Lecture notes on money, finance, risk management, and public policy

Introduction to financial markets, intermediation and risk

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Financial intermediation

Financial instruments

Financial risk taxonomy

Broader postwar economic developments

Financial intermediation

- Overview of financial intermediation
- Financial intermediaries
- Operational aspects of intermediation

Financial instruments

Financial risk taxonomy

Broader postwar economic developments

Types of financial intermediaries

- **Institutional perspective:** focus on types of firms
  - Depository institutions, e.g. banks
  - Investment companies, e.g. mutual funds, hedge funds
  - Broker-dealers
  - Insurance
  - And much more...
- **Functional perspective:** focus on efficient resource allocation
  - Production of information, e.g. price information, advice, monitoring
  - Facilitating transactions, transfer of assets across time and space
  - Facilitating payments, clearing and settlement
  - Pooling of funds.
  - Mitigate incentive and asymmetric-information problems, e.g. contract design
  - Managing risk, providing safety, e.g. diversification

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

Aspects of asset transformation

Important part of 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)

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

Trading frictions

- Frictions result from limits of

  Memory: "historical record of past actions" (Kocherlakota, [1998])

  Trust: promises of future actions are hard to enforce

- Specific sources of frictions include

  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

Role of technical progress

- Nature of financial markets has changed vastly in past half-century
- Three major contributors to change

  Advances in knowledge: examples include
    - Understanding of option valuation
    - Advances in cryptography, security of data transmission and communication

  Technical progress especially in computing and communication speed and capacity

  Changes in regulation (often mischaracterized as "deregulation")
- Together have led to ongoing transformations, e.g.
    - **Electronic** and **algorithmic trading systems**
    - **Decentralized finance**, including applications such as **bitcoin**, **smart contracts**,

Crucial institutional innovations in finance

Evolution in Italian, Flemish, and Dutch city-states and republics

Banking: taking deposits, making loans, transferring funds

- Evolution from moneychangers and merchants to banks
- Discovery that not all precious-metal or trade liabilities redeemed at once
- Payments between trading centers without transport of coin

Corporations: distinction between debt and equity financing, limited liability, permanency

Insurance: originally designed for overseas trade ventures' exposure to weather, piracy

Accounting: bookkeeping, use of **ledgers** as mechanism for keeping track/recording transactions

- **Double-entry accounting:** system for managing ledgers
- Supports **memory**

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

- Increasingly carried out also by ($\rightarrow$)nonbank financial intermediaries (NBFIs)

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

Investment management

Institutional investors manage large pools of assets on behalf of outside investors

- **Investment management companies** operate mutual and other pooled funds as well as separate accounts
- **Pension funds** investing primarily in long-term assets
- **Insurance companies** invest insurance premiums to meet future claims

[Alte]

Alternative investments manage investment funds outside the public stock and bond markets

- **Hedge funds** operate mutual and other pooled funds on behalf of outside investors
- **Private equity** take ownership positions in new or existing, privately held or publicly traded firms
- **Private credit** vehicles extend credit to private companies, often owned by private equity funds

The back office

Also called **back-office** operations or, together with elements of money markets, **"plumbing"** of the financial system

Clearing includes

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

Payment and **settlement** systems 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

Payment systems

- Money not the only means for effecting transactions
- **Payment systems** predominate in contemporary finance
- Settlement takes time, payment systems generally do not function absolutely instantaneously
  - Although rapid progress in that direction
  - Even very short settlement times costly
- Requirements: ledger system, trust, rapid communication
- Payment systems therefore have both a monetary and credit aspect
  - Imperfect simultaneity of payments by the two parties→short-term credit extension
  - System operator may be granting short-term credit to payment recipient
  - Payment system functions as money

Examples of payment systems

Most, but not all, rely directly or indirectly on banking system

Automated Clearinghouse Services (ACH): payments between banks and between banks and depositors

Paypal introduced direct **person-to-person** (P2P) payments

- Employ variety of existing payment systems
- **Pix**, introduced 2020, operated by Central Bank of Brazil

Credit and **charge cards:**

- Card operator extends short-term credit to purchaser, pays vendor/merchant immediately
- Network connects merchants to card operator

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
- Netting is easier because securities, money and many other assets are fungible, i.e. irrelevant which units of the asset you own
- **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

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
    - Recorded 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
- 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”?

Corporate securities

- Corporate **capital structure**
  - Debt versus equity instruments: who takes the first loss?
  - Long- versus short-term debt

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
- **Fungibility** of money and securities issues reduces frictions
- Units of asset interchangeable

What is money?

- **Money** describes a range of assets providing **money services**:
  Payment services: acts as a **means of payment** or **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
- Money is fungible
- Along with accounting, provides memory to economic system

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 or **chartalism**: 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**
- Forms of money can be classified in several ways, most importantly by whether they are debt claims

  Store of value, token or **object:** money in form of some thing of value, e.g. commodity money, fiat money, bitcoin
  - Intrinsic value or confidence in wide acceptance
  - Oldest form of money

  Claim or **account-based:** many forms of money are liabilities of liability of governments, central banks, financial intermediaries and nonfinancial businesses
  - Value depends on trustworthiness of issuer

Money and near-money

- Some forms of liquid, short-term claims called **near-money**
    - May also be interest-bearing
    - Used infrequently as means of payment, but may be readily sold at reliably foreseeable value for means of payment
- Includes shorter-term government issues, some forms of bak deposits

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

What are interest rates?

- An **interest rate** is a rate paid for borrowing money
  - Expressed as a percent of **principal**—amount of money borrowed—per unit of time, generally per annum
  - E.g. 5 percent per annum→\$5 per annum for each \$100 of principal
- **Term** or **time to maturity** of the borrowing generally contractually specified
- Interest rate may be categorized by whether it varies over the term

  Fixed rate: set at a particular value for all or part of the term
  - Borrower exposed to falling rates

  Floating rate: varies over the term by reference to an index
  - Borrower exposed to rising rates

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$\Rightarrow$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
- $\Rightarrow$Cannot have zero NPV at initiation.

Swaps: definition and general structure

- A **swap** is a contract in which each counterparty agrees to make a series of payments, based on some observable fixed-income benchmark or index, to the other
    - Indexes are typically money market benchmarks, e.g. Libor
- Size of payments determined by a **notional principal amount** stipulated at outset
    - Notional principal amount itself may or may not be exchanged at start and end of swap
- Two counterparties make payments to one another at set times (quarterly,semi-annually, annually) until a set maturity date
- Generally done through a large bank (so $\exists$ two swaps), and governed by a standardized contract, the **ISDA Master Agreements**
    - Regulatory reform$\rightarrow$**mandatory clearing** replaces bilateral contracts

Major types of swaps

Foreign exchange swap: simultaneous spot purchase and future sale of one currency for another

Interest rate swap: counterparties exchange fixed- for floating-rate interest payments on an agreed principal

Currency swap: counterparties exchange interest payments on agreed principals in two different currencies

- **Cross-currency basis swap:** counterparties exchange fixed-rate for floating-rate interest payments on an agreed principal

Credit default swap: protection purchaser makes fixed payments to a seller in exchange for contingent payment if a reference entity defaults

Asset swap: portfolio consisting of a cash position in a bond and an interest rate swap

- E.g. long fixed-rate bond plus paying fixed rate in swap

Options

- Contracts in which option seller promises to pay option buyer the difference between the future value of an **underlying asset** and a **strike** or **exercise price** stipulated now
- With X the strike and S_τ the underlying asset price at time of exercise τ, payoff for option buyer is
  - $\max(S_\tau - X, 0)$, positive when underlying price higher than strike on exercise, for a **call**
  - $\max(X - S_\tau, 0)$, positive when underlying price lower than strike on exercise, for a **put**
- Time of exercise

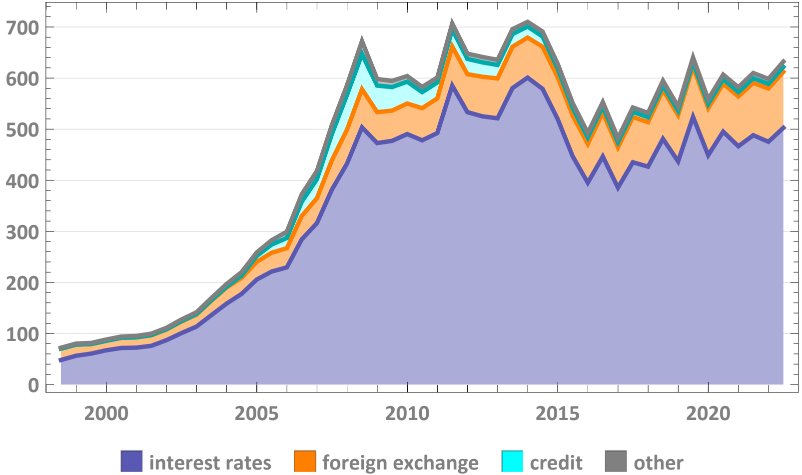
  European option can be exercised only on the option expiry date

  American option can be exercised anytime up to expiry

Issues in derivatives markets

- Largest **over-the-counter** (OTC) markets: interest-rate swaps, foreign-exchange forwards
- Measurement problem: size of market differs greatly depending on metric
  - **Notional amounts outstanding:** par value of existing contracts
  - $\leftrightarrow$ market value or NPV
  - Gross vs. net amount: many offsetting trades between pairs of counterparties
  - Efforts at **trade compression**
- Counterparty credit exposure
- Regulatory developments ($\rightarrow$central clearing)

OTC derivatives markets 1998–2017



Notional amounts outstanding, G10 countries including Switzerland, trillions of U.S. dollars, through H1 2017. *Source*: BIS, Semiannual OTC derivatives statistics, Table D5, `www.bis.org/statistics/derstats.htm`.

Types of fixed income instruments

Loans: bilateral contract between lender—generally a bank—and borrower

Securities such as bonds, bills and notes

- Legal design facilitates offering them to many potential lenders at issuance and secondary market trading

Money markets: short-term lending, including

Bank deposits and other **unsecured interbank lending**
Repo and other **secured** forms ($\rightarrow$collateral markets)
Short-term securities such as Treasury bills, **commercial paper**

Derivatives including

Money market and bond futures: exchange-traded contracts
Interest-rate swaps: largest OTC fixed-income market
Credit default swaps: exchange of regular fixed payments for a par amount in the event of the default of an underlying security

Long-term loans and securities

- Long-term loans typically
  Commercial and industrial loans to corporations
  Residential and commercial mortgages to fund real estate purchases
- Large corporate loans may be **syndicated**: several lenders extend credit
- Issuance shifting from banks to private credit
- Long-term securities: bonds and notes
  - May be fixed or floating rate
  - **Convertible bonds** can be exchanged for common equity of issuer

Money market taxonomy

- Many and varied instruments' risks, participants, liquidity
  - $\rightarrow$Incomplete "arbitrage" among them
  - Complex interaction with central bank operations in rate determination
- **Secured** versus **unsecured** by collateral
- **Demandable**—must be repaid at par without delay—versus **non-demandable**
- **Term structure**: overnight to $\approx$1 year
  - Overnight loans rolled over until notice are demandable
- **Administered**—set by central banks—versus **market-adjusted** rates
- **Derivatives** and **underlying instruments**
- **Negotiable**—can be sold or transfered, e.g. **commercial paper**, T-bills—versus **non-negotiable** instruments
- **Money market mutual funds** (MMMFs) invest in money market instruments and create demandable liabilities

Money market instruments

- 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 (→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

Reserve balances and federal funds

Reserve balances: deposits at a Federal Reserve district bank

- Negligible credit-risk vis-à-vis obligor, the Fed
- Reserve balance are held by
    - Commercial banks and other DIs: subject to reserve requirements, may hold excess reserves
    - Some non-banks eligible to hold deposits at Fed: **Government-sponsored enterprises** (GSEs), e.g. Fannie Mae; banks in **Federal Home Loan System**

Federal funds: *unsecured* claim on a DI or GSE lending reserves

- Fed funds are not identical to reserves
- Fed funds generally present low credit risk
- But non-negligible: banks selling fed funds has insufficient reserve balances to settle
- Can become—or be perceived as—material during stress events

Federal funds market

- **Federal funds market:** secondary market in reserve balances, traded among DIs and GSEs eligible to hold reserve balalnces
- Same-day settlement via **Fedwire**
- On-shore market$\nleftrightarrow$off-shore **Libor** or **Eurodollar markets**
- Trades change holders but not aggregate volume of reserves
- Are themselves subject to regulatory capital rules (**leverage ratio**)
  - But are not themselves subject to reserve requirements
- Term structure anchored by Fed control of overnight rate
- Liquid futures and options markets
  - **Overnight interest swaps** (OIS) pay realized compounded return on funds rate minus strike or "fixed rate"

Other key money market instruments

Demand deposits: demandable; unsecured

Repurchase agreements or **repo:** short-term loan collateralized by securities in possesion of lender or third-party custodian

Interbank lending: Unsecured, non-negotiable

- Liquid derivatives markets, esp. futures, options
- Rate fixings, e.g. **LIBOR**, serve as benchmarks

Commercial paper: Unsecured, negotiable, highly-rated; financial and nonfinancial issuers

- Banks issuers make markets in own paper→demandability
- Key source of non-U.S. banks' dollar funding
- **Asset-backed commercial paper** (ABCP): issued by securitization vehicles holding commercial paper

Definition and classification

- **Digital money** or **coins**: privately-issued means of payment operating via decentralized computer algorithms

  Cryptocurrencies: algorithmically limited quantity of means of payment

  Central bank digital currency (CBDC): digital money issued by central banks
- Designed to share essential desired characteristics of money
  - Fixed supply
  - Stable market value
  - Finality and anonymity of payment
- Part of larger set of **digital assets**
  - Ownership claim represented by a digital "**token**" or account entry
  - Includes non-monetary assets, primarily **Non-fungible tokens** (NFTs) or **digital art**

Cryptocurrencies

- Ownership claims via electronic ledger: cryptography safeguards claim
- **Distributed ledger:** decentralized, enhances security, prevents double spend
  - **Blockchain:** form of ledger, records new transactions through additions of cryptographic encoding
  - **Public** and **private keys** verified to change ownership
- Accelerates trend toward less use of government-issued cash
  - But may preserve anonymity
- **Stablecoins:** privately-issued digital coins
  - Value pegged 1-for-1 to that of a currency (e.g. USD, €, yuan) or other asset (e.g. gold)
- Privacy of financial transactions vs. regulatory concerns re tax evasion, criminal use

Bitcoin and Ether

- Proliferation of digital coins, most with low market capitalization
  - Larger ones trade on organized exchanges
- **Bitcoin:** earliest example
  - Currently coin with highest market capitalization
- **Ethereum:** platform to manage blockchain algorithm
  - Suitable for **smart contracts:** enable scheduled, contractually-stipulated future transactions
  - **Ether**: native cryptocurrency on Ethereum platform
- Leads to more general use in **digital finance** (DeFi)
  - Continues digitization trend in payment systems: PayPal, Alipay, Zelle
  - Potential for greater reliability and trust, reduced settlement time and transaction costs
  - **Tokenization** potentially applicable in repo, swap, other markets

Stablecoins

- Rapid growth, heavily concentrated ina few USD-linked coins:
  - Tether (USDT), USD Coin (USDC), Binance USD (BUSD)
- Close substitutes for other means of payment
  - Potential to greatly reduce payment settlement time, esp. international
- Stablecoin stability
  - Requires 100 backing by low-risk assets
  - Provide money services to holder, NIM to issuer
  - Susceptible to runs absent 100 backing
  - **Example:** TerraUSD (UST) May 2022: complex issuance algorithm linked to digital asset Luna
- Inroads anticipated at expense of banks, MMMFs
- May strengthen USD dominance
  - Payment speed attractive even for typically non-USD payment flows
  - Backing increases demand for US T-bills ($\rightarrow$safe assets)

The cryptocurrency paradox

- Cryptocurrency design and rationale: replace fiat currencies with non-state issued money
- But speculation on exchange value vis-à-vis USD its main actual use
  - Apart from tax evasion, criminal use
- Stablecoins are not designed to replace state-issued money, but volume fluctuates with bitcoin price

Central bank digital currency

- Thus far few launched, with limited domestic use
  - Bahamas, Jamaica, and Nigeria (acc. Atlantic Council)
  - Many pilot programs, eg. e-CNY
- Functionally equivalent to stablecoin reliably backed by currency the central bank issues
- Distinction between wholesale and retail
  - Wholesale CBDCs effectively have long existed in form of interbank markets in reserve balances with RTGS
  - Retail would make such a payment system available to general public
- Privacy concerns

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 general credit spread widening
  - No decline in investor appetite for credit risk
  - **Example:** previously AAA-rated company downgraded to AA
  - But no change in AAA spreads or in risk-free rates
- Pure market risk event: general spread widening—decline in risky bond prices—without downgrades
  - Increase in investor aversion to credit risk
  - **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

- 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
- **Wrong-way risk:** exposure increases under market conditions putting counterparty at greatest default risk
  - Credit quality depends in part on macroeconomic or specific market conditions
  - **Example**: Asian crisis 1998-99
    - Banks and their customers borrow extensively in USD at pegged rates
    - Devaluation increases default risk and local-currency exposure
  - Arises frequently in counterpary risk, NPV of CDS rises with credit deterioration of underlying firm
- 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 NYSE's 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

Financial intermediation

Financial instruments

Financial risk taxonomy

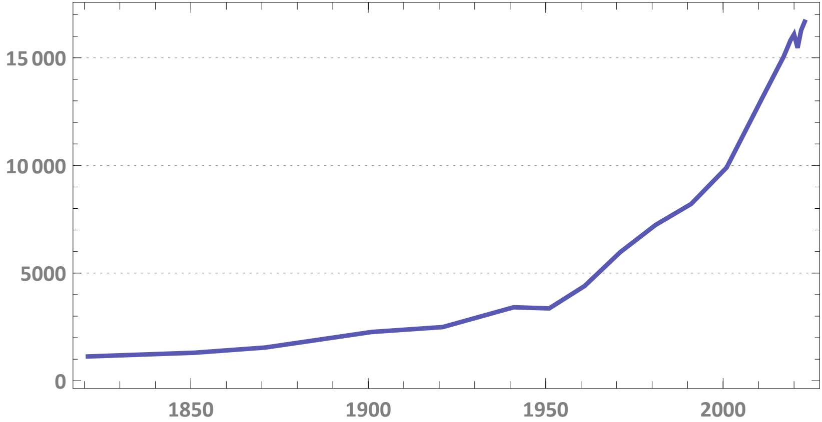
Broader postwar economic developments

- Rapid growth of income and wealth
- The Great Inflation and the Great Moderation
- The era of low interest rates

Rise in world income

- Rapid rise in world income in postwar era
  - Approx. 4-fold rise since 1950
  - Compare to approx. 4-fold rise in preceding *millennium*

Growth in world real income 1820–2022

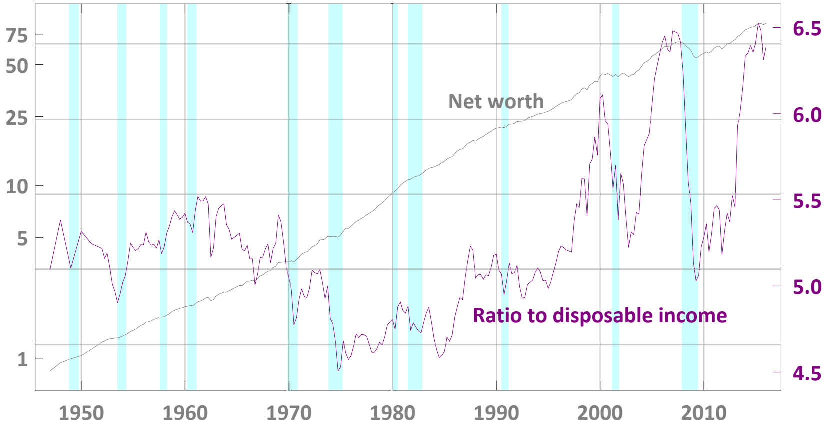


Real GDP per capita in 2011 dollars. *Source*: Maddison Project Database 2023, `https://www.rug.nl/ggdc/historicaldevelopment/maddison/`.

Growth in assets

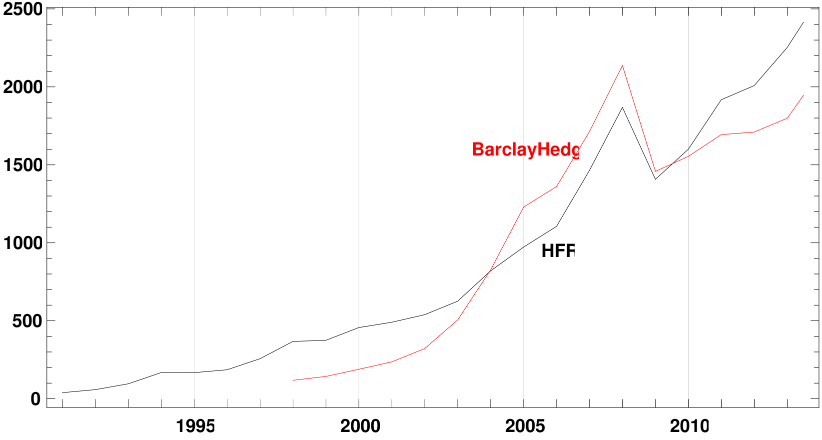
- Rise in household wealth
  - In U.S. and other countries, recent volatility due to house prices
  - And even greater volatility in ratio to income($\rightarrow$leverage)
- Rise of large capital pools ($\rightarrow$safe assets, international imbalances)
  - Hedge funds
  - International reserves and sovereign wealth funds

U.S. household net worth 1945–2015



Logarithm of household net worth, trillions of 2005 U.S. dollars (left *y*-axis) and ratio to disposable personal income (right *y*-axis), quarterly. Vertical shading represents NBER recession dates. *Source*: Federal Reserve Board, Financial Accounts of the United States (Z.1), Table B.101.

Hedge fund assets under management 1990–2013



Annual, last observationQ2 2013, $ bill. *Source*: HFR, BarclayHedge.

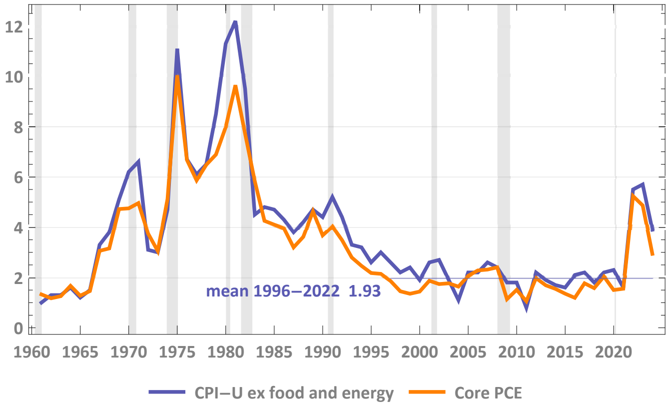
From postwar growth to Great Inflation

- Growth of GDP through 1960's high by historical—and current—standards
- **Inflation:** rise in general price levels
    - Equivalently: decline in purchasing power of money unit
- Inflation rises from ca. 1965
    - **"Stagflation":** high inflation together with low growth
- Collapse of Bretton Woods
    - **Gold-exchange standard** in place 1945–1971
- **Volcker disinflation** late 1979–1984

The Great Moderation

- Period of perceived success of monetary policy
- Ca. 1984 until outbreak of global financial crisis
- Sharp decline in volatility of GDP growth, level and volatility of inflation
- **Interest-rate smoothing:** gradual adjustment of target funds rate
- Policy below rule 2000–06
  - But inflation itself suppressed by low import prices

U.S. inflation 1960–2023

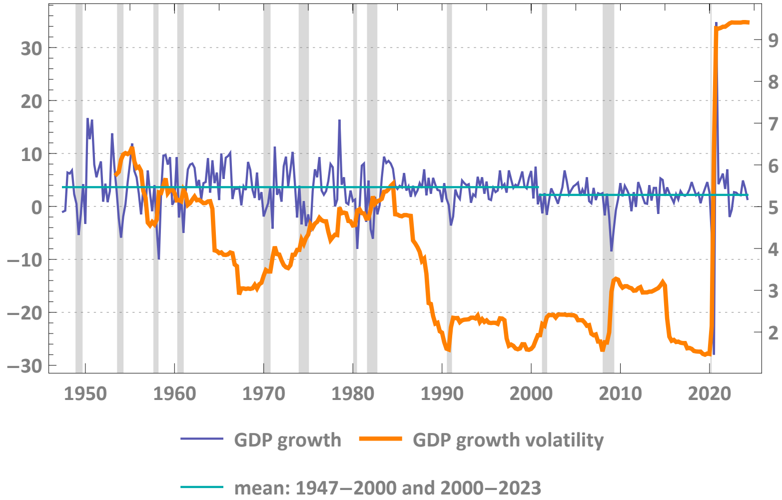


Annual percent change in the consumer price index–all urban consumers (CPI-U), all items less food and energy (*Source*: U.S. Bureau of Labor Statistics, series CUUR0000SA0L1E), and core Personal Consumption Expenditures price index (PCE) (*Source*: U.S. Bureau of Economic Analysis). The core PCE is a somewhat broader index and has different weights from CPI-U. Vertical shading represents NBER recession dates.

Explanations for low inflation

- Credibility of monetary policy after 1980
  - Realized inflation low because central banks expected to pursue low-inflation policy
- Real factors:
  - Increase in productivity from 1980 until crisis (technology)
  - International factors: increase in trade, competition
- Since crisis, **Neo-Fisherian** effect of low interest rates on realized inflation
  - Low interest rates inconsistent with high expected inflation, so latter adjusts

U.S. GDP growth rate and its volatility 1947–2023

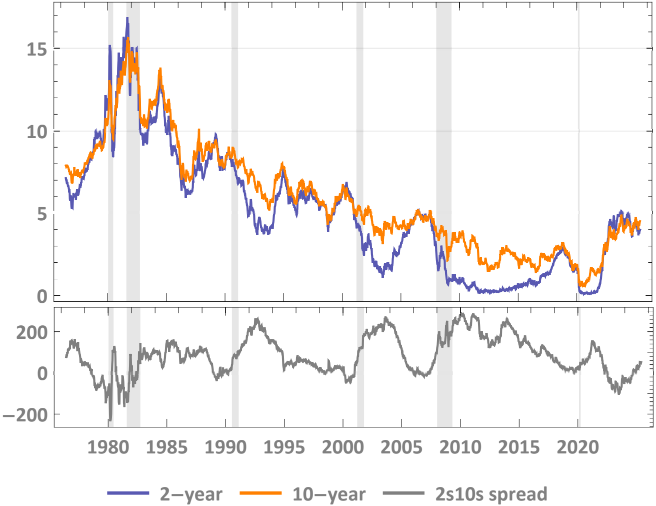


Percent change from preceding period in real gross domestic product, U.S. GDP growth, quarterly, percent, seasonally adjusted at an annual rate (black, left *y*-axis), and rolling standard deviation of the past 5 years' growth rates in percent (red, right *y*-axis). Vertical shading represents NBER recession dates. *Source*: U.S. Bureau of Economic Analysis.

Behavior of U.S. interest rates

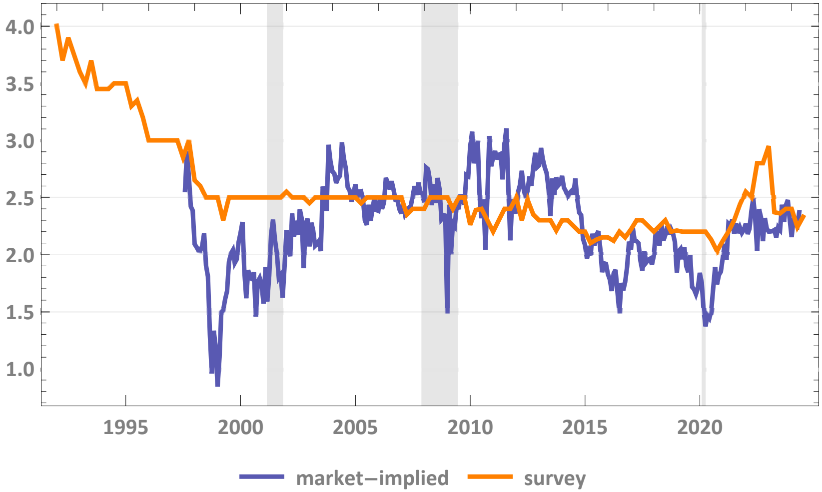
- **Nominal interest rates**: measured relative to money units
- **Real interest rates**: measured relative to purchasing power units
- Nominal rate can be decomposed into real rate plus *expected* inflation
- Three-decade decline in nominal rates and flattening of yield curve
  - Early manifestation: the Japan trap
  - **Conundrum** in U.S. rates 2004–2005: rising short-term rates, but steady or declining longer-term rates
  - Further decline during global financial crisis, policy response
- Both components of nominal rates falling
  - Expected inflation declining to below 2 percent
  - Real rate of interest declining to zero

U.S. 2- and 10-year nominal rates 1997–2025



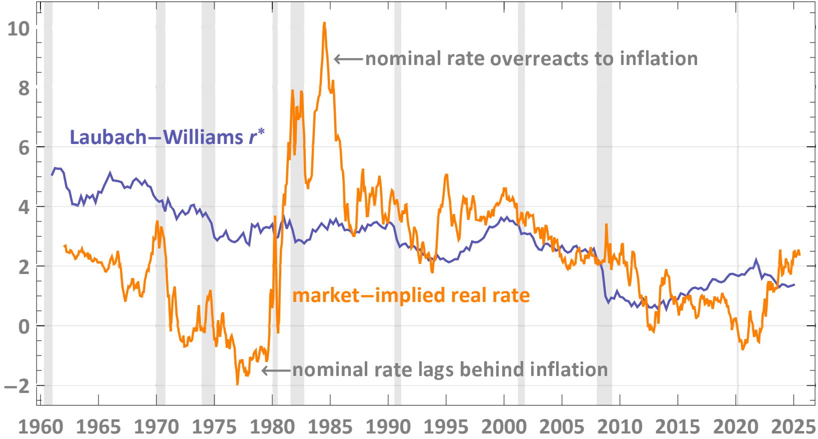
Constant maturity U.S. Treasury yields, daily, 04Jun1976 to 23May2025. Spread in basis points. *Data source*: Bloomberg LP.

Market-implied and survey inflation 2007–2024



Purple plot: 5-year 5-year forward breakeven inflation; Orange plot: Survey of Professional Forecasters median 10-year-ahead annual average inflation forecast, quarterly. Forward breakeven inflation is the inflation rate over some future interval implied by yields on nominal and inflation-adjusted bonds of two different terms to maturity. *Source*: Bloomberg LP, Federal Reserve Bank of Philadelphia.

U.S. real interest rates 1961–2024

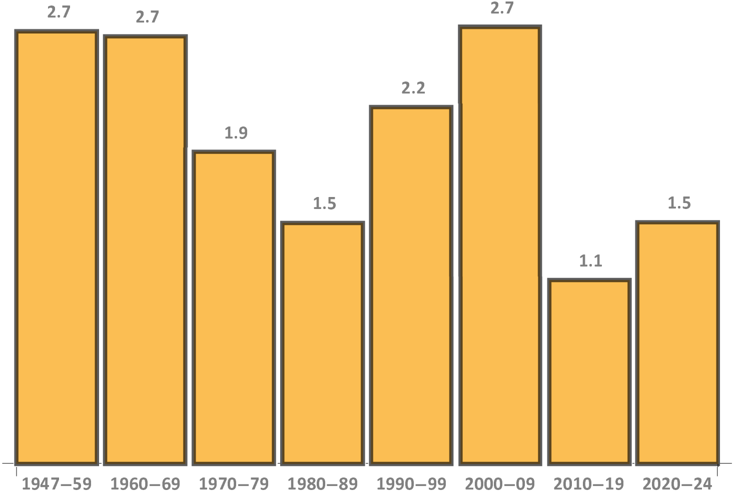


Laubach–Williams short-term natural rate r^* [see Measuring the natural rate of interest, *Review of Economics and Statistics* **85**(4), 2003, 1063-1070], estimates downloadable at `http://www.newyorkfed.org/research/policy/rstar.xlsx`; Q1 1961–Q4 2024, quarterly. Market-implied real rate: 5-year 5-year forward U.S. TIPS yield from July 1997 (Bloomberg tickers USGGT05Y, USGGT10Y) and the 5-year nominal yield (Bloomberg ticker USGG10YR) minus a 10-year moving average of annual CPI-U All Items inflation rates centered on the current month Jan. 1967–June 1997; monthly.

Why the decline in real rates?

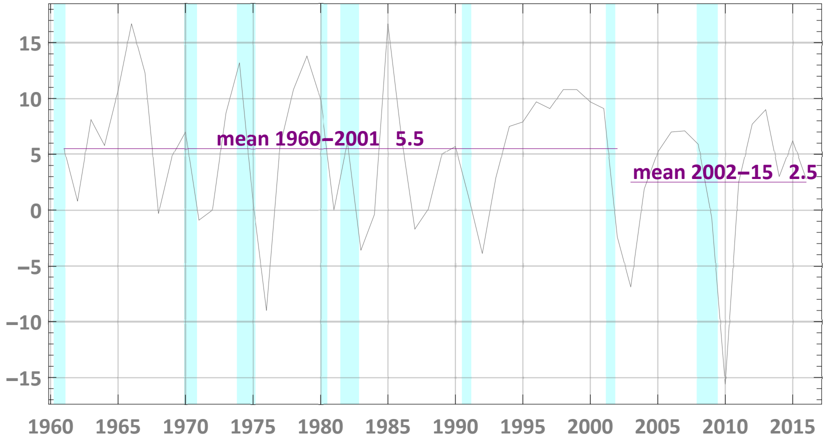
- Real interest rates unobservable, must be estimated
  - Models of equilibrium real rate
    - Considerable uncertainty around estimates
  - Market real rate based on inflation-indexed bond yields
    - Doesn't account for liquidity, inflation-risk premiums
- Possible explanations of low real rates:
  - Demographics: aging population motivates higher saving
  - Leads in turn to
    - Rise in world saving: **global savings glut hypothesis**(→international imbalances)
    - Higher demand for **safe assets**
  - **Secular stagnation** driven by low aggregate demand or by slowing technical progress
  - **International balances:** capital flows from less-developed to more advanced countries
- Consistent with low growth of productivity, business formation, and private investment

U.S. labor productivity 1947–2024



Percent change in output per hour at an annual rate, nonfarm business, quarterly 1947Q2–2016Q2. *Source*: U.S. Bureau of Labor Statistics, series PRS85006092.

Growth of U.S. investment spending 1960–2015



Percent change in gross domestic private nonresidential fixed investment, annual, National Income and Product Accounts, Table 1. *Source*: U.S. Bureau of Economic Analysis (BEA).