Lecture notes on risk management, public policy, and the financial system

Introduction to financial intermediation and financial risk

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Financial intermediation

Financial risk taxonomy

Financial intermediation

- Financial intermediaries
- Financial instruments

Financial risk taxonomy

Functions of the financial system

Resource allocation under uncertainty, over time and geographically

- Gather resources from savers/lenders, transfer to investors/borrowers, or distribute among investors
  - Savers: person or firm with a surplus
  - "Investors": person or firm using resources to add to society's capital stock, e.g. machines, education, consumer durables
- Many steps along the chain, many multilateral connections

Reduction and sharing of risk via

- Insurance and diversification
- Trading and hedging

Identification of opportunities for investment or allocation of capital

Monitoring of agents, managers, e.g. **corporate control**

Facilitate exchange of goods and services, e.g. via money and **media of exchange**

- More generally, creation of ($\rightarrow$)**liquid** assets

Financial innovation e.g. securitization, derivatives, cryptocurrencies

Constituents of the financial system

Human beings: also called i.a. **households**, **individuals**, **agents**, or **investors**

- May be organized into specialized firms called **financial intermediaries**
- Primarily banks and insurance companies, but also other types of firms
- Intermediaries *gather and create information*
  - Vetting, selecting and monitoring borrowers
- Information is costly: intermediaries are low-cost producers

Assets include

- **Financial instruments:** contracts such as equity, debt, derivatives contracts
- **Real assets:** real estate, commodities

Financial markets in which assets trade, prices set

Why is financial intermediation difficult?

- Who needs intermediaries? Intermediation should be easy through markets:

  Arrow-Debreu model: contracts now for all future states and times; trade once at the beginning of history

  Modigliani-Miller theorem: firm capital structure—mix of equity and debt financing—doesn't affect firm value

  - Households can adjust their own balance sheets

- But in the real world, costly due to **frictions**

  Incomplete markets: only a tiny fraction of the necessary **contingent claims** actually exist

  Information costs of distinguishing good from bad borrowers, monitoring, establishing **trust**

  Transaction costs of contracting, including the costs of navigating conflicts of interest

- Intermediation also displays **economies of scale**→opportunities to specialize in carrying out every aspect, e.g. mortgage servicing, factoring

Types of financial intermediaries

- **Institutional perspective:** types of firms
  - Depository institutions, e.g. banks
  - Investment companies, e.g. mutual funds, hedge funds
  - Broker-dealers
  - Insurance
  - And much more...
- **Functional perspective:** types of services
  - Asset transformation, e.g. maturity, liquidity, diversification
  - Production of information, e.g. advice, monitoring
  - Facilitating transactions, e.g. brokerage, payments, clearing and settlement
  - And much more...

Aspects of asset transformation

How financial firms "use their balance sheets" to intermediate:

Credit transformation: changing (not always raising!) the credit quality of a debt contract. For example:

- Monitoring may raise quality
- **Collateral:** borrower puts assets under control of lender
- Adding guarantees
- Tranching ($\rightarrow$capital structure, structured credit)

Maturity transformation: changing the term to maturity of a debt contract by borrowing short-term and lending long

Liquidity transformation: make debt contract more like money

- Goes hand-in-hand with maturity transformation
- **Examples**: banks, **money market mutual funds** (MMMFs)

Operational aspects of intermediation

Also called financial system **"plumbing"** or **back-office** operations

Clearing includes

- Matching trade records with counterparties
- Reconciling trades with firm's books and records

Payments and **settlement:** transferring securities or other assets and making **final payments** via payments systems

- **Payment systems** transfer money between market participants and intermediaries
- **Examples:** **Fedwire** for interbank U.S. dollar funds transfers, **Depository Trust and Clearing Corporation** (DTCC) for securities, some derivatives

Custodial services include record-keeping, managing cash flows from investments

Gross and net settlement

- **Netting:** cancelling offsetting trades when contractually mandated or permitted and appropriate

  Gross settlement occurs via transfer of gross amounts due without netting

  Net settlement occurs at specific times, e.g. end of day, via transfer of net amount due

- **Real-time gross settlement** (RTGS) system
  - Large-value interbank funds transfer
  - Final settlement effected continuously
  - Have become widespread worldwide, **examples** include Fedwire, **TARGET** in Europe

Bank intermediation

- "What do banks do" a perennial question, no universally accepted definitions

  Commercial banks make loans to households and companies
  - Funded by equity, **deposits** and other borrowing
  - **Retail banking:** loans to households, e.g. **residential mortgages**

  Investment banking: financial services to companies include
  - Facilitate securities issuance by companies through **underwriting** and **syndication**
  - Advice, esp. on corporate actions such as merges and acquisitions

Brokers and dealers

- **Broker-dealers** facilitate trading and investment in securities
- As principal: **dealers** take positions, use equity and borrowed funds to finance and execute security trading
  - Also called (esp. in regulatory context) **market makers** or **liquidity providers**
  - Bear market and credit risk of securities inventories
  - Compensation through trading profits, interest
- As agents: **brokers** facilitate trades, provide trading infrastructure without taking positions
  - Compensation through fees, commissions, **payment for order flow** by dealers

A taxonomy of financial instruments

- Cash or **spot** versus **derivatives**: is the passing of time involved in the delivery of a payment or good?
- **Securities** versus bilateral contracts:
  - Securities are **fungible** (uniform) claims, can be bought, sold or transfered, documented via a certificate or book entry
- **Nominal** versus **real assets**:
  - Nominal assets are claims expressed in units of money
  - Real assets: claims expressed in units of purchasing power, e.g. **inflation-indexed bonds**, or on physical assets
- Debt versus equity instruments: who takes the first loss?
  - Long- versus short-term debt
- Over-the-counter (OTC) versus exchange-traded: do you find a counterparty at an organized exchange or at your dealer?
  - Standardization of OTC contracts via **master agreements**, defining payments, collateralization, termination conditions
- On- versus off-balance sheet, affecting tax and bankruptcy treatment, transparency
- Primary versus securitizations: is it a "claim on a claim"?

Cash forms of intermediation

Some important examples:

- Money, in its myriad forms
- Foreign exchange
- Shares
- Physical assets: real estate, commodities, artworks
- Short-term lending: money markets
- Long-term lending:
  - Bank loans, primarily mortgage loans, commercial and industrial (C&I) loans
  - Capital markets, great variety of bonds
- Even with cash forms, there is a time to **settlement** of trades

What is money?

- **Money** describes a range of assets providing **money services**:

  Payment services when used: acts as a **medium of exchange**, can be readily transferred to third parties
  - Exchanged for other goods, assets
  - Or in settlement of debts

  Liquidity services in storage: provides relative certainty of value
  - Stable **store of value**
  - Can be used as collateral to borrow a relatively certain amount
- Functions as **unit of account:** prices and values measured in money units

Why is money important?

- Money is a tool for overcoming trading frictions
- Widely-accepted medium of exchange solves two fundamental limitations of barter in a market economy

  Double coincidence of wants: low likelihood of pair of agents meeting, each preferring the good offered by the other
  - Myriad agents and commodities
  - Desired at many points in time

  Trust: IOU, or promise to "pay" later with counterparty's desired good once located (indirect barter) isn't credible
- Historical origins of money in remote past; competing theories:

  Emergent via gradual, informal social agreement based on characteristics
  - Uniform, divisible, valuable, difficult to counterfeit
  - Value in exchange gradually exceeds intrinsic, direct-use value

  State theory: government-annointed via taxation, military pay

Forms of money

- Characteristics of assets used as money:
  - Agreement/common acceptance
  - Stability of exchange value
- More recently includes **digital currencies**
- Many forms of money are liabilities of governments, central banks, financial intermediaries and nonfinancial businesses
  - The most liquid and short-term called **near-money**
  - May also be interest-bearing

> *...a species we may call monetary assets—marketable, fixed in money value, free of default risk.* Tobin, "Liquidity Preference as Behavior Towards Risk" (1958)

Money markets

- Forms of short-term lending:

  Bank deposits: includes **interbank lending**, **certificates of deposit** (CDs)
  - Distinguished by **par redemption:** ability of depositor to withdraw funds at par value
  - On demand, i.e. instantaneously, for most deposit types

  Commercial paper: short-term capital markets instrument

  Repo and other **secured** forms ($\rightarrow$collateral markets)
- Non-bank deposit-like lending also intermediated by MMMFs
  - Funds with **fixed net asset value** (NAV) offer a form of par redemption
  - No bank charter, par redemption via accounting rule (SEC's Rule 2a-7 under the Investment Company Act of 1940)
  - Fixed NAV restricted under postcrisis reforms to funds investing in government securities or with retail shareholders

Derivatives forms of intermediation

Futures, forwards, and swaps: Linear and symmetric relation of value to underlying asset price

- **Static hedging**: can be hedged with a one-time trade in the underlying asset
- Value driven by underlying, not volatility⇒zero **net present value** (NPV) at initiation

Options Nonlinear and asymmetric relation of value to the underlying asset price

- **Dynamic hedging**: repeated trades are needed to stay hedged
- Value driven by volatility as well as underlying, asymmetric payoffs
- ⇒Cannot have zero NPV at initiation.

Financial intermediation

Financial risk taxonomy

- Market risk
- Credit risk
- Operational risks

Varieties of market risk

- **Market risk:** risk of loss from changes in market prices or **risk factors**
- Some forms of market risk

  Price risk: asset prices go the wrong way

  Execution risk: cannot execute trades quickly or skillfully enough to avoid loss
    - Example: **stop-loss risk**, the risk that you cannot exit a trade at the worst price you were willing to accept

  Mark-to-market risk: losses may not be realized through sale or unwinding
    - Losses may nonetheless be recorded in firm's accounts, publicly reported
    - Use of models to value illiquid, infrequently traded assets→**model risk**

Categories of market risk

- Major categories of market risk include exposures to prices or values of

  Equity: ownership interests in or residual claims on firms
  Interest rates: fixed claims to cash flows
  Foreign exchange: one currency in terms of others
  Physical assets: commodities, real estate
- **Inflation rate risk** is the risk arising from changes in the general price level
  - Generally associated most closely with interest rate risk
  - But interacts closely with all risk factors
- Many single-position exposures are exposed to several categories of market risk
- **Examples**:
  - Foreign stock indexes values in local currency depends on both foreign exchange and equity risk factors
  - Commodity futures prices fluctuate with both commodity prices and short-term interest rates

Risk factors

- Market risk measurement generally decomposes exposures embedded in assets into exposures to **risk factors**
- Enables risk modeling of positions falling in several risk categories
- Accuracy: risk factors may help focus on predictable sources of variations in value
- Data on specific assets generally less available than than on factors
- Tractability: extremely large number of assets—securities, derivatives—but limited number of risk factors
- Dimensionality of larger sets of risk factors may be reduced via **principal components analysis** of their joint return behavior

Risk factor mapping

- Risk factor approaches require **mapping:** assignment of risk factors to positions
  - Including a measure—the **loading**—of the impact of each risk factor on each position
  - For **example**, option risk measured using price of underlying, with loading based on delta
- Risk factor mapping may combine intuition, statistical analysis and asset modeling
  - May include macroeconomic factors as well as asset prices
  - May be latent or unobservable
- **Factor models** that explain prices or values in terms of underlying and possibly unobservable variables
- **Examples** of risk mappings include
  - Equity prices as functions of stock market indexes or valuation measures
  - Long-term bond values as functions of key rates along curve
  - Foreign exchange rates as functions of major exchange rates, interest-rate differentials

Definition of credit risk

Risk that the creditworthiness of a debt obligation deteriorates:

Default risk: debtor becomes insolvent, i.e. unable to pay timely and in full

Credit migration risk: default *likelihood* rises$\rightarrow$

- Issuer or security receives a lower **credit rating**
- Fall in market price of the security

Fixed income exposed to both market and credit risk

- Pure credit risk event: deterioration of firm's credit quality without credit spread widening
  - **Example:** previously AAA-rated company downgraded to AA
  - But no change in AAA spreads or in risk-free rates
- Pure market risk event: spread widening—decline in risky bond prices—without downgrades
  - **Example:** widening spread between AAA and risk-free rates
  - But no credit event or change in credit quality

Counterparty risk

- It's not just who you *lend* to, but also who you *trade* with
- **Counterparty risk:** trading counterparty does not fulfill an obligation to pay or deliver securities.
  - Exposure to credit risk, but size of exposure fluctuates with market prices
  - Challenging to disentangle market from credit risk
- Arises in derivatives trading
  - **Examples:** long option market value or swap NPV

Operational side of credit risk

Clearing risk includes

- Failure to record trades accurately in firm's books and records (e.g. Soc Gen 2008)

Settlement risk includes

- Counterparty fails to complete settlement
- An issue particularly in foreign exchange transactions
- Also known as **Herstatt risk** after 1974 failure of large German correspondent bank

Custodial risk: examples include

- Customer securities or cash may be commingled with custodian's assets, become unavailable in event of insolvency
- Examples: Lehman U.K. subsidiary 2007, MF Global 2011

Interactions between market and credit risk

Some examples:

- Counterparty risk: can arise from market or credit risk
  - Market risk: swaps and options on non-credit derivatives
  - Credit risk: CDS exposed to **double default risk**, both the underlying credit and counterparty default
- Credit quality depends in part on macroeconomic or specific market conditions
  - **Wrong-way risk:** interaction between counterparty and market risk
  - Presents itself when exposure greatest under market conditions putting counterparty at greatest default risk
- Sovereign debt convertibility risk: low default risk, but risk of
  - Redenomination at unfavorable exchange rate
    - E.g. if euro member leaves single-currency and converts debt to new local currency
  - Currency depreciation or inflation

Liquidity risk

Falls between market and credit risk: several meanings, interaction

Market liquidity risk The market is not deep enough, at the time you have to buy or sell, to trade without pushing price against you

- $\rightarrow$Greater risk to lender

Funding liquidity risk Credit becomes unavailable, or offered only on more stringent terms

- $\rightarrow$Forced unwinding, mark-to-market loss

Operational risk and other firm-killers

Model risk: potential for loss arising from incorrect model or use of a model, e.g. data, parametrization, omitted variables

Operational risk: "risk of loss resulting from inadequate or failed internal processes, people and systems or from external events" (Basel Committee, 2011)

- Major regulatory capital component, alongside market and credit

Legal risk: firm may be sued for its financial practices, or a valuable contract cannot be enforced.

- Part of operational risk in Basel taxonomy

Regulatory and **compliance risk,** including prohibition of a currently-permitted activity

Reputational risk: potential for damage to firm goodwill or brand

Business or **strategic risk**

Operational risk examples

- Unauthorized trading: Nick Leeson at Barings Bank (1995), Jérôme Kerviel at Société Générale (2008)
- Squirrels and power lines: Nasdaq trading interruptions 09Dec1987 and 01Aug1994

The Knight Capital episode

Some examples:

- 01Aug2012: market-making firm Knight Capital places over 4 million erroneous orders in first 45 minutes of trading day
  - Resulting trades lead to losses of about $460 mill., eventual forced sale of firm
- Operational risk: "error in the operation of its automated routing system" (SEC cease-and-desist order) drives erroneous orders
- Business risk: code changes in response to NYSEs Retail Liquidity Program (RLP), permitting sub-penny pricing for retail investors
- Model risk: an existing algorithm had been revised and a new one introduced to implement RLP
- Regulatory risk: RLP a response to Rule NMS eliminating sub-penny pricing
  - And firm pays $12 mill. SEC fine for risk management failure
- Reputational risk: large customers cease trading with Knight
- Market risk: losses generated by changes in value of unintended positions taken