

## FRM1 Notebook1

### Foundations of Risk Management

#### 第一部分

- 风险管理流程
  - 发现风险
  - 评估风险敞口
  - 评估综合影响
  - 风控策略（避免、转移、减轻、承担）
  - 考察效果和修正策略
- 风险
- 风险评估
  - 量化：VaR
  - 定性：场景分析
    - 定性：最坏分析
    - 定量：stress testing
  - 企业风险管理 ERM
- 风险
  - 预期风险：预先预测、计算、提供
    - 价格考虑风险
  - 非预期风险：难以预测、计算、提供
    - correlation risk：一起
      - 多样性：不同市场和行业
      - 不同时：到期时间不一样
- 风险分类
  - 市场：汇率、股票、外汇、商品
  - 信用：毁约、破产、降级、结算
  - 流动性：融资、交易
  - 操作：非金融（技术、内控、欺诈、人为）
  - 法务和监管：起诉、税收、法律
  - 商业：收入出问题、需求不多、价格过高、运营成本高
  - 战略：方向不对
  - 名誉：
- 对冲风险
  - 无价值 – 理论
    - 完美竞争市场（无交易代价和税收）
    - 关注系统风险，不需要关注非系统风险（可以通过分散）
    - 零和游戏，衍生品价格完全考虑了所有风险因子。
  - 无价值 – 实际
    - 失去重点关注核心商业
    - 没有人才
    - 有缺陷的对冲策略
    - 有 compliance 代价、泄露机密
  - 有价值
    - 降低资金成本（增加负债能力、条件限制少）

- 股价升值
  - 用交换和期权比保险便宜
  - 税收?
- BOD
  - 目标定性、量化
  - 冲突: debt and share stakeholders
  - 目标: 清楚、可行动
  - 目标: accounting vs economic (cannot at the same time)
  - 短期和长期 (增加股价),
  - use future contracts 用于 sales receipts 导致
    - profits for accounting
    - premature taxes payable
  - risk limits
- Mapping
  - Avoid, transfer, mitigate, assumption
- 对冲
  - Operational risk -> income statement
    - purchase
    - sale
  - Financial -> balance sheet
  - Pricing
    - Forward or futures
  - Currency
    - 控制未来 cash flow 或者资产负债
    - Put option, Forward contract
  - Interest rate
    - 控制 net exposure (资产或者负债)
    - swap
- ET vs OTC
  - 流动性、标准性
  - ET 无 credit risk

## Corporate Governance Risk Management

- Corporate Governance
  - Board of directors
  - Interest for shareholder and debtholder
  - Agency risk, take greater risk to maximize personal remuneration
  - **Compensation committee**
  - maintain independence from management
  - **separate** risk and audit committee
- Risk Management
  - Demand substance over form, prefer economic not account performance
  - **Ethics committee**
  - Approval for major txns
  - **Risk committee**
  - **Audit committee**

- Risk Advisory Director
  - Attend to both risk and audit committee
- Risk Management Committee
- Compensation committee
  - Ensure long-term goal
  - Independent of management
  - Stock-based, bonus bond
- Audit Committee
  - Financial reporting, regulatory compliance, internal control, risk management
  - **All** members should have sufficient financial knowledge
  - Is largely meant to be independent of management but should work and communicate
- Risk Appetite and Business Strategy
  - Tolerance to accept risk
  - Board work with management to develop overall business strategy
  - Logical relationship between them
- Interdependence of functional units

#### What's ERM?

- Risk are managed within each unit but centralized at the senior mgt
- Strong ERM strategy allows a firm to accept more of the profitable risk and reject unprofitable risks.
- Motivations
  - Integration of risk organization, risk transfer, business process
- Benefits and Costs
  - Risk Organization: Increased Organizational Effectiveness
    - Top-down, coordinated framework
  - Risk Transfer: Better Risk Reporting
    - Reporting can be inconsistent and contradictory.
    - A holistic view of all risks
    - Hedge undesirable residual risks that still remains after factoring in diversification across risks.
  - Business Process: Improved Business Performance
    - Value at risk (VaR) and risk-adjusted return on capital (RAROC)
- CRO
  - Top-level executive for all risk
  - Responsible for all risk factors
  - Develop and implement an ERM risk strategy
  - Set overall risk appetite
  - Measure and quantify risk
  - Set risk limits
  - Develop risk systems
  - Skills: leadership, power of persuasion, ability to protect the firm's assets,
    - Technical skills to understand all risks
    - consulting skills to educate the board and business functions
- Components
  - Corporate governance

- Line management
  - Relate directly to producing Products and services.
- Portfolio management
- Risk transfer
  - Undesirable or desirable but considered concentrated
  - Offloaded via derivatives, insurance, and hybrid products.
- Risk analytics
  - Quantify risk exposures
  - Internally or externally
  - Boost net present value (NPV) and economic value added (EVA)
- Data technology resources
  - Improve quality of data
- Stakeholder management
  - Shareholder, creditors, regulators, and the public

#### Risk Management, Governance Culture, and risk taking in banks

- Optimal levels of risk exposure
  - Sensitivity analysis or scenario analysis
- Bank
  - Deposits: set level of risk lower and target a higher credit rating
  - transactional activities set level of risk higher and target a lower credit rating
  - relationship between value of a bank and its credit rating is concave
- Risk taking implication
- Add or destroy value
  - If there is a very high cost of having incremental risk above the optimal level
  - Flexible to allow take profitable risk, value creation
- Challenges and limitations
  - Limitations of Hedging
    - Risk measurement technology
      - Risk buffer
    - Hedging limitations
    - Risk-taker incentive limitations
- Market
  - Risk: normal distribution
  - Credit and operational risk: fat-tailed and very skewed
- Governance
- Incentive Structure
  - Risk capital
- Risk Culture

#### Financial Disasters

##### Housing Bubble

- Cheap credit
- Decline in lending standards
  - Originate-to-distribute model

## Liquidity Squeeze

- Liquidity squeeze
  - Risk transference through asset securitization
    - Via originate-to-distribute model
  - Asset-liability maturity mismatch
    - Purchase of long-term assets through rollover of short-term debt instruments

## Securitization

- Banks transfer the default risk to investors through securitization.
- Structured products
  - CDO: collateralized debt obligations 担保债务凭证
  - Portfolio was sliced into different tranches (mainly senior, mezzanine, and equity) 分级
  - MBS(Mortgage-Backed Security)称为抵押支持债券或者抵押贷款证券化。
    - 抵押担保证券 (Mortgage-backed Security)
  - 住宅抵押贷款证券化(Residential Mortgage-Backed Securities)
  - 商用不动产抵押贷款证券化(Commercial Mortgage-Backed Securities, CMBS)

## 担保债务凭证(CDO)

- 债务债券抵押产品，把所有的抵押打包在一起，并且进行重新的包装，再以产品的形式推放到市场。
- 高级(Senior)、夹层(Mezzanine)，和低级/次顺位( Junior /Subordinated)三系列
- 另外尚有一个不公开发行的系列，多为发行者自行买回，相当于用此部分的信用支撑其它系列的信用，具有权益性质，故又称为权益性证券(Equity Tranche)
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## ABS

- 信贷资产是指银行所发放的各种贷款所形成的资产业务。
- 按保障程度(风险程度)，贷款可划分为信用贷款、担保贷款和抵押(贴现)贷款。
- 期限：贷款可分为短期、中期和长期贷款。1年以内为短期贷款；1—7年为中期贷款；7—10年为长期贷款。
- 对象和用途：工业贷款、农业贷款、科技贷款、消费贷款、投资贷款、证券贷款等。
- 质量或占用形态：正常贷款、逾期贷款、呆滞贷款、呆账贷款等
  - 逾期贷款是指超过贷款合同规定期限而银行又不同意延期的贷款。
  - 呆滞贷款是指预计两年以上时间不能归还。
  - 呆账贷款是指企业倒闭以后无力归还的贷款
- 证券化步骤
  - 银行首先向央行提出申请，
  - 经批准后，一方面
    - 将其信贷资产出售给特殊目的载体 SPV
    - 由特殊目的载体发行 ABS (资产支持证券)
    - 经投资银行承销卖给投资者

- 然后投资银行将发行收入转让给特殊目的载体，特殊目的载体按与银行签订合同中的资产出售价格转让给银行
- 另一方面，银行委托服务商向借款人收回本息，经受托人将本息偿还给投资者。
- 好处
  - 流动性：银行是短期存款，投资长期。
  - 盘活不良资产

#### CDO vs ABS

- CDO 可以采取有限度的主动管理的权利，而传统的 ABS 则属被动经营的方式
- 债务人
  - CDO: 100 到 200 人，至少 100
  - ABS: 比较多，约有上千人
- 资产池性质
  - CDO: 想异性，来源不能相同，相关性低，分散
  - ABS: 一致性高，以对现金流适度掌握
- 发行动机
  - CDO: 套利
  - ABS: 信用风险转移、筹资
- Find a diversified portfolio
  - Mortgage, corporate bonds, loans
- Slice the portfolio into tranches
  - Investable tranches
    - Most junior = equity tranche
    - Mezzanine
    - Super senior AAA
- Sell tranches to investors
  - In theory, equity tranche was retained by CDO issuer to give the bank incentive to monitor the loan.

#### Asset/Liability Maturity Management

- Structured investment vehicles (SIV) 结构性投资工具
  - borrows for the short-term by issuing commercial paper in order to invest in long-term assets with credit ratings of between AAA and BBB.
  - Long term assets frequently include structured finance products such as Mortgage-Backed Securities (MBS), Asset-Backed Securities (ABS), and the less risky tranches of Collateralized Debt Obligations (CDOs)
  - Funding liquidity risk
- Liquidity backstop 防止流动性枯竭

#### Credit Default Swaps

- Insurance contracts that pay off when some reference instrument (bond, CDO tranche) defaults.

#### Growth

- Originating institutions were in a position to offer **lower** interest rate because they could spread the risk to several investors who were willing to bear the risk.
- **Securitization** offer benefits certain institutional investors that faced regulatory prohibition against investing in, for example, less than AAA-rated securities. Even
- Provides regulatory and rating arbitrage opportunities to the originating institutions.
  - Higher rating allow a bank to meet lower regulatory capital charge requirements, without actually decrease overall risk.
  - Create an off-balance sheet entity (SIV), move pool of loans to SIV, lowering the number of loans on the balance sheet. Reduce the capital charge as mandated by Basel I
  - Sponsoring institutions granted a non-contractual credit line to SIV.
- Were given high ratings based on faulty over-optimism. Delinquency 拖欠债款

#### Consequence of financial crisis

- Delinquencies (不法行为; 少年罪犯; 过失; 罪过) and foreclosures (丧失抵押品赎回权, 排斥) started to rise.
- Repo market 回购市场; 买回市场;

#### Funding liquidity and market liquidity

- Funding liquidity refers to an institution's inability to immediately settle obligations when they are due. Illiquid 非现金的, 无流动资金的
- Collateral 担保物 pledge 使发誓, 保证; 典当, 抵押 deteriorate 使恶化
- Three forms of funding liquidity risk
  - Margin/haircut funding risk
    - A decline in the **collateral** value of an asset results in an increase in margin requirement, requiring additional equality capital
  - Rollover risk
    - Investors may not be able to roll over short-term debt to finance the purchase of an asset.
    - Short-term debt dried up, SIVs and hedge funds were unable to use the securities as collateral for rolling over debt.
  - Redemption risk
    - Depositors will withdraw funds from banks or redeem their shares
- Market liquidity
  - Define: the ease or difficulty of selling an asset to raise money.
  - Three forms
    - Bid-ask spread
      - The **difference** of the bid ask price. The higher the spread, the lower the market liquidity, and vice versa.
    - Market depth
      - The **number** of units of an asset a trader can buy or sell at the current market quote. Greater better
    - Market resiliency
      - The **length** of time it will take an asset to regain its price after the price has fallen temporarily.
- Compare
  - Selling an asset -> Market liquidity
  - Use asset as collateral to borrow money against it. -> funding liquidity

### Loss spiral and margin spiral

- Loss spiral
  - the decline leads to a cycle of further price decrease and further forced sales
  - a function of market liquidity. Low market liquidity -> greater loss
  - Predatory trading
    - Trader, already distressed from reducing his position, is forced to sell at an unnaturally low price.
- Margin spiral
  - Forced sale of an asset as a result of an increase in required margin, a decline in the permitted **leverage** ratio.
- Loss spiral, trader sell to maintain **leverage** ratio. Margin spiral: sale to fulfil a decline in the **leverage** ratio (as a result of rising margins). Consequently, all else equal, a margin spiral situation results in a lower overall position value lower borrowing amounts than a loss spiral situation.

### Network risk

- Network risk arises a result of an increase in **counterparty** credit risk, particularly in the environment of market stress. It can produce a systemic risk.
- Clearinghouse 票据交换所
- Network risk is exacerbated by the **absence** of a clearinghouse.

### A one week guide

- ABCP (asset-backed commercial paper)
  - Nonfinancial firms with high ratings raise capital by issuing short-term debt.
  - It is the bundling of longer-term debt from mortgages, credit card receivable, and other loans.
- Bank run or "run"
  - Withdraw money from any financial institutions
- Shadow bank
  - A financial institution other than a regulated depository institution.
  - regulated depository: commercial banks, thrifts, credit unions
  - shadow banks: investment bank, private equity funds, hedge funds, mortgage lenders, insurance companies.
- Repurchase agreements (repos)
  - Repos involve an institutional investor making a short- term deposit of cash with a shadow bank that in turn pays the investor interest on the cash (called the repo rate).
  - 短期抵押融资方式
  - 狭义指的是在回购协议市场出售证券等金融资产时签订的协议，约定在一定期限后按原定价格或约定价格购回所卖证券，以获得即时可用资金；协议期满时，再以即时可用资金作相反交易。回购协议从即时资金供给者的角度来看又称为"反回购协议"
  - 正回购协议，是指在出售证券的同时，和证券的购买商签订协议，协议在一定得期限后按照约定价格回购所出售的证券，从而及时获取资金的行为



- 逆回购协议(**Reverse Repurchase Agreement**), 是指买入证券一方同意按照约定期限和价格再卖出证券的协议。
- **Haircut 估值折扣**
  - A haircut is the amount of collateral in a repo agreement in relation to a deposit
- **Major contributing factor**
  - Bundling of subprime mortgages into mortgage-back securities (MBSs) as well as asset-back securities (ABSs) in the form of ABCP.
- **Process**
  - Hour price down -> the value of ABCP is reduced -> cannot reissue -> bank run -> liquidity crisis -> spread into repo (increase haircut) ->
- **Lehman brothers failure**
  - Large exposure to subprime mortgages

#### Banking crisis

- A run on banks that leads to a merger, takeover by gov. , or closure of financial institutions
- a merger, takeover, government assistance, or closure of a financial institution that spreads to other financial institutions.
- **Increase in credit** in the form of bank loan is a strong predictor of financial crisis
- an acceleration in economy-wide **leverage** in the form of external debt and domestic debt precedes a bank crisis, and these bank crises lead to sovereign debt crises.
- **Significant role**
  - The large amount of institutional case pools
- **Pattern**
  - Public and private debt, increased credit supply, and increase housing prices

#### Panic periods

- Aug. 2007, Sep 2008 to Oct 2008
- Aug. 2007
  - Runs on ABCP -> spread to MMF -> other nonmortgage assets -> Other countries
- Sep 2008 to Oct 2008
- The second panic period started when Lehman Brothers filed for bankruptcy,
- the rise in haircuts prevented Lehman access to financing in the repo markets, which led to its downfall.

#### Government Policy Responses

- **Central Bank – Monetary Policy and Liquidity support**
  - interest rate change
    - reduction of interest rates
  - **liquidity support**
    - longer funding terms, reserve requirements
- **Government - Financial Sector Stabilization Measures**
  - **Recapitalization**
    - Capital injection (common stock/preferred equity)

- Capital injection (subordinated debt)
- Liability guarantees
  - Enhancement of depositor protection/ debt guarantee
- Asset purchases
  - Asset purchases
- Economic stress index (**ESI**) and the financial stress index (**FSI**). The ESI is a composite of confidence measures from businesses and consumers, nonfinancial firm stock prices, and credit spreads.
- The FSI is an index representing a composite of stock prices, spreads, and bank credit.
- **Liquidity support** was measured using interbank spreads and the FSI.
- the most effective measures taken were the **liquidity** support stabilizing the interbank markets in the pre-Lehman period, and **recapitalization** (i.e., capital injections), which was considered the most effective tool in the latter two periods.

#### Global effects on firms and the economic

- as the global recession deepened, the demand for credit decreased
- syndicated loans
  - major source of loans made to large corporations
- financial crisis
  - main trigger: Losses on subprime mortgages
  - main vulnerability: ABCP and repo agreements
- The main vulnerability of commercial paper:
  - The inclusion of subprime mortgage in the form of MBS.
- the major impact of Lehman Brothers filing for bankruptcy was:
  - a run on money market mutual funds
- Which of the following statements best describe the factors linking the Great Depression to the most recent financial crisis
  - An increase in overall borrowing, an increase in the supply of credit, and an increase in housing prices.
- Which of the following governmental policy responses to the financial crisis was most effective in the short term?
  - Liquidity support, recapitalization

#### Risk Management Failures: What Are They and When Do They Happen?

- Process
  - identify, measure, communicate, monitor, and manage
- Process
  - The output of a particular metric (VaR) and attempts to keep the metric at a specific target amount.
- Fail
  - Not measuring known risks correctly
  - Not recognizing some risks
  - Not communicating risks to top management
  - Not monitoring risk adequately
  - Not managing risk adequately
  - Not using the appropriate risk **metrics**

- Risk mismeasurement
  - Risk managers do not understand the returns of a single risky position or the relationships of the distributions among different positions.
  - The degree to which return distributions and/or correlations can change over time.
  -

#### Efficient Portfolio

- Return and volatility of a two-fund asset
- Return/risk space, C-curve, above concave (efficient frontier), below convex
  - $P=1$ , a line
  - $P=-1$ , two line segments ( $\sigma=0$ , on point on the y-axis)
  - $P=0$ ,  $w_1 = \sigma_2^2 / (\sigma_1^2 + \sigma_2^2)$
  - $P$ , decrease, a straight line to left, to two line segments
- Minimum variance portfolio: left-most point
- short sales
  - efficient frontier expands up and to the right
  - higher return and volatility
- risk-free rate with efficient frontier
  - become a line, capital market line (CML)
  - CML is tangent to efficient frontier
  - Market portfolio P: the tangent point
  - Separation theorem:
    - Risk-averse: lending, risk-taking: borrowing

#### CAPM

- Assumptions
  - No transaction cost
  - No tax
  - Assets are infinitely divisible
  - Perfect competitive: buy and sell decisions have no effects on prices
  - Short-selling is allowed
  - Can borrow and lend unlimited amount at risk free rate
  - Only concern about returns and risks over a single period, which is the same for all investors
  - homogeneous expectations: all investors have the same forecast of returns, variances and covariances.
  - All assets are capital including human capital.
- CML
  - Slope: Sharpe ratio, market price of risk
  - CML is used to compute price for **efficient** portfolio. 算有效组合。
  - CAPM inefficient portfolio and **individual security** 无效组合和个体。
  - This universally agreed upon optimal risky portfolio is called the market portfolio, M, and it is defined as the portfolio of all marketable assets weighted in proportion to their **relative** market values.
- Beta Individual
  - $\text{Beta} = \text{covariance}(P, M) / \text{variance}(M) = \rho \sigma_p / \sigma_m$

- Estimation: regression
  - Y: asset excess return  $R_i - R_f$
  - X: market excess return  $R_m - R_f$
  - Slope is the beta
  - Line: asset's security characteristic line
- Portfolio Beta
  - The beta of a portfolio is the sum of the weighted individual asset betas within a portfolio.
- CAPM Individual
  - $R_f + \text{Beta} * (R_m - R_f)$
- Equal weight portfolio
  - $\text{Sig}^2 = 1/n \text{ avg}(\text{sig}_i^2) + (n-1)/n \text{ Avg}(\text{cov})$
  - Unsystematic risk
  - Systematic risk: covariance
- CAPM Portfolio
  - $R_p = a + \text{beta} \& m$
  - Based on
    - Portfolio beta is the weighted average of beta
    - Portfolio return is the weighted average of return
- Security Market Line
  - Space of return \* **beta**
  - Two points (risk free and market)
  - $R_i = R_f + \text{beta}_i (R_m - R_f)$

## Measure

- Sharpe ratio =  $|(R_p - R_f) / \text{sigma}|$ 
  - General
  - 分散性
- Treynor ratio =  $|(R_p - R_f) / \text{beta}|$ 
  - Compare for well-diversified
  - 系统风险
- Jensen measure =  $R_p - (R_f + \text{beta} (R_m - R_f))$ 
  - Excess return over return predicted by CAPM
  - Compare portfolio with the same beta
- Tracking
  - Alpha: Difference  $E = R_p - R_b$  (**alpha**)
  - Tracking error:  $\text{sigma}(e)$  standard deviation
  - Information ratio:  $|(R_p - R_b) / \text{sigma}(e)| = \text{alpha}_p / \text{sigma}_{ep}$
- Sortino ratio
  - Return are not symmetric 非对称
  - Replace risk free with a minimal acceptable return
  - Replace standard deviation with semi-standard deviation
  - $(E(R_p) - R_{\min}) / \sqrt{\text{MSD}_{\min}}$
  - $\text{MSD}_{\min} = \sum \{R < R_{\min}\} (R - R_{\min})^2 / N$
  - Meaning:  $\text{STD}(\max(R - R_{\min}, 0))$

## Arbitrage Pricing Theory 套利定价理论

<http://wiki.mbalib.com/wiki/%E5%A5%97%E5%88%A9%E5%AE%9A%E4%BB%B7%E7%90%86%E8%AE%BA>

- CAPM
  - Exposure (beta 相关系数) to Market portfolio
- APT
  - expected returns are determined by exposures to economy-wide risk factors
- Multifactor Model
  - $R = E(R) + \sum \beta_i * F_i + e$
  - Expected return:  $E_r$  期望值
  - Factor beta:  $\beta_i$  beta 敏感度, 变化因子
    - **sensitivity** of the stock return to a 1-unit change in the factor.
    - 用多元线性回归 multiple linear regression。
  - Factor of factor to its expected value:  $f_i$  因子差距, 变化
  - Firm-specific return:  $e$  误差, 未考虑因素
    - unexplained by macro factors
- Law of one
  - One price regardless of location
- The Law of One Price can be extended to different assets that have identical risks.
- Factor portfolios
- APT 重写
  - $E(R) = R_F + \sum \beta_i * RP_i$ 
    - $RP_i$ : risk premium
  - $E(R) = R_F + \sum \beta_i * (E(R_i) - R_F)$
- Three assumptions
  - Return follows a K-factor process:  $R = E(R) + \sum \beta_i * F_i + e$
  - Well-diversified portfolios can be formed
  - No arbitrage opportunities exist.
- Fama-French model
  - Market risk factor
  - SMB (small minus big):  $R_S - R_B$  (firm size)
  - HML (high minus low):  $R_H - R_L$  (book-to-market, book value per share divided by stock price)
  - $R - R_F = \alpha + \beta_M (R_M - R_F) + \beta_{SMB} SMB + \beta_{HML} HML + e$

## Data Aggregation and Risk Reporting

- Principle 1—Governance
- Principle 2—Data Architecture and Infrastructure
  - data characteristics (metadata) and naming conventions for legal entities, counterparties, customers, and account data.
- Principle 3—Accuracy and Integrity
  - Single source of truth
  - manual workaround
  - Data should be defined consistently across the bank. The bank may maintain a dictionary of risk data concepts and terms

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- Principle 4—Completeness
- Principle 5—Timeliness
- Principle 6—Adaptability
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- Principle 7—Accuracy
- Principle 8—Comprehensiveness
  - Relevant risks: credit risk, liquidity risk, market risk, and operational risk.
  - forecasts and stress tests
- Principle 9—Clarity and Usefulness
  - Data, analysis, interpretation, qualitative explanation
- Principle 10—Frequency
- Principle 11—Distribution

#### Code of Conduct

- Principles
  - professional integrity and ethical conduct
  - conflicts of interest
  - confidentiality
- Professional standards
  - fundamental responsibilities
  - adherence to generally accepted practices in risk management.