Credit

4 Key Questions

What is a debt contract?

In [ ]:

Why are debt contracts so prevalent?

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In [ ]:
```

When do debt markets fail?

In [ ]:

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Why do we need banks for credit?

In [ ]:

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Map

1. Financial contracts
2. The cheapness of debt
3. The failure of credit markets
4. The structure of credit markets

1. Financial Contracts

When an investor or a bank lends to an entrepreneur or a corporation, the agreement takes the form of a **financial contract**.

Designing such contracts requires balancing the borrower’s **incentives to repay**, the lender’s **willingness to finance**, and the **efficient use of resources**.

Ideal World

In a world of **complete information**, the two parties could write a **complete contingent contract** — specifying obligations and repayments for every possible future state of the world.

- Repayments could be perfectly linked to realized earnings.

> *Example: lender receives a fixed fraction of profit → equity-style contract.*

- **No default** would occur, since payments automatically adjust to outcomes.

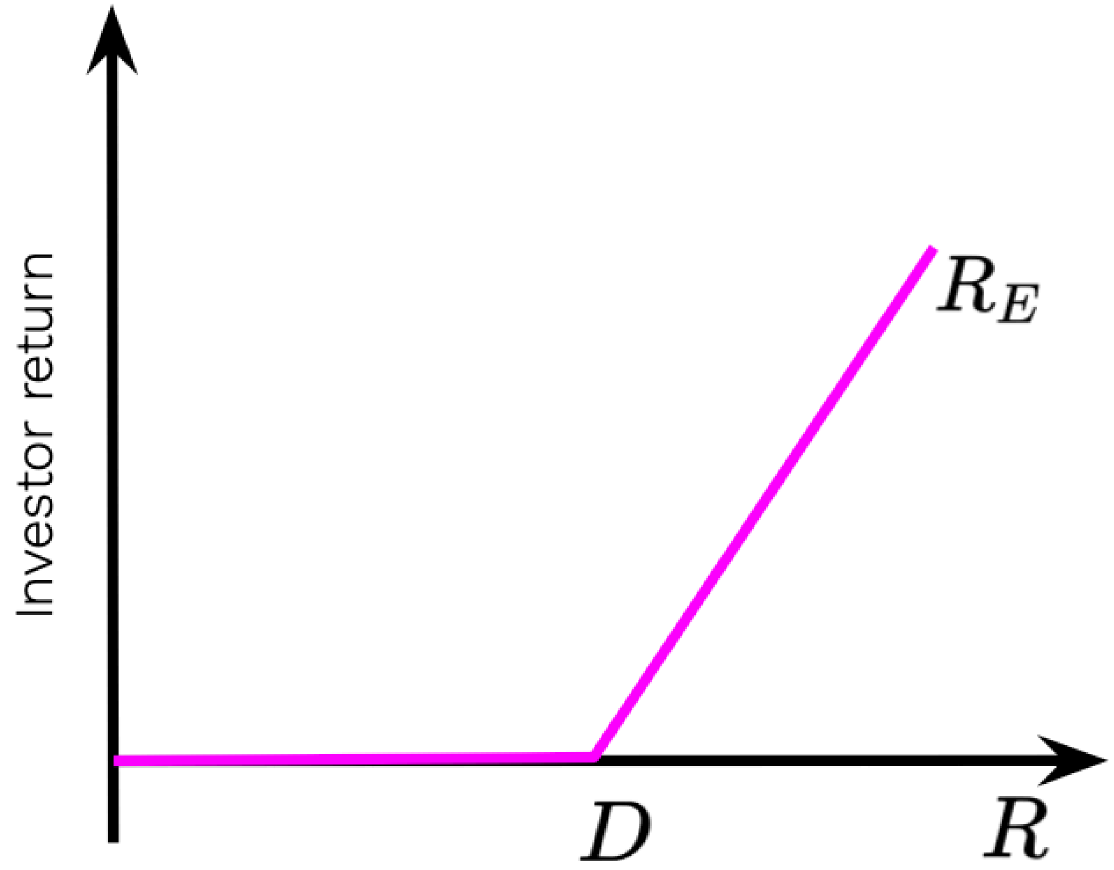
Real-World

However, real-world financial contracts differ markedly:

- (Most) Investments are made through **intermediaries**
- Some profitable investments **do not get funded**
- Repayments are typically **fixed**, not contingent on earnings.
- If earnings are insufficient → **default occurs**.
- Default triggers **costly procedures**: bankruptcy, foreclosure, asset seizure.

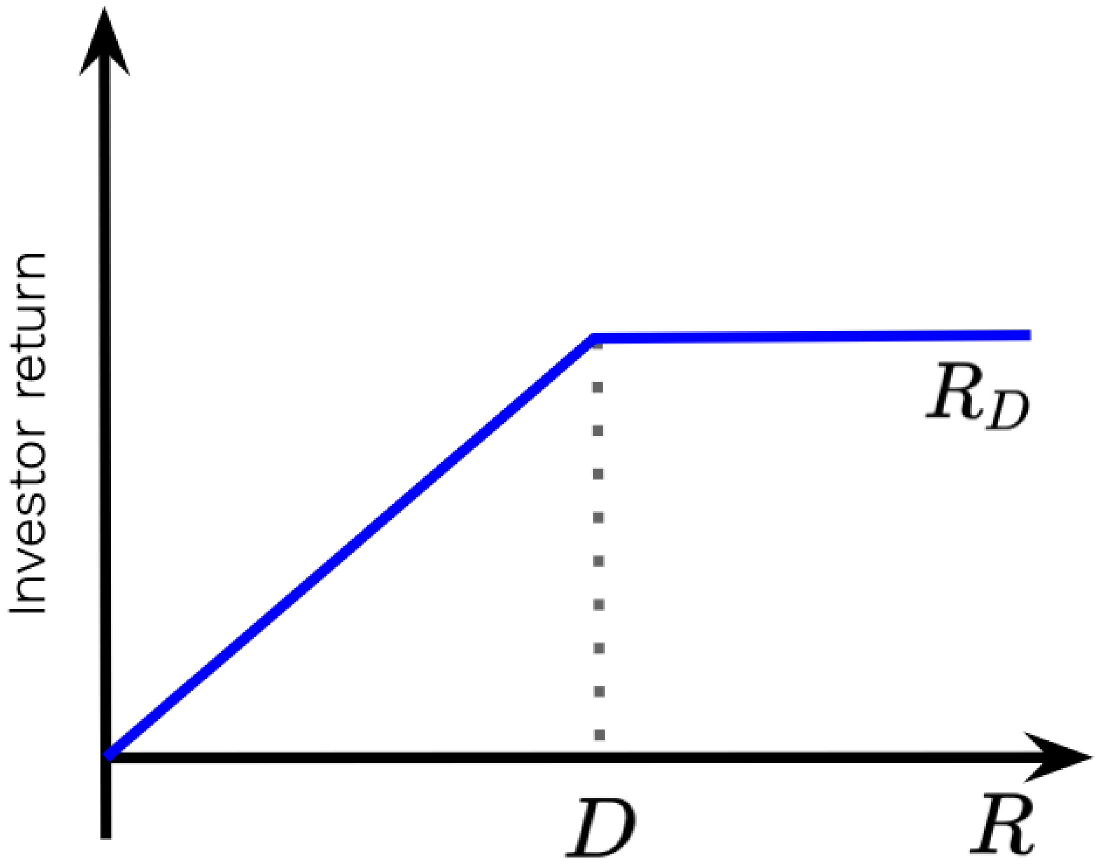
Stylized equity-style contract

Where R is the return from the financed project and R_E the return to the investor



Stylized debt contract

Where R is the return from the financed project and R_D the return to the investor



Overview of the Lecture

1. **Why** the standard debt contract dominates other financial contracts in credit?
2. **Which** market failures arise from credit contracts?
3. **Why** financial intermediation co-exists with direct market lending?

Approach: Study how different **information frictions** — costly verification, adverse selection, moral hazard — shape the **design of credit contracts** and the **role of intermediaries**.

Three guiding models

1. Why are **debt contracts** so prevalent?
   → *Townsend (1979): Costly state verification*
2. What is wrong with debt contracts?
   → *Stiglitz & Weiss (1981): Credit rationing*
3. Why do we need **banks** for credit?
   → *Holmström & Tirole (1997): Monitoring and intermediation*

One common framework: <u>**Information frictions**</u>

Information Frictions and Credit

Type of Friction	Model	Main Problem	Technological Fix	Implication for Credit
Costly state verification	Townsend (1979)	Lender cannot freely observe project outcomes	**Auditing**	Debt contract minimizes verification cost
Adverse selection	Stiglitz & Weiss (1981)	Lender cannot observe borrower type	**Screening**	Credit rationing emerges
Moral hazard	Holmström & Tirole (1997)	Borrower actions unobservable	**Monitoring**	Banks add value through monitoring

2. The Cheapness of Debt

The Puzzle

> *Why do credit markets rely so heavily on* ***debt contracts***
> *— a structure that often leads to costly defaults —*
> *instead of contingent, equity-like contracts that could avoid them?*

The Answer: Information Frictions

- Borrower actions and project outcomes are **not perfectly observable**.
- Information may be **private** or **non-verifiable**.
- Complete contingent contracts are therefore **infeasible**.
- Standard debt contracts emerge as a **constrained-efficient solution** once **asymmetric information** and **incentive constraints** are considered.

Costly-State Verification

The work of Townsend (1979) and Gale & Hellwig (1985) launched the **modern theory of financial contracting**.

It explains **why debt exists** — as the optimal response to **information frictions** and **costly verification** — and how incentives, participation, and efficiency jointly determine contract structure.

Setting

- Entrepreneur and investor write a contract where the investor provides financing for a project.
- The entrepreneur pays back an amount that depends on the **state of the world** (e.g. success / failure).
- The state of the world is **observed only by the entrepreneur**.
- The investor can observe it **only by incurring a monitoring cost**

$\downarrow$

costly state verification

Goal

Show that a **standard debt contract** is optimal:

Maximization of the entrepreneur's wealth subject to the participation of the investor.

Framework

Adapted from Tirole (2006), Chap. 3–7

Environment

Project

- Investment I
- Returns R: random variable with density $p(R)$ on $[0, +\infty)$

Entrepreneur

- Own wealth A
- Needs to raise $I - A$ from investor

Investors

- Funds > I
- **Audit technology**: reveal R at cost K

Financial Contract

Specifies:

- The entrepreneur engages in project yielding return R and **reports** $\hat{R}$
- The investor provides $(I - A)$
- Investor audits the reported return $\hat{R}$ with probability $y(\hat{R})$

Entrepreneur payoff

$$w = y(\hat{R})w_0(\hat{R}, R) + (1 - y(\hat{R}))w_1(\hat{R}, R)$$

Investor payoff

$$R_i = R - w(\hat{R}, R) - y(\hat{R})K$$

Timeline

1. Loan agreement
2. Investment is sunk
3. Income R is realized according to $p(R)$
4. Entrepreneur reports $\hat{R}$
5. Audit decision by investor
6. Repayment R_i to investor

Optimal Contract

The optimal contract maximizes the **entrepreneur's expected income**

$$\max_{y(\cdot),R_i(\cdot)} \mathbb{E}[w(\hat{R},R)]$$

Constraints

- **[IC]** Entrepreneur's incentive compatibility (truthful reporting)

$$w(R,R) = \max_{\hat{R}} \left\{ y(\hat{R})\, w_0(\hat{R},R) + \Big(1 - y(\hat{R})\Big)\ w_1(\hat{R},R) \right\}$$

→ Reporting the true return ($R = \hat{R}$) maximizes w

- **[IR]** Investor's individual rationality (participation)

$$\mathbb{E}\left[R - w(R) - y(R)K\right] \geq I - A$$

→ Investor at least breaks even

If perfect competition: zero profit

Standard Debt Contract

- $D =$ debt payment
- $y(\hat{R}) = 0$ if $\hat{R} \geq D$ `no audit`
- $y(\hat{R}) = 1$ if $\hat{R} < D$ `audit`

Entrepreneur's payoff

$$w = \max(R - D, 0)$$

Investor's payoff

$$R_i = \min(R, D)$$

Standard Debt Contract

- $D =$ debt payment
- $y(\hat{R}) = 0$ if $\hat{R} \geq D$ `no audit`
- $y(\hat{R}) = 1$ if $\hat{R} < D$ `audit`

Entrepreneur's payoff

$$w = \max(R - D, 0)$$

Investor's payoff

$$R_i = \min(R, D)$$

Assuming $y(\hat{R})$ is **binary** for all $\hat{R}$

↓

This debt contract is optimal

Proof

Step 1: Minimizing audit costs

As investors' break even (perfect competition), the **[IR]** constraint can be re-written:

$$\mathbb{E}\left[R - w(R) - (1 - y(R))\, K\right] = I - A,$$

- Isolate $w(R)$ inside the expectation.

$$\begin{aligned} \mathbb{E}[w(R)] &= \mathbb{E}\big[R - (1 - y(R))K\big] - (I - A) && (1) \\ &= \mathbb{E}[R] - K\mathbb{E}[1 - y(R)] - (I - A) && (2) \end{aligned}$$

- Constants: $\mathbb{E}[R]$, $(I - A)$ and $K > 0$

Therefore,

$$\max\ \mathbb{E}[w(R)] \quad \Longleftrightarrow \quad \min\ \mathbb{E}[1 - y(R)].$$

$$\downarrow$$

<u>Goal:</u> Minimize audit zone

Step 2: Regions of Returns

Define the following regions:

- $\mathcal{R}_0$ = `no-audit` zone
- $\mathcal{R}_1$ = `audit` zone

such that:

$$\mathcal{R}_0 \cap \mathcal{R}_1 = \emptyset, \qquad \mathcal{R}_0 \cup \mathcal{R}_1 = [0, \infty)$$

Step 3: Audit cost

Any [IC]-satisfying contract must have a **cutoff region** where the borrower repays a **fixed** amount whenever no audit occurs.

Why?

1. **Flat Payments in No-Audit States**
    - If repayments varied with R in no-audit states, borrower would underreport.
    - Thus, all no-audit states must involve the **same repayment** F.
2. **Cutoff Audit Rule**
    - Since borrower's incentive is always to under-report, audits should target **low reports**.
    - Efficient rule: audit only when reported under a **threshold** F.

$$\downarrow$$

$$R - w(R) = F \quad \text{when} \quad R \in \mathcal{R}_0$$

Debt contract:

$$\boxed{R_i = R - w(R) = D \quad \text{when} \quad R \in \mathcal{R}_0^*}$$

$$\boxed{\mathcal{R}_0^* = [D, \infty) \quad \& \quad \mathcal{R}_1^* = [0, D[}$$

$\mathcal{R}_0^*$ is the largest possible no-audit region consistent with incentive compatibility.

Any other contract that satisfies **[IC]** and **[IR]** must audit at least as often: $\mathcal{R}_0 \subseteq \mathcal{R}_0^*$.

<u>Hence the **expected audit cost is (weakly) lower** than any other contract.</u>

Step 4: Investor payoff

Debt contract payoff: $(\mathcal{R}_0^*, \mathcal{R}_1^*)$

$$\boxed{R_i = \begin{cases} R - w(R) = D, & \text{if } R \in \mathcal{R}_0^*, \\ R - K, & \text{if } R \in \mathcal{R}_1^*. \end{cases}}$$

Assume any other **arbitrary contract**: $(\mathcal{R}_0, \mathcal{R}_1)$

- For $R \in \mathcal{R}_1 \cap \mathcal{R}_0^*$
  - Arbitrary contract `audit` | Debt contract `no audit`
  - But the repayment under no-audit is constant at D → Same repayment but arbitrary contract pays audit cost
- For $R \in \mathcal{R}_1 \cap \mathcal{R}_1^*$
  - Arbitrary contract `audit` | Debt contract `audit` → Same return

The debt contract, when auditing, extracts the maximum enforceable amount $R - K$ (the project's realized return minus audit cost).

No alternative contract can give the investor more.

<u>Hence, the **investor's expected payoff is weakly higher** under the debt contract.</u>

Step 5: Entrepreneur payoff

Given competitive investors, the [IR] constraint binds: $\mathbb{E}[R_i] = I - A.$

If the investor gets the same expected payoff but with lower audit cost, the entrepreneur receives the higher expected income.

<u>Debt → fewer audits → smaller total verification cost → **larger borrower surplus**</u>

Discussion

Intuition Recap

In presence of **costly state verification**:

- **Debt contracts** emerge naturally as the **cheapest funding contract**:
  - Flat payments in good states (no audit).
  - Audits only in bad states (defaults).
- **Default is not a system failure** — it is part of the optimal contract when verification is costly.

Why Alternatives Fail

Alternative	Why It Fails
Equity-like contract (repayment depends on profits)	Requires verifying R in every state → too costly
Variable repayment in no-audit states	Breaks incentive compatibility (borrower lies)
Random audits	Wasteful, not targeted at incentive problem

↓

Debt minimizes verification costs while preserving incentives.

Policy and Market Implications

- **Efficient bankruptcy systems** → reduce verification costs.
- **Collateral registries & credit bureaus** → improve verification and enforcement.
- **Auditing and accounting standards** → lower information asymmetry.
- **Development finance:** where verification/enforcement is costly, credit markets remain underdeveloped.

Technological Fix: Reducing Verification Costs

Technologies that make **performance observable in real time** (data-sharing, digital payments, IoT, blockchain) push markets **closer to the optimal design** by:

- Reducing audit frequency or cost.
- Allowing more state-contingent (equity-like) payoffs.
- Expanding access to credit.

Applications

Setting	Mechanism	Effect
Fintech lenders (e.g., Shopify Capital, Stripe)	Real-time revenue data	Lower verification cost → more flexible contracts
Smart contracts / Blockchain	Automated on-chain verification	Replaces manual auditing
DeFi lending	No verification possible	Requires **over-collateralization**

3. The Failure of Credit Markets

Credit Markets ≠ Standard Markets

In most markets, **prices clear**

Supply and Demand: Excess demand → price rises → market equilibrates

In **credit markets**, however, **raising the interest rate** changes **who borrows**, not only **how much**.

The price (interest rate) itself affects the **risk composition** of borrowers.

Why? Information Asymmetry and Adverse Selection

- Borrowers differ in **riskiness** and **project quality**, but lenders **cannot observe** this before lending.
- Higher interest rates drive out **safer borrowers**, leaving a **riskier applicant pool** — a case of **adverse selection**.

When Prices Stop Working: `Credit rationing`

- Because of adverse selection the lender’s **expected return** may **decline** when the interest rate rises.
- At some point, it becomes **unprofitable** to raise rates further — even if **loan demand exceeds supply**.

Credit rationing → A market where **some borrowers remain creditworthy but unfunded**

A Model of Credit Rationing

The Stiglitz–Weiss (1981) model

- Showed formally how **asymmetric information** can produce a **non-clearing equilibrium**

→ *Market failure* in the credit market.

- Formalized the concept of **credit rationing**:
    - Banks keep **interest rates below market-clearing levels**
    - **Limit quantity** rather than **raise prices**.

Environment

Project

- Investment I
- Returns R

NEW: projects can be of **different risk types** θ

Conditional distribution of returns:

$$R \mid \theta \sim F(\cdot \mid \theta),$$

where a higher θ implies a **mean-preserving spread** (riskier project).

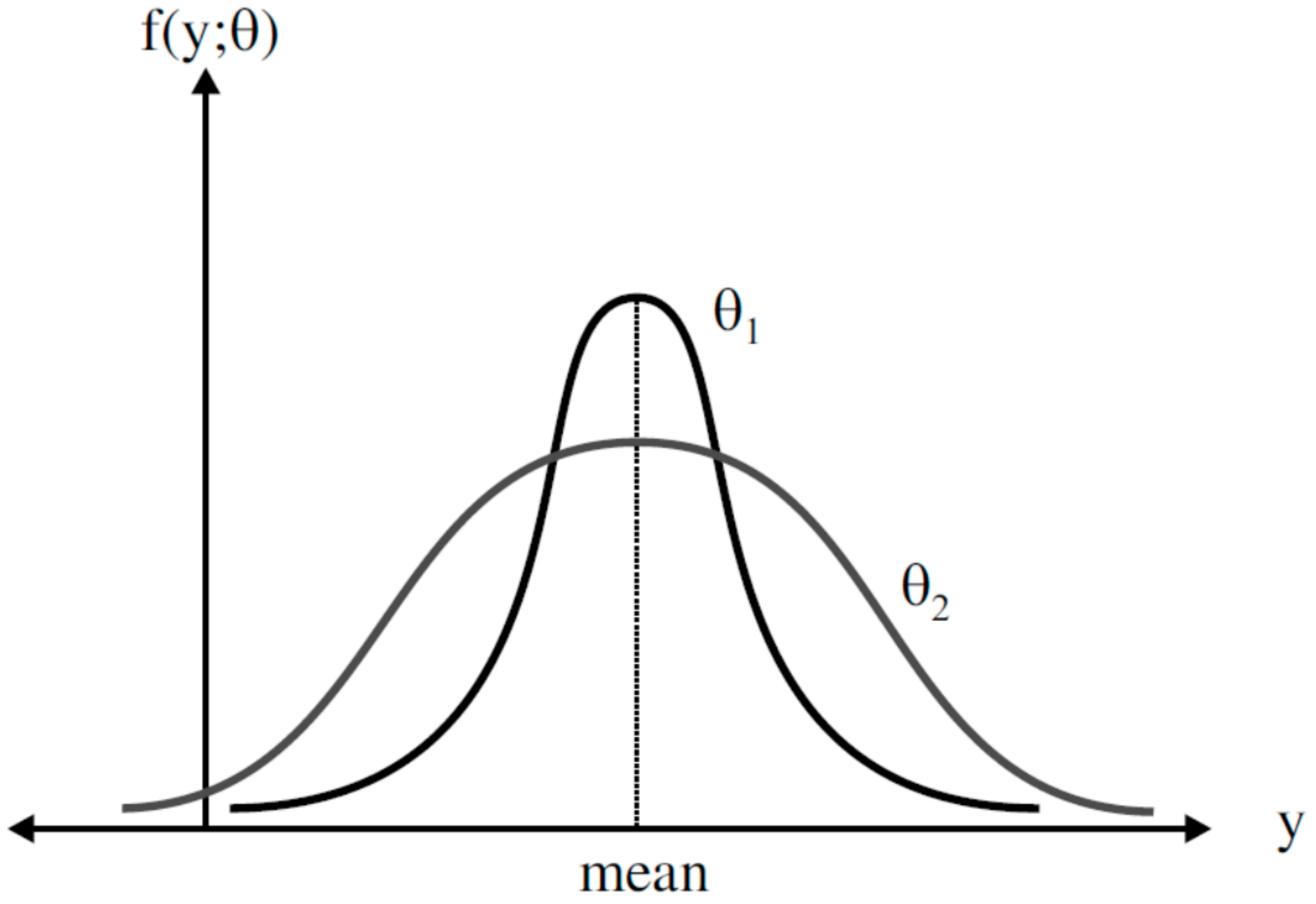
Entrepreneur/Borrower

- Own wealth A
- Associates with a project of risk type θ
- Needs to raise $I - A$ from investor

Investors

- Funds > I
- Requires repayment D (principal + interest)

Riskiness of projects



Borrower participation

Outside option π_0

$$\mathbb{E}[\max\{R - D, 0\} \mid \theta] \geq \pi_0.$$

Define **cutoff type $\theta^*(D)$** such that

$$\mathbb{E}[\max\{R - D, 0\} \mid \theta^*(D)] = \pi_0$$

<u>Result</u>: Borrower type θ participates iif $\theta \geq \theta^*$

<u>Key</u>: Safer borrowers exit as D increases

$$\boxed{\frac{d\theta^*(D)}{dD} > 0}$$

Benchmark: Perfect Information

Suppose the bank **can observe each borrower's type** θ.

Then, it would offer a **type-specific contract** $D(\theta)$ that maximizes expected profit:

$$\max_{D(\theta)} \Pi(D(\theta) \mid \theta) = \mathbb{E}[\min\{D(\theta), R\} \mid \theta] - (I - A)$$

subject to borrower participation:

$$\mathbb{E}[\max\{R - D(\theta), 0\} \mid \theta] \geq \pi_0.$$

Because the lender can price risk perfectly, **each type** gets a distinct rate or face value $D(\theta)$.

- There is **no adverse selection**: the bank faces only project risk.
- The market **clears through prices** (interest rates differentiate across borrowers).

Information Asymmetry: Adverse Selection

Information asymmetry: θ **is hidden** - only known to the borrower.

The bank **cannot price each type** separately — it must offer a **single contract** (D) to a mixed pool of applicants.

- **Per-loan expected profit (conditional on type θ):**

$$\Pi(D \mid \theta) = \mathbb{E}[\min\{D, R\} \mid \theta] - (I - A)$$

- **Applicant pool at face value D:**

$$\text{Borrowers with } \theta > \theta^*(D)$$

- **Average (pool) expected profit:**

$$E\Pi(D) = \mathbb{E}_{\theta>\theta^*(D)}\Big[\mathbb{E}[\min\{D, R\} \mid \theta]\Big] - (I - A).$$

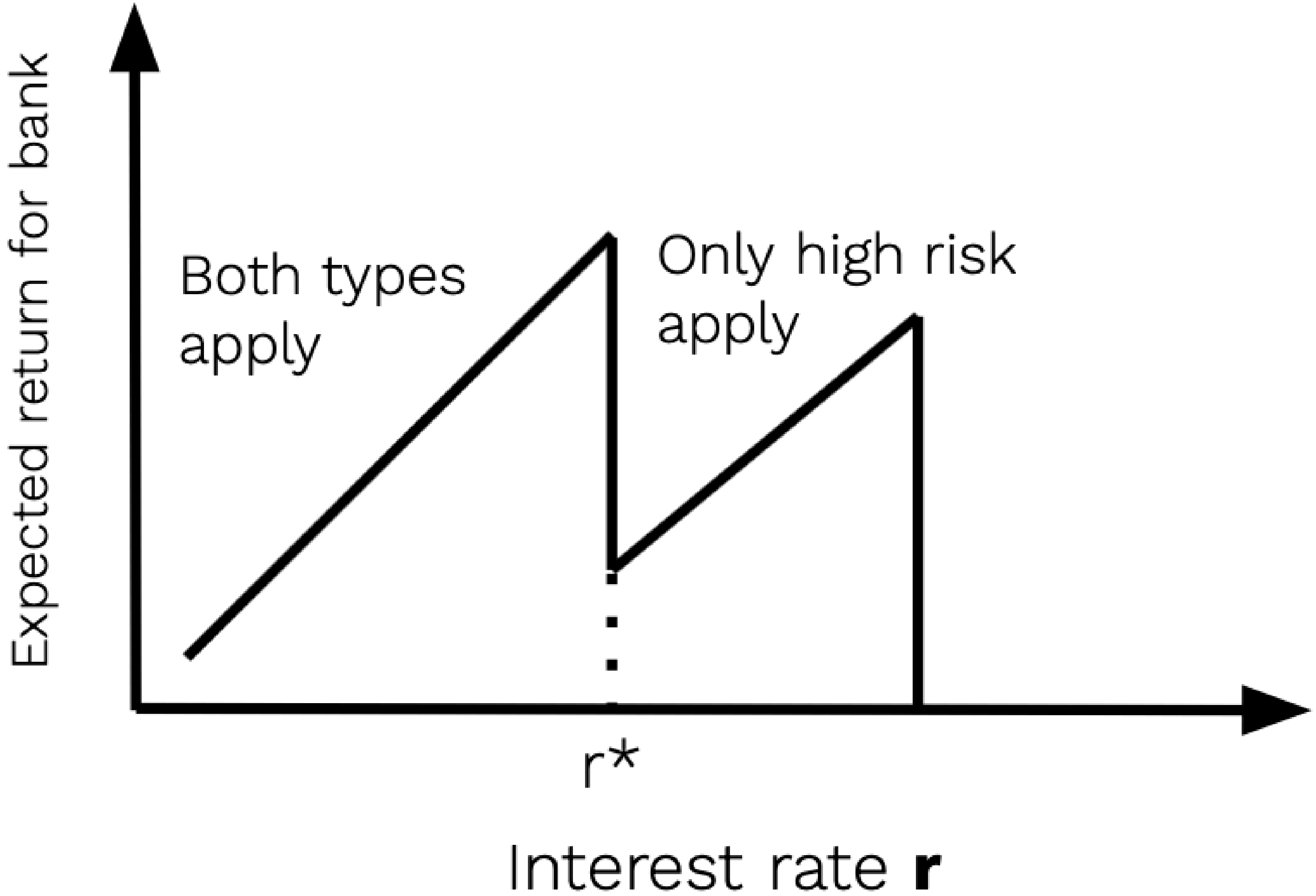
Equilibrium - Credit Rationing

The bank's **expected profit curve** $E\Pi(D)$ reflects two opposing forces:

- **Direct effect (price effect):** raising D increases revenue per loan.
- **Composition effect (selection):** higher D drives out safer borrowers (raises $\theta^*(D)$), worsening the pool.

With 2 types

Let $r = D - I$



As D (price) rises:

- $E\Pi(D)$ first **increases** (direct effect dominates),
- then **decreases** (composition effect dominates).

$$E\Pi(D) \text{ is inverted-U shaped.}$$

Let D^* be the profit-maximizing face value:

$$\left.\frac{dE\Pi(D)}{dD}\right|_{D^*} = 0, \qquad \left.\frac{d^2E\Pi(D)}{dD^2}\right|_{D^*} < 0.$$

If at D^*, **loan demand exceeds supply** (many applicants still want loans), banks do **not** increase D further — doing so would **reduce expected profit** (worse selection).

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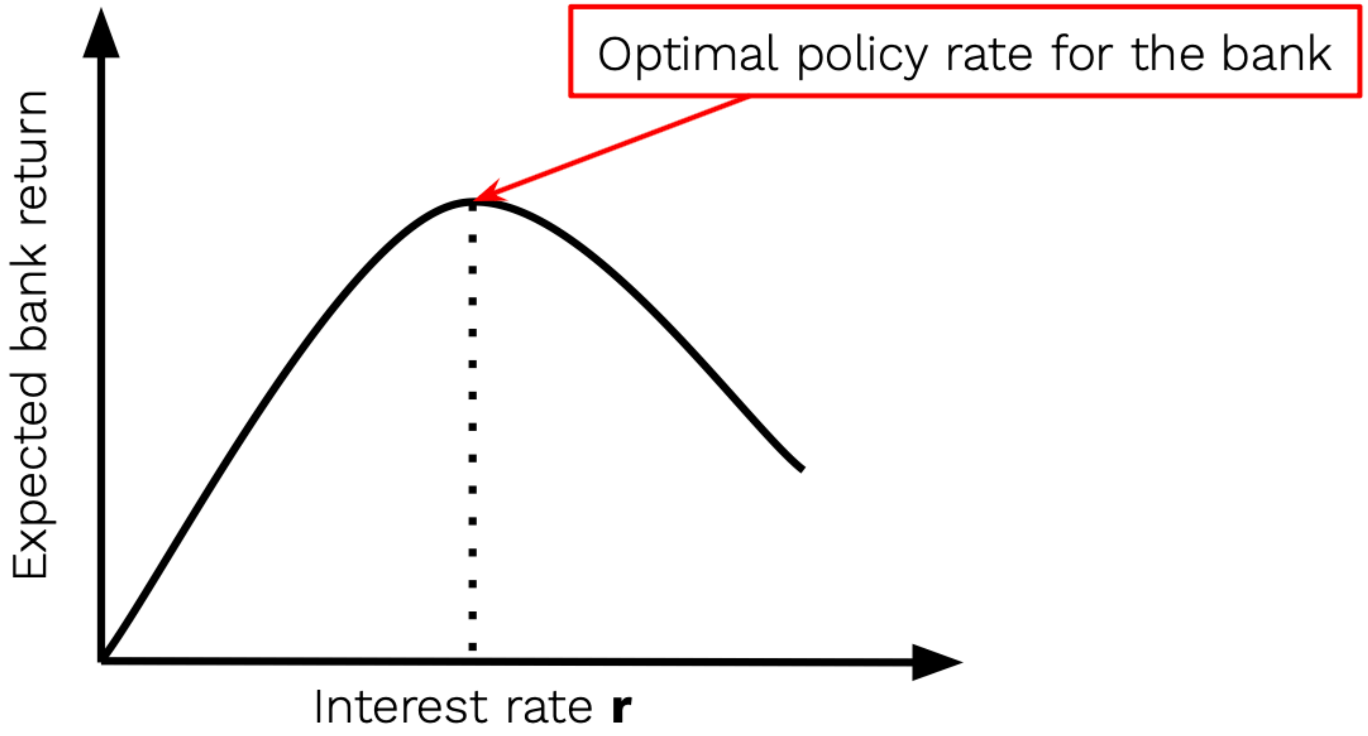
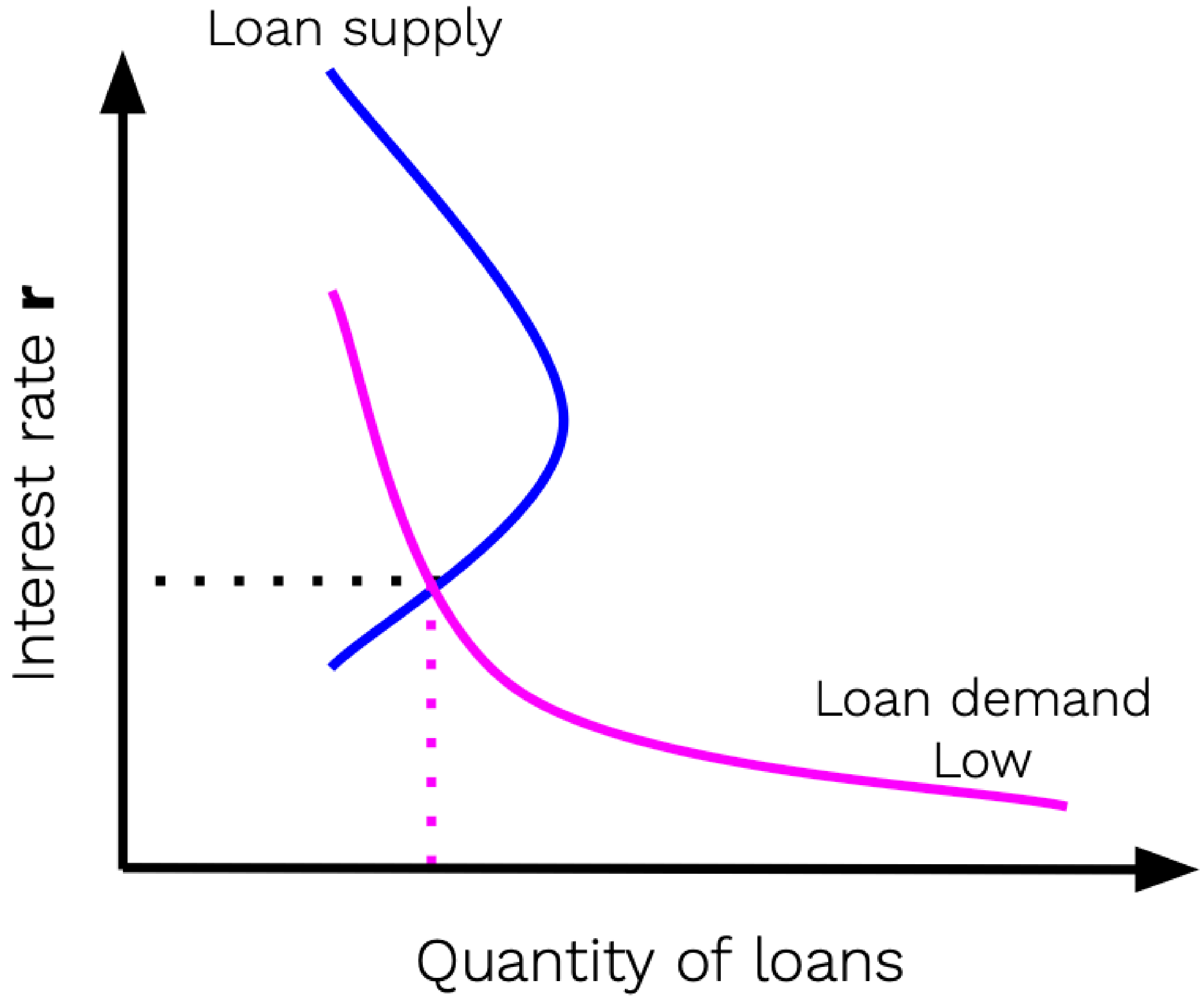
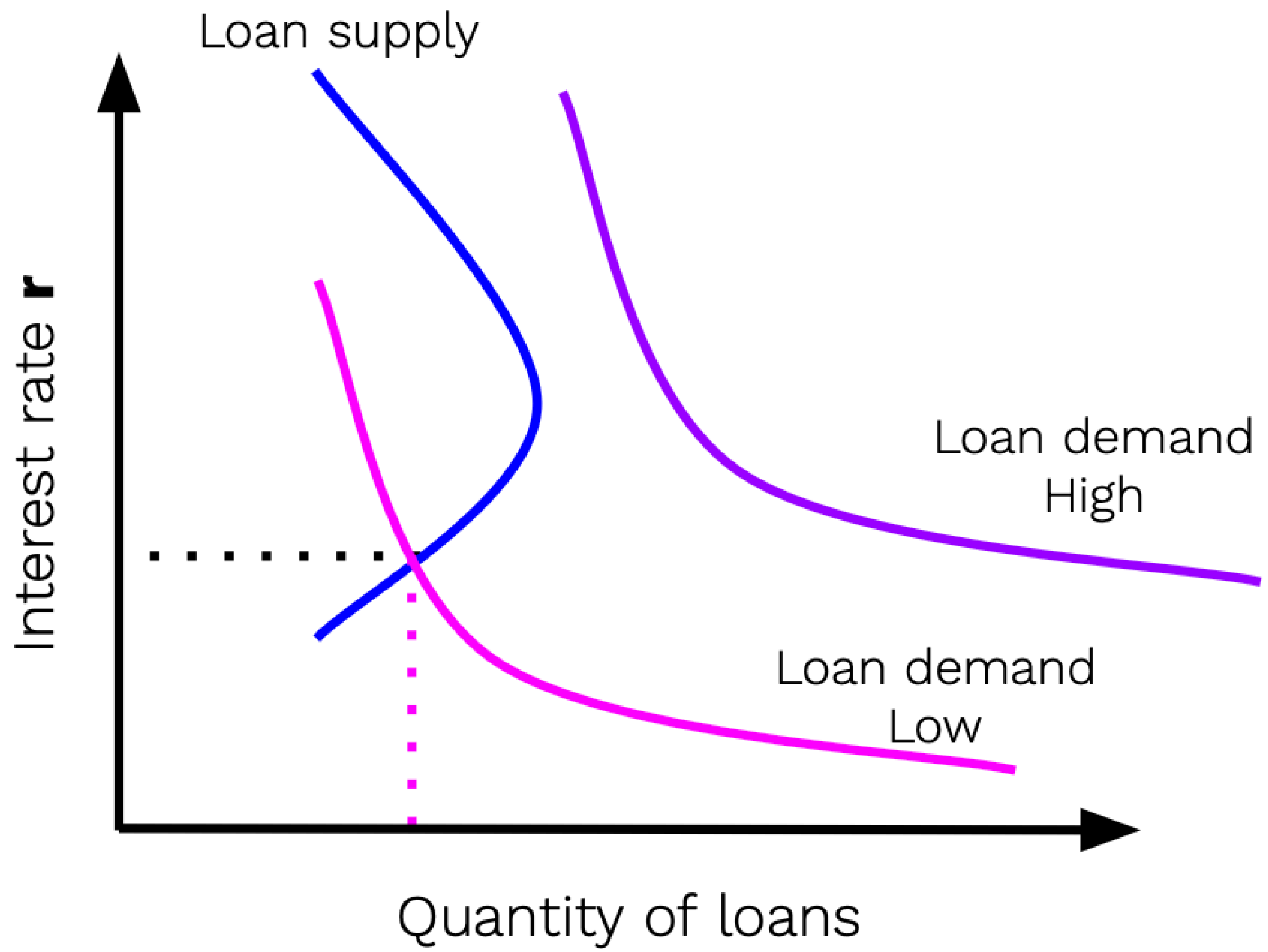
Credit Rationing

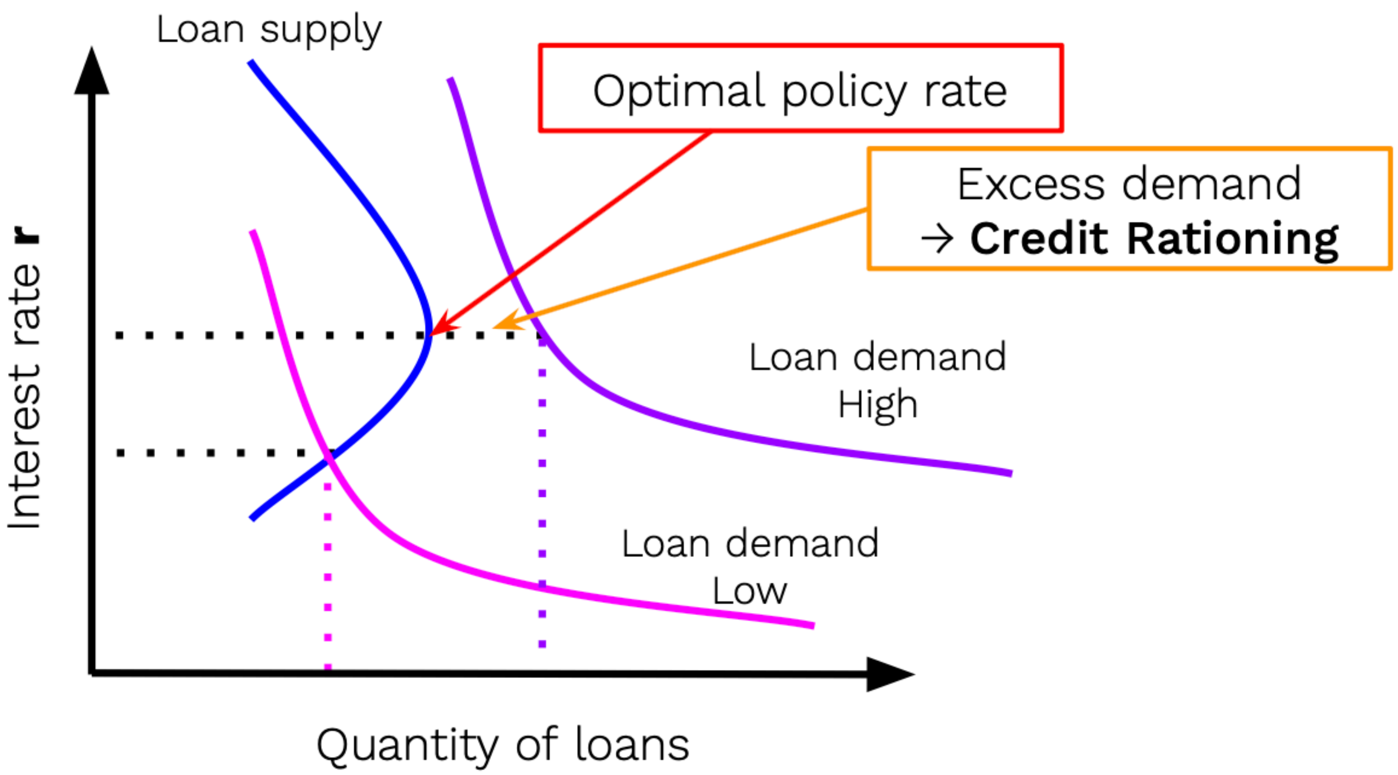
With continuum of types

Let $r^* = D^* - I$




Loan supply
Interest rate r
Loan demand
Low
Quantity of loans


Loan supply
Interest rate **r**
Loan demand
High
Loan demand
Low
Quantity of loans


Loan supply
Optimal policy rate
Excess demand
→ Credit Rationing
Interest rate r
Loan demand
High
Loan demand
Low
Quantity of loans

Hence,

- Banks **do not increase the rate**; they **ration**: lend a fixed quantity at D^* and reject the marginal applicants.
- Some borrowers remain **creditworthy but unfunded**.
- The **market fails** to clear via price adjustment.
- This outcome is **credit rationing**.

Key message:

With **adverse selection**, the profit-maximizing rate **does not clear the market**.
Credit rationing is an **equilibrium** outcome.

Discussion

The Stiglitz–Weiss model shows that:

- Information asymmetries make bank profit a **non-monotonic function of interest rates**.
- Optimal lending rate D^* does not clear the market.
- Credit rationing is an equilibrium phenomenon rooted in **adverse selection**.

Implications

- **Banks prefer to ration credit** at D^* rather than raise rates further.
- Explains why even solvent, willing borrowers can be denied loans.
- Highlights role of **collateral, covenants, relationship lending** to reduce adverse selection.

Why It Was Such an Impactful Discovery

Classical view (before 1981):

In competitive markets, excess demand is eliminated by raising prices. By analogy, if too many borrowers wanted credit, interest rates should rise until demand = supply.

Stiglitz & Weiss (1981):

- Showed that in credit markets, raising interest rates changes *who* borrows, not just *how much*.
- Higher rates drive safe borrowers out, leaving a riskier pool (adverse selection).
- Expected bank profit is an inverted-U in the interest rate → banks may stop lending before the market clears.
- This means **credit rationing is an equilibrium outcome**, not a temporary imperfection.

Impact (together with Akerlof 1970):

- Akerlof's *Market for Lemons*: price affects the quality of goods traded.
- Stiglitz–Weiss: interest rates affect the quality of borrowers.
- Together, these papers reshaped economics by showing how **information asymmetries lead to persistent market failures**.

What the Model Explains in Practice

Financial exclusion: Some creditworthy borrowers are systematically denied loans (e.g., SMEs, low-income households).

Underinvestment in innovation: Innovative projects are harder to evaluate → more likely to be rationed.
Explains why banks prefer lending against collateral (mortgages) rather than financing startups.

Persistence of informal credit markets: When banks ration, borrowers turn to moneylenders or payday lenders, often at exorbitant rates.

Structural inequality: Borrowers without collateral, reputation, or long relationships with banks are most likely to be excluded.

Why credit markets look different from goods markets: In goods markets, prices usually clear demand. In credit markets, queues, rejections, and “no” are common.

Interventions

Screening and information tools:

- Credit registries, credit bureaus, big data credit scoring.
- Better borrower information reduces adverse selection.

Collateral and covenants:

- Lenders use assets and contractual restrictions to screen and align incentives.

Relationship lending:

- Long-term interactions between bank and borrower reduce information asymmetry.

Public interventions:

- Loan guarantees (e.g., for SMEs).
- Targeted credit programs (student loans, housing finance).

Policy Implications

Justification for regulation and intervention:

- Market failures in credit justify government involvement.
- Explains the existence of development banks, credit guarantee schemes, and subsidized lending.

Financial stability link:

- Rationing shows banks will not necessarily raise rates in response to stress → instead, they may cut lending ("credit crunch").
- Connects to procyclicality of bank lending during crises.

Distributional effects:

- Credit rationing disproportionately affects marginalized groups, creating inequality of opportunity.
- Policies promoting financial inclusion (e.g., open banking, digital ID) have efficiency and equity benefits.

Modern Issues and Fintech

Fintech credit scoring:

- Use of alternative data (e.g., transaction histories, mobile phone data) reduces information gaps.
- Can mitigate adverse selection, expand credit access.

Peer-to-peer and platform lending:

- Platforms claim to overcome rationing by better matching of borrowers and investors.
- But information asymmetry and selection issues persist (ratings, defaults).

Stablecoins and DeFi lending:

- Collateral-based lending dominates (e.g., overcollateralized crypto loans).
- Illustrates persistence of rationing: without information about borrower quality, only fully collateralized loans are feasible.

Policy debates today:

- Open Banking and data portability as tools to reduce information frictions.
- Balancing **financial inclusion** with **privacy**.

4. The Structure of Credit Markets

So far:

- **Townsend (1979)** → *Costly state verification* → why **debt contracts** arise.
- **Stiglitz & Weiss (1981)** → *Adverse selection* → why **credit rationing** occurs.

Now → a third question:

> **Why do banks exist, and why do they coexist with direct market investors?**

In reality, we observe **segmentation** in financing:

- Large, established, transparent firms → access **capital markets**.
- Smaller, opaque, riskier firms → rely on **banks**.
- Some firms → **credit constrained** or excluded.

During crises, this segmentation widens leading to **credit crunch** phenomenon.

The Core Problem: Moral Hazard

Many investment projects require **effort** from the entrepreneur/borrower and **monitoring** of the investor to succeed.

- **Effort** increases expected returns but is **not observable** by outsiders.
- If the entrepreneur can enjoy **private benefits** from **shirking** → may not exert effort

↓

<u>Moral hazard</u>: unobservable actions distort incentives and funding decisions.

This information friction explains the **boundary between banks and markets** and allows to address:

- Which firms **borrow directly** from investors?
- Which rely on **intermediated (bank) finance**?
- Which cannot obtain finance at all?

→ A **micro-foundation** for the structure of the financial system:

> Banks arise to **mitigate incentive problems** that markets alone cannot solve.

A Model of Monitoring Effort

Holmstrom and Tirole (1997) provide a unified framework showing that:

1. **Moral hazard** (hidden effort) limits the **pledgeable income** of projects.
2. **Monitoring** can relax this constraint — but at a **cost**.
3. The optimal allocation features a **coexistence** of:
    - **Market-financed projects** (self-enforcing effort),
    - **Bank-financed projects** (monitoring needed),
    - **Unfunded projects** (inefficient due to severe moral hazard).

This paper was a foundation for theories of:

- **Financial intermediation** (banks as delegated monitors),
- **Capital structure** (internal vs external finance),
- **Credit cycles** and **financial amplification** (via limited pledgeability).
- Basel-style **capital regulation** (bank skin in the game),
- **Corporate finance hierarchy**: internal → bank → market financing.

Key idea:

Banks and markets coexist because they address different incentive problems.
Financial structure is not arbitrary — it reflects the **nature of information and monitoring** in the economy.

Environment

Project

- Investment I

NEW:

- Returns $R \in \{R_H, R_L\}$

Project outcome depends on **effort** e

Effort	Success probability	Return if success	Return if failure
High effort ($e = 1$)	p_H	R_H	0
Low effort ($e = 0$) (shirking)	$p_L < p_H$	$R_L < R_H$	0

Entrepreneur/Borrower

- Own wealth A
- Needs to raise $I - A$ from investor
- Choses to exert effort e
    - When shirking ($e = 0$): gets **private benefit** B

Investor (direct market)

- Funds > I
- Requires repayment D (principal + interest)
- **Cannot observe** e ex ante

Bank (intermediary)

- Same financing as investor
- **Monitoring technology**: $B = 0$ at cost K

NPV assumptions:

$$p_H R_H > I > p_L R_L$$

→ The project is socially efficient **only with high effort**.

Entrepreneur's expected payoff

Limited liability: Let D be the repayment due **in success** and nothing is paid in failure.

Expected payoff

$$\mathbb{E}[w] = \begin{cases} p_H(R_H - D) & \text{if } e = 1 \\ p_L(R_L - D) + B & \text{if } e = 0 \end{cases}$$

Incentive Compatibility

Without Monitoring

[IC] Effort is **incentive-compatible** iff

$$p_H(R_H - D) \;\geq\; p_L(R_L - D) + B.$$

- Rearranging:

$$\big(p_H R_H - p_L R_L\big) - (p_H - p_L)D \;\geq\; B,$$

→ There is a **maximum face value** that can be charged to the entrepreneur while keeping consistent with effort:

$$D_{\max} \;=\; \frac{p_H R_H - p_L R_L - B}{p_H - p_L}.$$

- For $D > D_{\max}$, the entrepreneur prefers to shirk.

Direct Market Funding

Investor expected payoff:

When $D < D_{max}$: investors expect to receive $p_H D$ (since effort is exerted under [IC]).

Feasibility of direct funding:

- Market finance is feasible if **there exists** $D \leq D_{\max}$ such that

$$p_H D \;\geq\; I - A.$$

- A **necessary condition** is therefore that:

$$p_H D_{\max} \;\geq\; I - A \quad \Longleftrightarrow \quad A \geq I - p_H \frac{p_H R_H - p_L R_L - B}{p_H - p_L} = A_M$$

Where A_M defines the **minimum capital for market finance**:

→ If $A \geq A_M$, effort is self-enforcing and **direct market funding** is possible.

Bank Funding

A bank can monitor at cost $K > 0$ and **prevent shirking**

- The [IC] constraint is no longer binding for the monitored loan
- $B = 0$

Bank's expected profit

$$\Pi_B(D) \;=\; p_H D \;-\; (I - A) \;-\; K.$$

Feasibility of bank funding:

- Bank funding is feasible with monitoring if there exists D such that

$$p_H D - K \; \geq \; I - A.$$

- A **necessary condition** is therefore that:

$$A > A_B \; = \; I - p_H R_H + K.$$

Where A_B is the **minimum capital** needed for **bank finance** (monitored loan).

> *The bank chooses the largest feasible repayment, $D = R_H$, to minimize the required own capital while respecting limited liability $D \leq R_H$).*

→ If $A_B \leq A$, effort is monitored and **bank funding** is possible.

Credit Market Structure

Co-existence condition

$$A_M > A_B \quad\Longleftrightarrow\quad p_H\frac{p_L(R_H - R_L) + B}{p_H - p_L} > K.$$

As long as the monitoring cost is **not too high**, monitoring is valuable because it **expands** the feasible set:

$$A_B \ < \ A_M,$$

But bank monitoring costs K so banking loans are costlier → Banks optimally fund the **intermediate region** where monitoring is necessary yet efficient.

Case	Effort enforcement	Monitoring?	Capital condition	Funding source
Market finance	Self-enforced	No	$A \geq A_M$	Direct market investors
Bank finance	Needs enforcement	Yes (cost K)	$A_B \leq A < A_M$	Bank (monitored)
No finance	Not profitable even with monitoring	—	$A < A_B$	Project not funded

Economic Interpretation

- **Positive NPV** requires high effort; otherwise, expected value is insufficient.
- With **enough entrepreneur capital** ($A \geq A_M$) → **markets** can fund directly.
- With **intermediate capital** ($A_B \leq A < A_M$), effort would fail without discipline; **banks** pay K to monitor and restore feasibility.
- With **low capital** ($A < A_B$), the project remains unviable even with monitoring → **no funding**.

Bottom line:

Markets fund well-capitalized projects; banks fund monitorable-but-risky ones; bad projects remain unfunded.
This explains the **coexistence** of banks and markets under moral hazard.

Discussion

Paper Impact

- A **foundational contribution** to the modern theory of **financial intermediation**.
- Provided a **microeconomic justification** for why banks and markets coexist:
    - Banks = *delegated monitors* under moral hazard.
    - Markets = *arm's-length financiers* when incentives are self-enforcing.

The paper reframed finance as a problem of **information governance**, not just capital allocation.

Conceptual Breakthroughs

- Introduced the notion of **pledgeable income**:

  > *Only the part of project returns consistent with incentives can be pledged to investors.*

- Explained the **hierarchy of finance**:
  1. Internal finance (self-enforcing),
  2. Intermediated finance (requires monitoring),
  3. Market finance (transparent, large-scale).
- Linked **firm size**, **transparency**, and **financing mode**:
  - Small, opaque → bank-dependent.
  - Large, visible → market-based.

Monitoring as Information Production

- In Holmström & Tirole (1997), banks **monitor borrowers** to prevent shirking.
- Monitoring does not only enforce effort — it also generates **information and data** about:
    - borrower performance,
    - business viability,
    - repayment behavior.

In modern terms: **monitoring = data production** about creditworthiness and operations.

The Private Nature of Monitoring Data

- The information a bank collects through monitoring is **proprietary**.
- It represents **private capital** in the form of data:
    - costly to produce,
    - and difficult for competitors to replicate.
- This informational advantage can **lock customers in**:
    - Borrowers may stay with their bank because the bank knows them best.
    - Competing lenders cannot easily assess risk without similar data.

→ **Private information → informational rents → market power.**

Policy Implication: Open Data and Interoperability

- From a **social efficiency** perspective, data about borrower quality is **non-rival** — once produced, it could improve credit allocation if shared.
- However, private ownership of monitoring data leads to **under-sharing** and **barriers to entry**.

This motivates **open data policies** such as:

- **Open Banking / Open Finance**:
  regulated data-sharing between financial institutions to enable competition and switching.

- **Standardized APIs and interoperability frameworks**:
  reduce information asymmetry while preserving privacy and security.

Economic Trade-Off

Open Data Policies

Benefit	**Cost**
Reduces switching costs and enhances competition	Weakens private incentives to monitor and collect data
Improves market contestability	Unravelling: may reduce banks' willingness to lend to no-data borrowers

The policy challenge:

Balance the benefits of open access to data with the need to preserve **monitoring incentives** that sustain credit to informationally intensive sectors.

Modern Relevance

AI and machine learning
Technologies to **detect** patterns of shirking or misuse of funds (reduce moral hazard).
As such they can **reduce the cost of monitoring** (K) thereby **expanding further access** to monitored credit

Data-driven economy
Monitoring rents are becoming **data rents**.

- Fintechs and BigTechs enter credit markets not through capital, but through **informational advantage**.
- **Open banking** and **data portability** are policy tools designed to:
    - lower barriers to entry,
    - prevent informational monopolies,
    - and reintroduce competition in the monitoring layer of finance.

The underlying principle remains Holmström–Tirole's insight:

- Information is costly to produce and privately valuable
- Public policy must decide **when to privatize it and when to share it**.