University of Warsaw
Faculty of Economic Sciences

Monetary policy implementation
Introduction to financial frictions

Advanced Macroeconomics QF: Lecture 12

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Conventional monetary policy

Creation of money and credit

In advanced economies central banks typically control interest rates

Majority of money supply is created by commercial banks who grant credit / loans

Credit (and money) are created when:

1. There is demand for credit
2. Banks want to grant credit (deem applicants creditworthy)
3. Banks have sources of financing and capital

Financing is not necessary at the moment of granting a loan,
but banks need to observe reserve requirements

This creates demand for time deposits and central bank reserves

Interest rate control: interbank market

The central bank wants to steer the interbank market to make overnight transactions at the central bank's main refinancing operation rate [Fed: main interest rate]

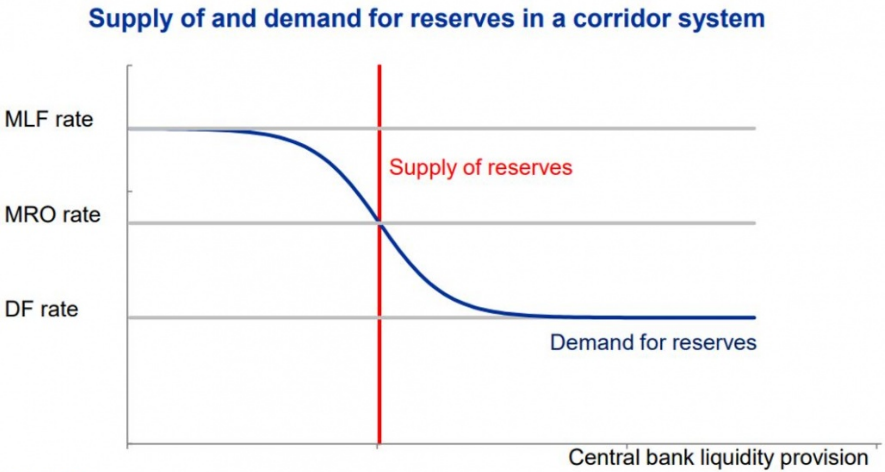
Upper and lower bounds for interbank interest rates:

- Any commercial bank can borrow reserves from the central bank at the marginal lending rate [Fed: discount rate]
- Any commercial bank can deposit reserves at the central bank at the deposit rate [Fed: rate on excess reserves]

Central bank performs open market operations, buying and selling assets for reserves, affecting the interbank market rates

Central bank can directly affect only the very short term interest rates!

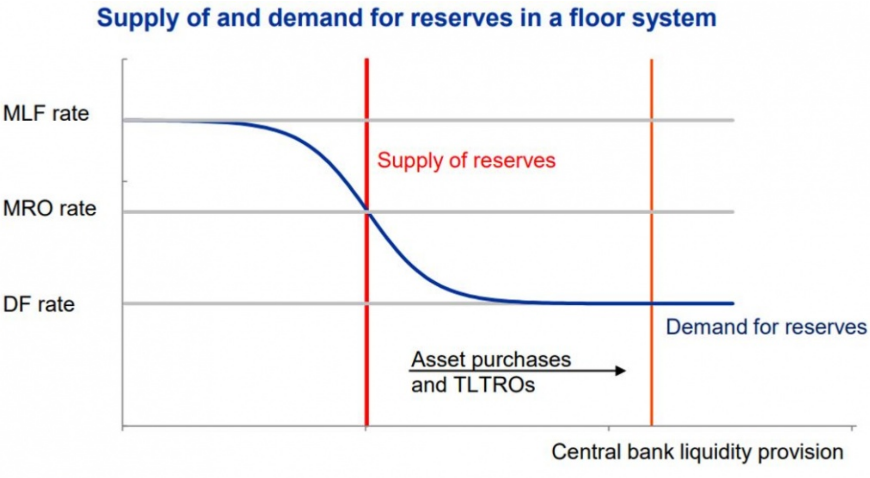
Interest rate control: interbank market



Source: ECB.
Notes: MLF refers to marginal lending facility, MRO to main refinancing operation, and DF to deposit facility.

Schnabel (2023)

Interest rate control: interbank market in a “floor system”



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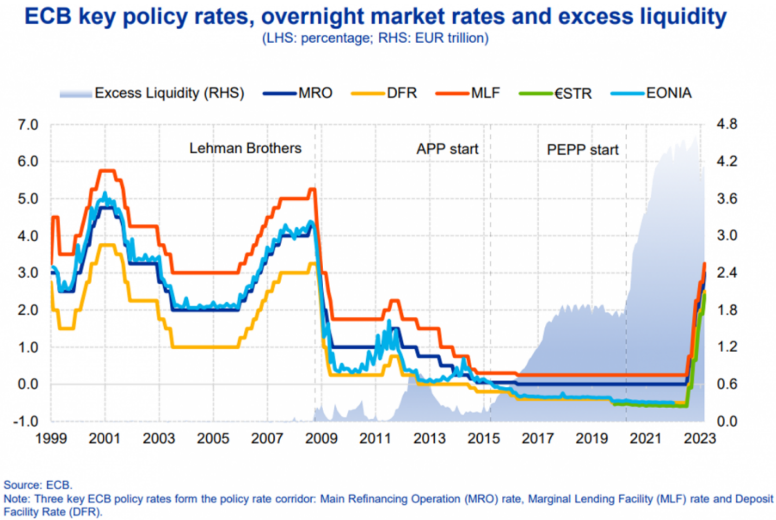
Interest rate control: interbank market



Schnabel (2023)

Short- and long-term interest rates

Monetary policy affects long-term interest rates via expectations on future interest rates

No-arbitrage conditions (omitting various premia)

- Two-period contract

$$i_{t+2} \approx \frac{i_t + i^e_{t+1}}{2}$$

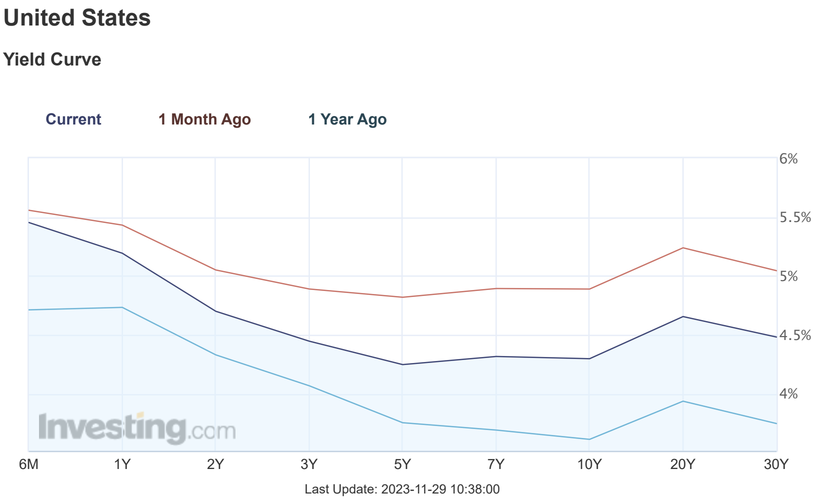
- n-period contract

$$i_{t+n} \approx \frac{i_t + \sum_{j=1}^{n-1} i^e_{t+j}}{n}$$

Usually long-term interest rates are higher than short-term
(liquidity premium, risk premium, etc.)

Yield curve inversion (short-term rates higher than long-term)
signals expectations of monetary policy easing in the future

Inverted yield curve in the USA



Investing.com

Interest rates on deposits and loans

Interbank market interest rates determine the "cost" of granting a credit / loan

Commercial banks are almost indifferent between financing loans from central bank reserves or non-bank agents' time deposits

Interest on deposits $\approx$ interbank market rate

Interest on loans $>$ interbank market rate

Reasons for the above:

1. Banks' market power
2. Monitoring costs
3. Credit risk premium

Interest on non-collateralized loans is higher than on collateralized (mortgages and business loans)

Monetary policy at the Effective Lower Bound

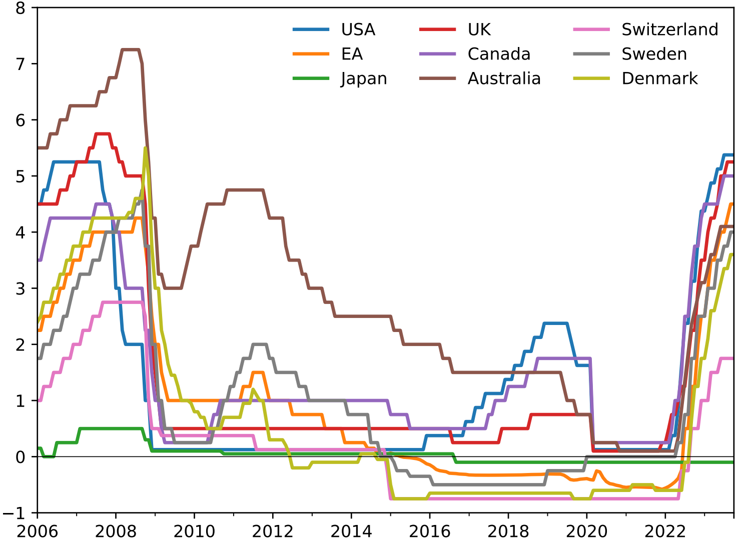
Liquidity trap

In response to the 2007-2008 financial crisis many central banks have cut interest rates to around 0%

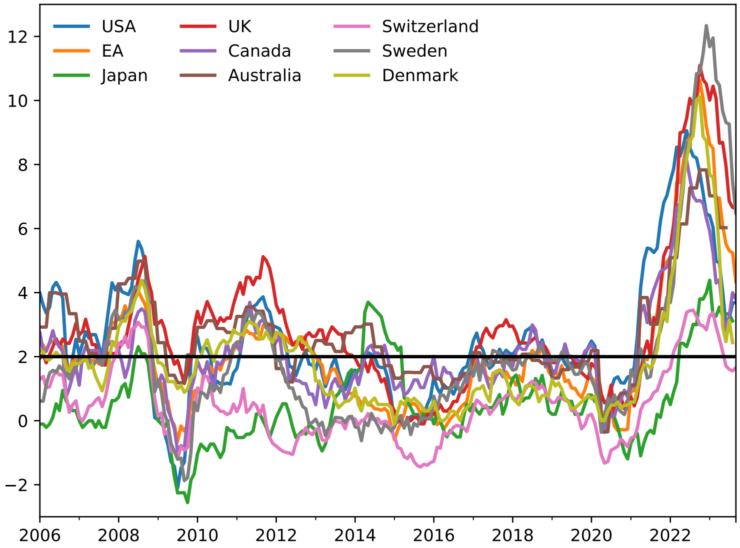
But the desired level of interest rates was then negative

Initially, central banks were reluctant to set negative interest rates, but since 2012 more and more central banks have decided to do so

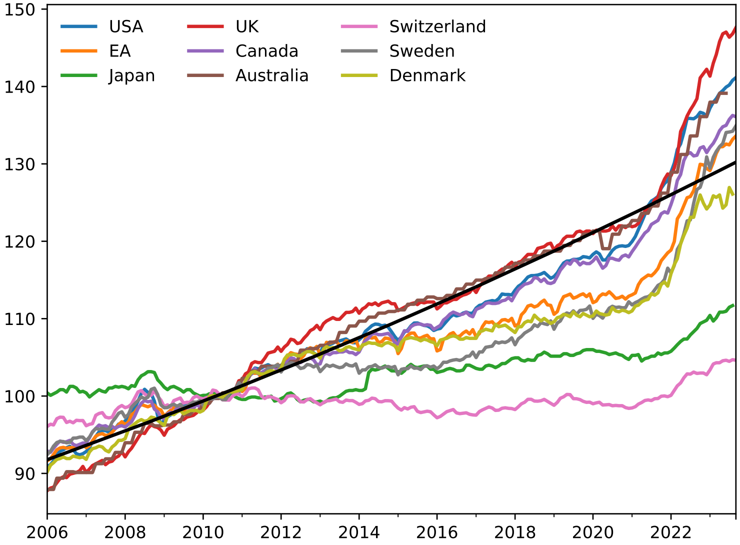
Nominal interest rates in advanced economies



Inflation rates (year over year) in advanced economies



Price level in advanced economies



Zero / Effective Lower Bound (ZLB / ELB)

Intuition: lower bound for nominal interest rates is 0%

The nominal rate of return from cash is 0%

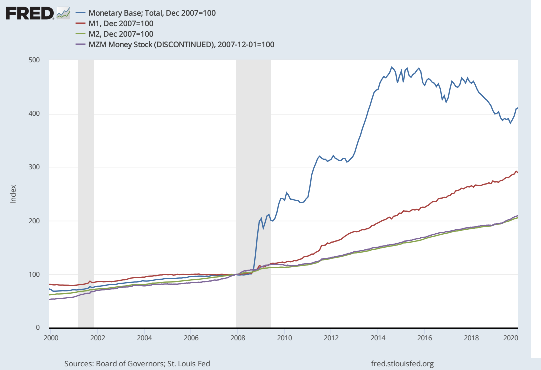
Households are not willing to hold assets that yield negative nominal return, prefer cash

In reality the ELB is not at 0, since there are costs of storing and securing cash

Monetary policy at the ELB

Reducing the nominal interest rate no longer available

Expansion in monetary base (accomodating higher demand for reserves) does not translate to increases in money supply aggregates



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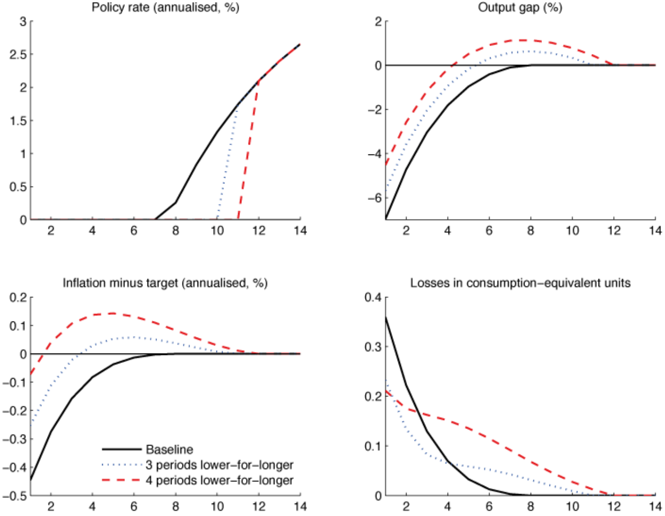
Monetary policy at the ELB

What works then?

- Forward guidance: central bank manages expectations
  on future nominal interest rates to indirectly affect long-term interest rates
- Quantitative easing: central bank purchases certain assets
  to directly affect long-term interest rates

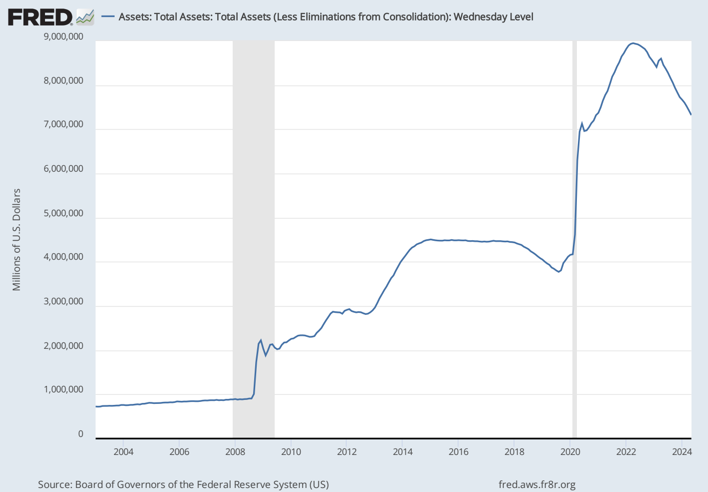
Both implemented in practice

Effects of forward guidance in the New Keynesian model



Harrison et al. (2017)

Quantitative easing: balance sheet of Fed



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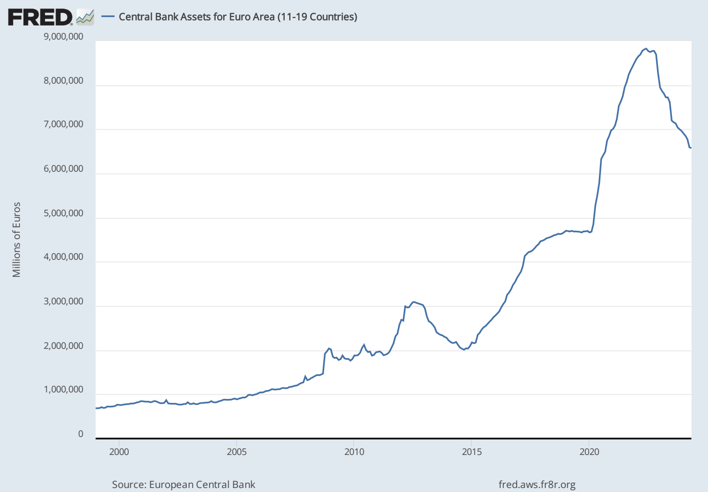
Quantitative easing: balance sheet of ECB



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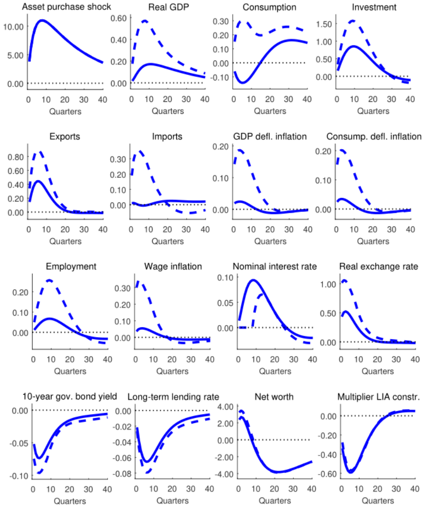
Effects of quantitative easing (+FG) in the EBC’s model



Coenen et al. (2018), Figure 14

Limits to effectiveness of unconventional policies

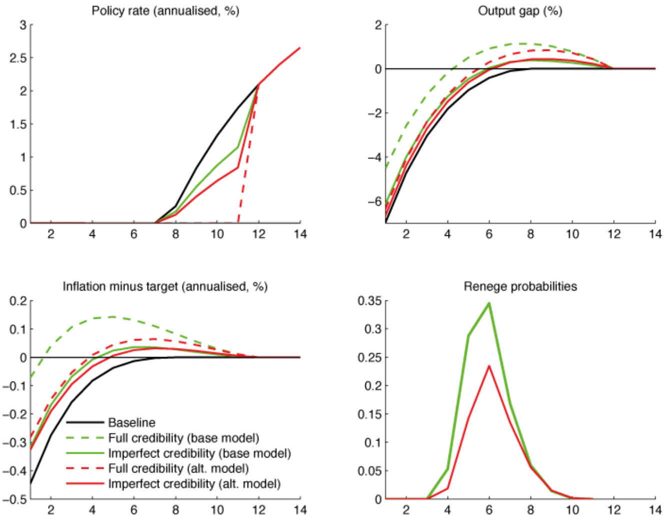
In the New Keynesian model forward guidance works "too well" (Del Negro et al. 2015)

In reality effectiveness of these policies depends on frictions and imperfections in the financial markets

Information frictions: private agents have less than perfect information on future monetary policy (Harrison et al. (2017), Campbell et al. 2019)

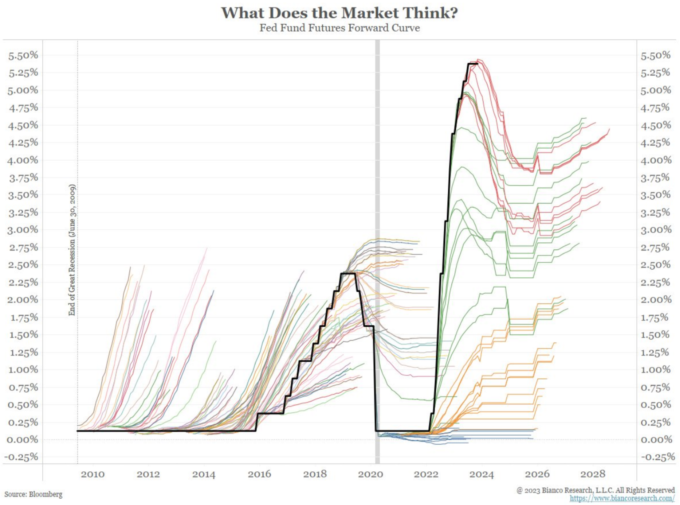
Market frictions: imperfect degrees of substitutability between different classes of assets (Haldane et al. 2016)

Forward guidance under imperfect central bank credibility



Harrison et al. (2017)

Fed forward guidance credibility: 2020-2021 vs 2010-2015



Jim Bianco

Four-equation New Keynesian model

Based on Friedman (2013)

Loan contracts have maturity longer that 1 period

Interest rates that households and businesses face are determined by the commercial banks, central bank affects them only indirectly

Simple modification of the three-equation mode:

NKPC	$\pi_t = \beta \mathrm{E}_t \pi_{t+1} + \kappa x_t + e_t$
NKIS	$x_t = \mathrm{E}_t x_{t+1} - \frac{1}{\sigma}\left(i_t^p - \mathrm{E}_t \pi_{t+} - \rho\right) + u_t$
Taylor rule	$i_t = \rho_i i_{t-1} + (1-\rho_i)\left(i^* + \gamma_\pi \left(\pi_t - \pi^*\right) + \gamma_x x_t\right) + v_t$

where $i_t^p \neq i_t$ is the interest rate relevant to the private spending decisions and $\mathrm{E}_t \pi_{t+}$ are expectations of inflation over the horizon corresponding to the maturity of loans

Fourth equation

The relation between the central bank interest rate
and the private sector interest rate takes into account:

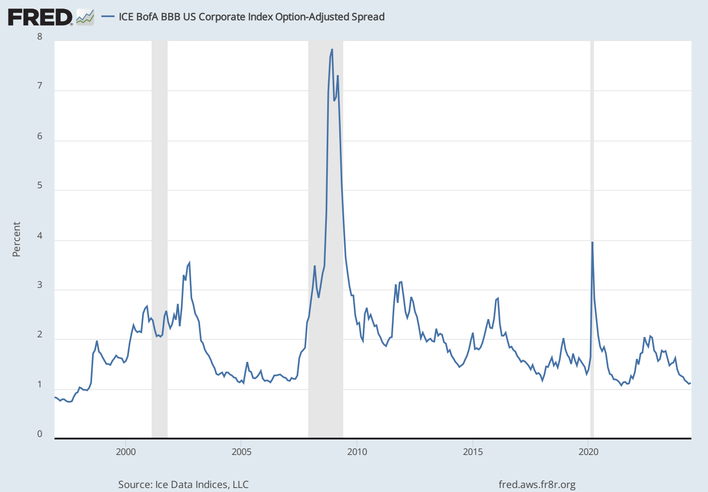
1. The default risk of private obligations
2. Their longer maturity

$$i_t^p = (1-\delta)\, i_t + \delta i_{t+}^e + \phi\,(R_t/A_t) + \omega_t$$

where:

- δ reflects maturity of the private sector assets
- R_t/A_t is the ratio of risky assets to total, $\phi' > 0$
- ω_t is a shock in the financial markets

Increase in the risk premium during the GFC and at the onset of covid



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Unconventional policies in the four-equation model

Forward guidance

- Communicating low interest rates in the future lowers i^e_{t+} and i^p_t

Quantitative easing

- Buying risky assets from commercial banks lowers R_t/A_t and i^p_t
- Buying longer maturity assets increases δ and (under forward guidance) lowers i^p_t

Introduction to financial frictions

Diamond and Dybvig (1983), Nobel 2022

Banks perform liquidity transformation: have short-term liabilities (deposits) and long-term assets (loans)

This is an efficient situation that allows for risk-sharing:
an investor that is uncertain on when they will need liquidity
may put a deposit at a bank that can be converted into cash on demand

Banks are then vulnerable to runs: if the customers want to withdraw more funds than expected, a solvent bank becomes temporarily illiquid and can go into default

The central bank as a lender of last resort can eliminate bank runs equilibria

Consumer / investor

Three time periods: 0, 1 i 2

Each consumer / investor has a unit of consumption good to invest in period 0

Each of the draws in period 1 their "type":

- With probability p they become impatient and will need to consume in period 1
- With probability $1 - p$ they can wait to consume until period 2

Preferences can be assumed to be e.g. CRRA, with no discounting (for simplicity)

Available assets

Assets are not risky, but have differing liquidity

The liquid asset has a payoff of 1 in both time periods

The illiquid asset has payoffs: $\ell < 1$ in period 1 and $R > 1$ in period 2

Autarkic equilibrium

Consumer / investor sets the share ω of illiquid asset in the portfolio

If they receive the “impatience” shock, they will consume in period 1

$$c_1^A = (1-\omega) + \omega\ell = \omega(\ell - 1) + 1 \leq 1$$

Otherwise they will consume in period 2

$$c_2^A = (1-\omega) + \omega R = \omega(R - 1) + 1 \leq R$$

There exists no ω for which jointly $c_1 = 1$ and $c_2 = R$

Insurance contract

Consumer / investor receives either $c_1^O = 1$ or $c_2^O = R$

Is such allocation feasible? Yes, for $\omega = 1 - p$

Fraction p of assets are held in liquid instrument and can satisfy the demand from "impatient" investors for liquidity in period 1

For the remaining investors it pays to wait until period R when they will receive $R > 1$

Naturally $U\,(1,\ R) \succ U\left(c_1^A,\ c_2^A\right)$

This allocation can be further improved upon

Optimal deposit contract

Consumer / investor receives either $c_1^D = r_1 \geq 1$ or $c_2^D = r_2 \in (r_1,\, R)$

The bank stores $x \equiv pc_1^D$ liquid assets and invests remaining $1 - x$

The optimal contract solves

$$\begin{aligned} \max \quad & U = pu\left(c_1\right) + (1-p)\, u\left(c_2\right) \\ \text{s.t.} \quad & pc_1 + \frac{(1-p)\, c_2}{R} = 1 \end{aligned}$$

For $u\left(c\right) = c^{1-\sigma} / \left(1 - \sigma\right)$ where additionally $\sigma \geq 1$ we get that

$$\begin{aligned} c_1^D &= \frac{1}{p + (1-p)\, R^{(1-\sigma)/\sigma}} \geq 1 \\ c_D^2 &= \frac{R}{pR^{(\sigma-1)/\sigma} + (1-p)} \leq R \end{aligned}$$

It can be shown that $c_1^D < c_2^D$ and that $U\left(c_1^D,\, c_2^D\right) \succ U\left(1,\, R\right) \succ U\left(c_1^A,\, c_2^A\right)$

Bank run

While the “patient” investor has incentive to wait until period 2, the situation changes under perceptions that other “patient” investors will withdraw their funds in period 1

The bank will have to liquidate (a part of) investment with payoff $\ell < 1$

Then not only $c_2^R < c_2^D$, but for a large enough share of period 1 withdrawals $c_2^R < 1$

Even the “patient” investors prefers then to withdraw in period 1!

A run on bank occurs, which is a “bad” self-fulfilling expectations equilibrium

The central bank can step in and provide liquidity in period 1,
preventing the run outcome (but can incentivize moral hazard)

Asymmetric Information

Generally refers to a situation in which different parties to a transaction are not equally informed about characteristics or actions of the other parties to the transaction

Two main kinds of asymmetric information:

1. Adverse Selection occurs before a transaction takes place
2. Moral Hazard occurs after a transaction takes place

Both help us understand the kind of financial structure we observe in the real world

Adverse Selection

The buyer of a product (e.g. a car, a stock) doesn't know the true "type" of the product (e.g. good or bad, risky or safe)

Buyer a priori knows only the average type

Hence, buyer will only be willing to pay the average valuation, which is more than the bad type but less than the good type

This tends to drive sellers of products that are a good type away and attract sellers of products that are a bad type

But then buyer knows this, and entire market can fall apart

Classic example in Akerlof (1970): "lemons" in the market for used cars

Financing firms

Two types of firms who need 1 unit to undertake a project

Project succeeds or fails with a given probability

Firm types and payoffs are:

	Safe Firm	Risky Firm
Payoff in “good” state	4	8
Payoff in “bad” state	0	0
Prob. of “good” state	1/2	1/4

Expected return the same for both firms,
but lender would prefer to loan to safe firm since it is less risky

Simple debt contract

Only one kind of debt contract: bank lends firm one unit, firm promises to repay R (gross) units if project succeeds, 0 otherwise (it can't pay back in event low state occurs)

Borrower only has to pay back in the good state

Borrower's expected payoffs are:

$$\text{Safe} = \frac{1}{2}(4 - R)$$
$$\text{Risky} = \frac{1}{4}(8 - R)$$

Borrower takes a loan only if her expected payoff is non-negative

If $R > 4$, safe firms won't take the loan

If $R > 8$, both firms won't take the loan

Adverse selection and collateral

Collateral is an important feature of many debt contracts

A firm receiving funds pledges some collateral
that can be seized in the event that the firm defaults

Banks can offer different kinds of contracts:

- Some require posting more collateral
- Some require less collateral but charge higher interest rates

This offering different kinds of contracts can get firms to voluntarily reveal their type

In mortgage finance: the more you put down (more collateral),
the better the terms on the loan typically

Collateral can be a useful way for financial contracts
to deal with information asymmetry

But when collateral loses value ("bubble bursting")
this can exacerbate information asymmetry problems

Loan contracts with collateral

Lender requires borrower to post collateral C,
which borrower has to pay in the event of project failure

Borrower's expected payoffs are:

$$\text{Safe} = \frac{1}{2}(4 - R) - \frac{1}{2}C$$
$$\text{Risky} = \frac{1}{4}(8 - R) - \frac{3}{4}C$$

R "hurts" the safe firm more, but C "hurts" the risky firm more

Suppose that the lender posts two contracts,
one without collateral ($R,\ C = 0$) and the other with collateral ($R_C < R,\ C > 0$)

Safe firm chooses to post collateral and reveals itself as safe

Firms' choices

Risky firm prefers no collateral

$$\frac{1}{4}(8 - R_C) - \frac{3}{4}C \leq \frac{1}{4}(8 - R)$$
$$R - R_C \leq 3C$$

1. $R > R_C$ (you get a lower interest rate if you post collateral)
2. Collateral must be big enough to induce risky firm to take R, $C = 0$

Safe firm prefers posting collateral

$$\frac{1}{2}(4 - R_C) - \frac{1}{2}C \geq \frac{1}{2}(4 - R)$$
$$R - R_C \geq C$$

1. $R > R_C$ again
2. Collateral can't be too big, otherwise safe firm won't post it

Financial accelerator and business cycles

Posting of collateral allows safe firms to reveal their type

Allows them to get loans (depending on market structure)
and results in more efficient allocation

Since collateral consists of assets,
asset price fluctuations can affect ability of firms to get loans

Financial accelerator:

1. Decline in economic activity (e.g. a recession) causes assets to lose value
2. Declining asset values makes it harder for firms to post collateral
3. Inability to post collateral $\rightarrow$ stronger adverse selection problem $\rightarrow$ less investment and/or a worse allocation of investment between safe and risky firms
4. Less investment causes more declines in economic activity, and further falls in collateral values
5. An adverse feedback loop! (although not without end)

Moral hazard

Information asymmetry occurring after a transaction takes place

For example, someone lends you money,
but then can't perfectly monitor what you do with the money

Because of limited liability, you have an incentive to "gamble"
with someone else's money

Moral hazard can encourage excessive risk taking

Can be applied to insurance markets too: once you have insurance,
you have less incentive to behave safely

Insurers know that, and may not sell you insurance in first place

Just like in case of adverse selection, markets can break down

Moral hazard and collateral

Collateral also plays a role in mitigating moral hazard

Requiring firms to post collateral gives them some “skin in the game” and encourages good behavior

Without collateral, lenders may be reluctant to lend because they can’t perfectly control what borrowers do

Similarly to adverse selection, this importance of collateral can give rise to a financial accelerator mechanism

Assets decline in value $\rightarrow$ harder to post collateral $\rightarrow$ harder for firms to get loans

Costly state verification

Townsend (1979), Bernanke and Gertler (1989),
Carlstrom and Fuerst (1997), Bernanke, Gertler and Gilchrist (1999),
Christiano, Motto and Rostagno (2004, 2014)

Entrepreneurs borrow funds to finance risky projects

Project outcome is known ex post to the entrepreneur only $\rightarrow$ information asymmetry

If the project outcome is low entrepreneur defaults on the loan

But successful entrepreneurs are temped to default as well $\rightarrow$ moral hazard

Verification of the project success by outsiders is costly

Optimal contract: fixed rate loan, verification in case of default

Endogenous premium on loans

Bernanke, Gertler and Gilchrist (1999) model

Bernanke, Gertler and Gilchrist (1999)

New Keynesian model with entrepreneurial sector
which requires external funding to invest in new projects

Entrepreneurs identical up to an idiosyncratic productivity shock

Funds provided by intermediary sector financed from household deposits

Asymmetric information, costly state verification (Townsend, 1979)

External finance premium (credit premium) is a decreasing function
of the share of project financed by net worth (equity)

Net worth equals retained profits by surviving entrepreneurs

Gives rise to a financial accelerator mechanism