部分準備 regulatory capital，但若賣出的都是評等高的債券，自己留下評等低的債券，則EC其實不該減少很多
  - 在上述情況下，若投資人只看到regulatory capital，而非EC，則會誤以為此銀行很安全，而讓銀行得到很便宜的資金，但銀行卻是從事高風險，(希望)高報酬的投資
  - 計算ABS之credit risk與分析一個portfolio of loan一樣，要先估計收入之機率分配，此部份與個別資產的風險與資產間的相關性有關，然後再看是否足夠支付ABS債券
Securities lending and Repurchase Agreements

- From a credit-risk perspective, both securities lending and repurchase agreements (repos) are short-term collateralized loans.
- For securities lending, the collateral is typically cash.
- Reops: 银行用证券去换钱，保证之后额外多付一些钱买回
- Credit risk 何时发生
  - Counterparty defaults
  - 借出的证券价值上升，且高於现金抵押或银行准备付出拿回证券的钱
  - P.240 Figure 17-2 (假设counterparty risk与security value无关)
    $$\text{Average Exposure} = \int_0^\infty \max[0, V - C] pr(V) dV$$
    $$= \int_C^{\infty} (V - C) pr(V) dV$$
■ Margin accounts

- A margin account is another form of collateralized loan

- In a margin account, a customer takes a loan from the bank, and then with the loan and his own funds, purchases a security, which is held by the bank as collateral against the loan.

- Typically, retail customers are allowed to borrow only up to 50% of the value of the securities they own.

- Margin call: if the value of the securities falls, the bank will ask the customer for more cash to maintain the 50% ratio.

- Current value of the security is $V_0$ and of the loan is $V_0/2$

  \[
  \text{Average Exposure} = \int_{0}^{V_0/2} \left( \frac{V_0}{2} - V \right) pr(V) dV
  \]
Credit exposure to derivatives

- 當衍生性商品對銀行而言是 in the money，亦即對 counterparty 是 out of the money，此時對銀行而言，才 有 default risk

- The current mark-to-market exposure is a good measurement of the credit exposures of trading counterparties

- For Vanilla Options
  - There is no credit exposure is the case of shorting option
  - For investing calls, t天後的 maximum likely exposure (MLE) 與 expected exposure (EE) (p.244 Figure 17-4, p.245 the term structure of MLE and EE)

\[
MLE_t = C(S_{t,95\%}, T-t) = C(E[S_t] + 1.64\sqrt{t}\sigma_S, T-t)
\]

\[
EE_t = \int_0^\infty C(S_t, T-t)pr(S_t)dS_t = E[(C(S_t, T-t)]
\]
◆ For FX Swaps
  - Considering a FX swap, paying $D$ dollars and receiving $P$ pounds, its value today is

  \[ V_0 = \left[ FX_{P,D} \frac{P}{(1 + r_{P,T})^T} \right] - \left[ \frac{D}{(1 + r_{D,T})^T} \right] \]

  - Current credit exposure = max$[0, V_0]$
  - $t$天後的MLE and EE

  \[ MLE_t = \max(0, E[V_t] + 1.64\sigma_V \sqrt{t}) \]

  \[ EE_t = \int_{-\infty}^{\infty} \max(0, V_t) pr(V_t) dV_t \]

  - 其實無論是vanilla option或是FX swap，對於隨機變數與其分配的假設都不符合真實的狀況，正確的做法應是把 $r_S$, $r_P$, $r_D$ 當作隨機變數，並對其分配做假設
For Interest-Rate Swaps

- Considering an interest-rate swap, receiving fixed rate every six months and paying six-month LIBOR rate, its value today is

\[
V_{\text{swap}, 0} = NPV_{\text{fixed}} - NPV_{\text{floating}}
\]

\[
= \left[ \sum_{t=T_{\text{next}}}^{T_{\text{final}}} \frac{N_r_{\text{fix}}}{(1 + r_t)^t} + \frac{N}{(1 + r_{T_{\text{final}}})^{T_{\text{final}}}} \right] - \left[ \frac{N_r_{\text{float}}}{(1 + r_{T_{\text{next}}})^{T_{\text{next}}}} + \frac{N}{(1 + r_{T_{\text{next}}})^{T_{\text{next}}}} \right]
\]

- Current credit exposure = max(0, \(V_{\text{swap}, 0}\))

- 因為利率的變動比較複雜，再加上會有多次的現金交換，\(t\)天後的MLE and EE for interest-rate swaps，沒有辦法用一個積分來表示

- 考慮模擬interest rate path，來得到\(t\)天後可能的swap value，並依此swap value的distribution，可估計出MLE與EE之term structure (p.247~248)
Mitigating credit risk when trading derivatives

- Requiring collateral
  - When the bank holds a derivative that is in-the-money, requiring at least collateral of equal value, if out-of-the-money, it is not required.
  - If derivative contracts or collateral are very volatile (e.g., collateral is stocks rather than cash), then it may require collateral higher than the contract's present value.

- Settling according to the mark-to-market
  - Similar to cash collateral, but both parties are insured, i.e., when it is not to the bank's benefit, the bank also has to pay cash collateral to the counterparty.
  - Irony is, if daily settlement is used, although it can reduce credit risk, it反而會造成交易对手的现金流量更volatile, 若交易对手的现金管理不好，反而會增加破產機率.
Early settlement in the event of a downgrade

- 與交易對手的合約中明定，若被downgrade，則立即清算。此條件對於交易對手很不好，因若它被downgrade，還要花一大筆錢來結束合約 (但必須請信評機構在downgrade前就先通知銀行)

Using a special-purpose vehicle (SPV)

- Derivative traders want to concentrate on market risks and generally do not want to be distracted by the credit risks
- 讓交易對手設立一legal separate，且AAA-rating之entity (SPV) 來處理此交易，當交易手破產時，其債務人對此SPV並無求償權，如此一來此交易之credit exposure下降
A netting master agreement (NMA)
- It is a legal agreement that covers all the derivatives transactions between two institutions
- 交易雙方可能有多個衍生性商品的交易，若有一方default，則只要依mark-to-market清算net amount即可
- 若雙方有此合約，會使得對此交易對手的credit exposure的估計變的困難，因為其實credit exposure與雙方交易的衍生性金融商品間的correlation有關，所以通常除了考慮net mark-to-market的exposure，還要加上不考慮NMA時exposure的某個比例

Counterparty exposure limits
- 接受交易對手有可能default造成損失，但限制在能接受之範圍內
- The limits have a term structure to limit the exposure at each point in the future (p.252 Figures 17-9, 17-10)
Pricing for credit risk

- 算出每個衍生性金融商品所需之EC，並將取得此EC之成本加到衍生性商品的價格上，例如，改變swap rate
- A simplified approach是將衍生性商品分為market-risk相關的部份與一個與credit exposure相同的loan，然後對此loan，charge與交易對手之債信相當的credit spread