Payments

4 Key Questions

1. What are the Different Forms of Payment?

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In [ ]:
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2. How Payments Work Today?

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In [ ]:
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3. What is Special About the Economics of Payments?

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In [ ]:
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4. Should Payment Systems Be Centralised?

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In [ ]:
```

Map

1. Means of Payment
2. Payment Infrastructures
3. A Model of Payment
4. Information in Payments

1. Means of payment

Payment

Definition: The web of arrangements that allow for the exchange of goods and services and assets.

Money is at the heart of it. But there exist multiple means of payment

Evolution of Means of Payment
Shaped by

- Technology
- Institutions
- Trust and credibility
- Practical needs of exchange and trade

#	Type of Money	Key Features	Historical Examples
1	**Commodity money**	Intrinsic value, widely accepted objects	Gold, silver, shells, salt, silk
2	**Paper money**	Credit notes and banknotes, backed (or not) by commodities	Chinese “flying money”, Assignats, Continentals
3	**Fiat money**	Value from government decree, legal tender	US dollar (post-1971), Euro, Yen
4	**Digital money**	Electronic claims on issuers, fast and borderless	Bank deposits, PayPal, debit cards, CBDCs

Each stage reflects a response to the **limits** of the previous system.

1. Commodity Money

First forms of money = **money with intrinsic value**

<u>Examples</u>: shells (global), silk (China), whale teeth (Fiji), salt (Venice)

Necessary characteristics:

1. Can be made into standardized quantities → **unit of account**
2. Durable → **store of value**
3. High value relative to weight/size → **easily transportable**
4. Divisible into small quantities → **easy to trade**

Best candidate: **gold**

2. Paper Money

Origins

- Initially: **credit notes** (promises against commodity money)
- Reduced transportation costs
- Leveraged parallel technology: **paper**

First Introductions

- **China: 7th century (Tang dynasty)**
  - Tang dynasty (618–907): shortage of coins → acceptance of paper notes
  - Traders deposited metallic currency with corporations → received bearer notes (*hequan*)
  - Authorities adopted and generalized the system → **"flying money"**
  - Early example of state involvement in paper money
- **Europe: Sweden, 1656**
  - 1660: debasement of coinage → citizens rushed for old coins
  - Stockholms Banco (Palmstruch): massive issuance of banknotes (not linked to any deposit!)
  - Notes became popular (lighter than copper coins)
  - Over-issuance under royal pressure to finance wars
  - Loss of confidence → redemption crisis → bank failure
  - Palmstruch imprisoned (died 1671)

Paper Money and Wars

In the 18th century: paper money emerged as a massive means to to finance wars of independence

- **US Independence (Continentals)**
- **French Revolution (Assignats)**

Benefits: expanded funding capacity, paid salaries and supplies
Risks: over-issuance with no explicit backing → hyperinflation

After wars: partial return to gold standard (mix of coins and notes)

3. Fiat Money

Definition: Money whose value comes from **government decree** (no intrinsic value)

- Legal tender enforced by law: must be accepted for payments

> *“This note is a legal tender for all debts, public and private”*

- Accepted for taxes → critical for stability

Benefits: reduced coordination and transaction costs

Risks: concentration of power, inflation risk, time inconsistency

- If a government prints too much money → threatens its value
- When time inconsistency is internalized, investment in projects decrease

> *"Ultimately, if a fiat currency is to outperform a commodity currency, policymakers must be credibly committed... As long as the government stands behind its paper money and doesn't issue too much of it, we will use it."*
>
> *— Cecchetti & Schoenholtz*

Core principle: money is about trust

4. Digital Money

Definition: Monetary value represented by a **claim on issuer** (e.g., bank)

Characteristics:

- Stored digitally
- Issued on receipt of funds
- Accepted as means of payment beyond issuer

Advantages:

- Fast, often instantaneous transfers
- Borderless reach

Forms

- Electronic funds transfers
- Stored-value cards (e.g., gift cards)
- Bank deposits, central bank reserves ®

Synchronisation problem: adoption of new medium requires coordination between buyers and merchants (see network effects and platforms)

2. Payment Systems

Main purpose of a payment: **discharge** a debt incurred by the **payer** by transferring an asset to the **payee**

Payment system

- The technologies, laws, and contracts that **enable payments** and determine when **settlement is final**
- Payment systems are the **plumbing of the financial system**.
- They enable the safe, efficient, and timely transfer of funds between individuals, firms, and banks.
- Governments and central banks treat them as **critical infrastructure** because disruptions can cause **systemic risk**.

Outside vs. Inside Money

While in principle a payment may be made with an asset, in practice virtually all modern payments are

Outside money

- Fiat or asset-backed money
- Net positive asset supply
- Examples: central bank currency, gold, government bonds

Inside money

- Private credit circulating as medium of exchange
- Zero net supply within private sector:
    - asset of one agent ~ liability of another
- Example: demand deposits

Modern infrastructures must interact with both **outside** and **inside** money

Token-Based vs. Account-Based Systems

Token-based

- Physical or digital **tokens** (coins, notes, e-tokens)
- **Verification**: authenticity of the token
- **Advantage**: anonymity
- **Risk**: counterfeiting

Account-based

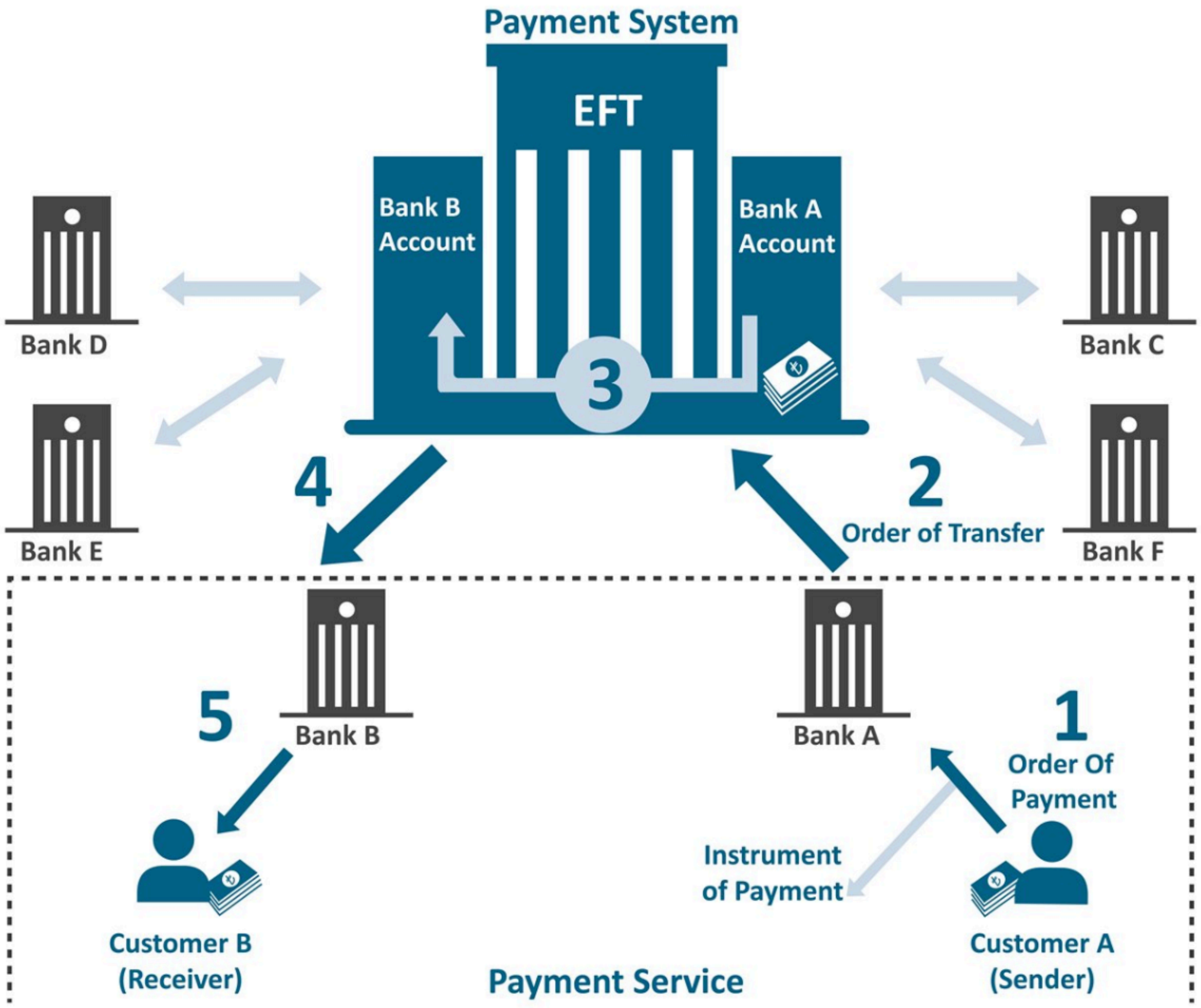
- Operate through **account records** (banks, cards, decentralized ledgers)
- **Verification**: identity of account holder + transaction record
- **Advantage**: safety, efficiency, lower costs
- **Risk**: tampering, un-authorized entries, exclusion

Historically

Both systems have long coexisted (e.g., banknotes + deposits)

- **Limitations of physical tokens (coins/metal):** costly and risky for large/long-distance payments
- **Medieval fairs**: banks cleared merchant balances → early clearing systems
    - Account-based systems start in Venice 14th, transfers for clients of the same bank
    - With increase in economic activity → growth and need for more payment options
        - Clearinghouses appear to enable transfers between different banks (clearing and settlements)
- Development of clearinghouses laid foundations for **central banks**
- **19th century US & Europe:** clearinghouses expanded into modern account-based systems

Backbone of Modern Payment Systems



Payment System
EFT
Bank B
Account
Bank A
Account
3
Bank D
Bank E
Bank C
Bank F
4
2
Order of Transfer
Bank B
Bank A
5
1
Order Of
Payment
Instrument
of Payment
Customer B
(Receiver)
Customer A
(Sender)
Payment Service

Banks hold accounts at the **central bank** to enable interbank transfers (**reserves**)

- Non-member banks can access indirectly via correspondent banks

Examples of central bank payment systems

- Fedwire (US)
- TARGET (EU)
- CHIPS (UK)

Retail payments
Similar to account transfers within a bank but through the reserves of the central bank.

In addition to direct transfers:

- Paper checks
- Credit cards

Settlement Systems

A crucial dimension of payment: **how and when payments are considered final**.

- Settlement defines the moment when a payment is **irrevocable and unconditional**.
- Different infrastructures handle settlement differently, reflecting trade-offs between **speed, liquidity, efficiency, and cost**.

2 main types of settlement systems:

- Real-Time Gross Settlement
- Automated Clearing House

1. RTGS – Real-Time Gross Settlement

Definition: Payments settled individually, in real-time, with finality

- "Gross" = each transaction processed separately

Features:

- Immediate settlement between banks
- Irrevocable and final once processed
- Eliminates settlement risk

Examples: Fedwire (US), TARGET2 (Eurozone), BOJ-NET (Japan), CHAPS (UK)

Use cases: large-value, time-critical payments (interbank transfers, securities settlement)

Drawback: liquidity-intensive (banks must hold sufficient balances at central bank)

RTGS Example: TARGET2

- Pan-European RTGS system operated by the Eurosystem
- Settles payments in central bank money
- Handles large-value and urgent transactions across the Eurozone
- Backbone of European financial stability infrastructure

2. ACH – Automated Clearing House

Definition: Batch-processing system with net settlement (end-of-day or periodic)

Features:

- Payments grouped into batches
- Settlement deferred
- Cost-efficient, less liquidity needed compared to RTGS

Examples: Nacha ACH (US), SEPA Credit Transfer/Direct Debit (EU)

Use cases: low-value, high-volume payments (salaries, utility bills, e-commerce)

Drawback: slower than RTGS; settlement not instantaneous

ACH Example: SEPA (Single Euro Payments Area)

Single integrated EU market for **euro payments** with same rules and costs across participating countries. Launched 2008, fully implemented by 2014.

Scope(euro-denominated payments only): 36 countries: EU + EFTA (Iceland, Norway, Liechtenstein, Switzerland) + Monaco, San Marino, Andorra, Vatican

SEPA Instruments

- **SEPA Credit Transfer (SCT)**: Standardized euro transfers, usually settled next day (D+1)
- **SEPA Direct Debit (SDD)**: Framework for recurring payments (utilities, subscriptions)
    - Works across borders (Belgian account can authorize a French firm)
- **SCT Instant (SCT Inst)**: <10 seconds Real-time euro payments (up to €100,000, 24/7/365)
    - Introduced 2017
    - Used in P2P and e-commerce

Policy and Stability of Settlements

- **Central banks** typically operate **RTGS systems** → backbone of financial stability
- **ACH networks**: usually under central bank oversight, but often run by **banking associations or private operators**

Growing interest in faster payments:

- Faster Payments (UK)
- FedNow (US)
- PIX (Brazil)

These systems blur the line between ACH (retail, deferred) and RTGS (wholesale, immediate)

Key point:
RTGS and ACH are complementary

- RTGS = speed and finality, but costly
- ACH = efficiency and scale, but slower

Credit Cards

Definition: A credit card payment is a **retail payment instrument** in which:

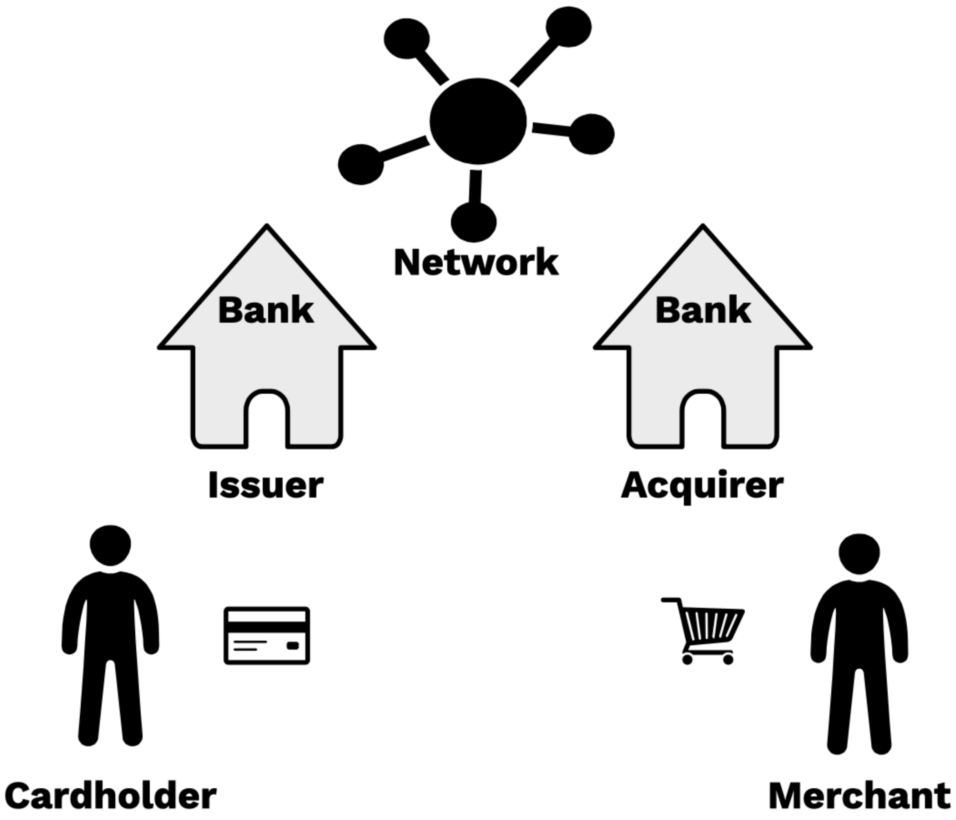
- A **cardholder authorizes** a purchase of goods or services using a credit card issued by a bank (**the issuer**).
- The **merchant** receives payment through its bank (**the acquirer**) via a card network (e.g., Visa, Mastercard).
- The **issuer extends credit** to the cardholder by settling the transaction on their behalf, while the cardholder agrees to repay the issuer (in full or in part, with possible interest).

Credit Cards operate on top of the **interbank payment backbone**

A single purchase involves multiple layers of:

- Networks
- Clearing and settlement arrangements
- Contracts and liability rules
- Creates complexity and interdependencies well beyond the buyer and seller

Key Players in Credit Card Payments



Network
Bank
Bank
Issuer
Acquirer
Cardholder
Merchant

Issuing bank

- The bank that **issues the credit card** to the customer
- Extends **credit** and **guarantees payment** to the merchant (through the network)

Acquiring bank (merchant's bank)

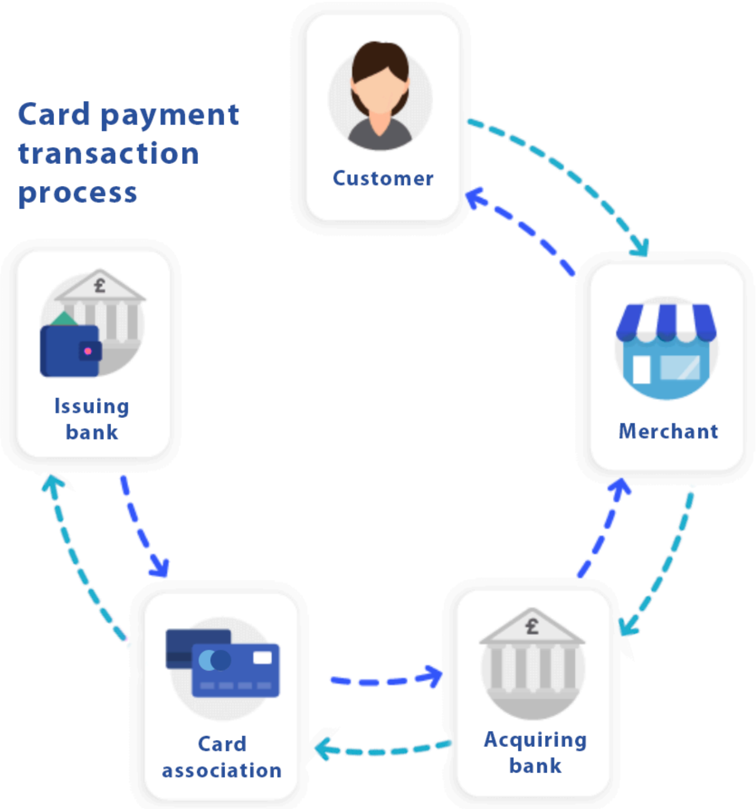
- Provides **payment services** to the merchant
- Collects authorization requests and forwards them through the network
- Ensures merchant receives funds (minus **fees**)

Card network

- Connects issuers and acquirers
- Routes **authorization, clearing, and settlement messages**
- Examples: Visa, Mastercard, American Express, Discover

Steps in a Credit Card Payment

1. Authorization
2. Authentication
3. Clearing
4. Settlement

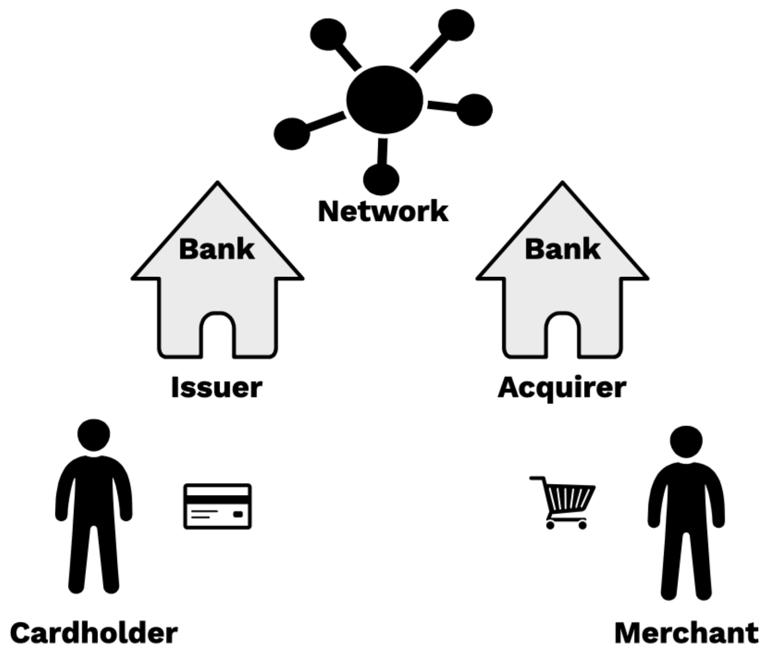

Card payment
transaction
process
Customer
Merchant
Issuing
bank
Card
association
Acquiring
bank

1. **Authorization** & **Authentication**
    - Cardholder presents **card details** to merchant
    - **Verification** of cardholder identity
        - Methods: PIN, signature, 3-D Secure (e.g., SMS/biometric code for online payments)
    - Merchant sends **request** to acquiring bank → card network → issuing bank
    - Issuing bank **checks** available credit and **approves or declines**

2. **Clearing**
    - Transaction **details** transmitted through the card network
    - Issuing and acquiring banks **reconcile transaction records**

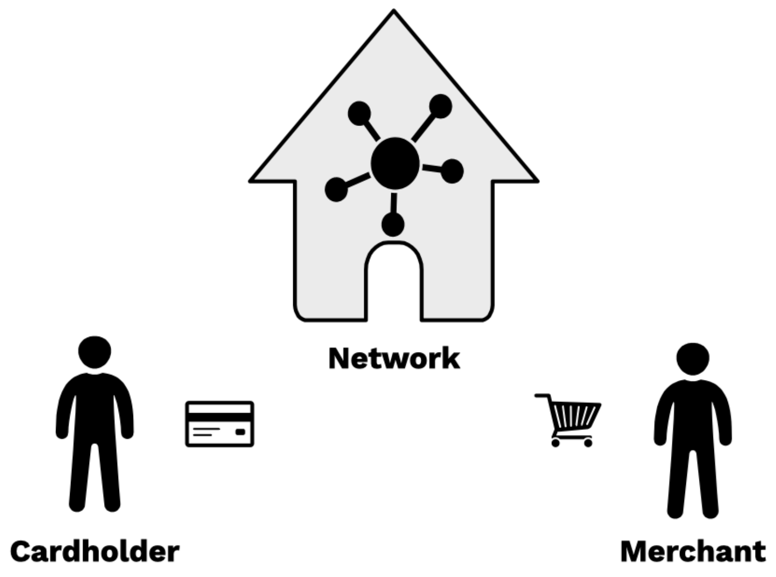
3. **Settlement**
    - Merchant **receives funds** (minus fees), cardholder **owes** issuer
    - Actual **transfer of funds** between issuing and acquiring banks via interbank payment system

Open vs. Closed Loop Systems



Open-loop systems

- Involve multiple intermediaries: issuer, acquirer, card network, merchant
- Widely used global models
- Examples: **Visa, Mastercard**



Closed-loop systems

- Issuer and network are the same entity
- Merchant often contracts directly with the card provider
- Examples: **American Express, Discover**

3. A Model of Payments

Why model payments?

- Modern payments (credit/debit cards, PayPal, Apple Pay, Alipay, Visa/Mastercard) are **platforms** connecting **two sides**:
  - **Cardholders / consumers** (paying side).
  - **Merchants** (receiving side).
- Value arises only if **both sides adopt** → special **two-sided market** problem.

  → Economic laws deviate from traditional settings

Central question: how should fees be set between consumers and merchants?

Economics of Payment Platforms

2 key ingredients

Network externalities:

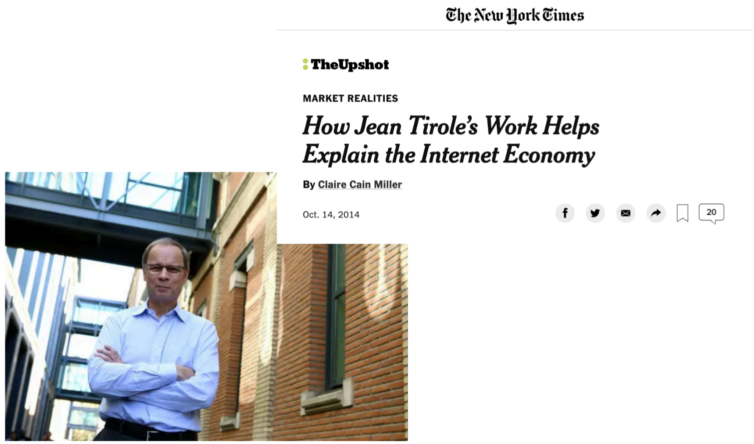
- More cardholders → more valuable for merchants.
- More merchants → more valuable for cardholders.

More on this in `Platform` *part*

Pricing structure matters more than total price:

- Who pays what (consumer vs merchant) influences adoption.
- A card scheme must balance both sides to achieve adoption.

Rochet & Tirole's Framework


The New York Times

TheUpshot

MARKET REALITIES

How Jean Tirole's Work Helps Explain the Internet Economy

By Claire Cain Miller

Oct. 14, 2014

Rochet and Tirole (2003) introduced a fundamental model of payments which influenced the rest of the digital economy.

Environment

Economy

- Buyers (cardholder)
- Sellers (merchants)
- Payment card system (monopoly platform)

Business model

- Fees per transaction:
    - a_b to buyers (cardholders)
    - a_s to sellers (merchants)
- Per-transaction cost: c.

Agents

Role	Utility Function	Participation
Buyer	$u_b = (\beta_b - a_b)\, n_s$	$n_b = N_b(u_b), \quad N_b'(\cdot) > 0$
Seller	$u_s = (\beta_s - a_s)\, n_b$	$n_s = N_s(u_s), \quad N_s'(\cdot) > 0$

Utilities scale with the other side's size: acceptance/usage externality → **network effect**

Platform profit

Transactions (simple network tech): $T(n_b, n_s) = n_b\, n_s = N_b(u_b)\, N_s(u_s).$

$$\Pi(a_b, a_s) = (a_b + a_s - c)\, T(n_b, n_s)$$

Equilibrium

Platform sets fees to maximizes profits

1. Start by differentiating profit w.r.t. a_b (buyer fee):

$$\frac{\partial \Pi}{\partial a_b} = N_s \left[N_b + (a_b + a_s - c) N_b'(u_b) \frac{\partial u_b}{\partial a_b} \right]$$

with $\frac{\partial u_b}{\partial a_b} = -n_s$.

2. Set to zero and isolate fees and costs:

$$N_s \left[N_b + (a_b + a_s - c) N_b'(u_b)(-n_s) \right] = 0$$
$$\rightarrow \frac{1}{a_b + a_s - c} = -\frac{N_b'(u_b)}{N_b(u_b)} n_s$$

3. Define **semi-elasticity in utility space**:

$$\varepsilon_b^u = -\frac{N_b'(u_b)}{N_b(u_b)} u_b$$

where: $u_b = (\beta_b - a_b)\, n_s$

$$\to \varepsilon_b^u = -\frac{N_b'(u_b)\,(\beta_b - a_b)\, n_s}{N_b(u_b)} \quad \leftrightarrow \frac{\varepsilon_b^u}{\beta_b - a_b} = -\frac{N_b'(u_b)}{N_b(u_b)}\, n_s$$

4. Plug elasticity expression in previous expression:

$$\boxed{\frac{1}{a_b + a_s - c} = \frac{\varepsilon_b^u}{\beta_b - a_b}}$$

By symmetry for the seller fee:

$$\boxed{\frac{1}{a_b + a_s - c} = \frac{\varepsilon_s^u}{\beta_s - a_s}}$$

Express condition in terms of fee elasticities

Define fee elasticity:

$$\eta_b^a = -\frac{N_b'(u_b)}{N_b(u_b)} \frac{\partial u_b}{\partial a_b} a_b$$

Since $\partial u_b / \partial a_b = -n_s$, we get:

$$\eta_b^a = \frac{N_b'(u_b)}{N_b(u_b)} n_s \, a_b = \frac{a_b}{\beta_b - a_b} \varepsilon_b^u$$

Plug back:

$$\boxed{a_b + a_s - c = \frac{a_b}{\eta_b^a}}$$

Similarly:

$$\boxed{a_b + a_s - c = \frac{a_s}{\eta_s^a}}$$

Main Result

Balancing condition

$$\boxed{\frac{a_b}{\eta_b^a} = \frac{a_s}{\eta_s^a}} \quad \Longleftrightarrow \quad \boxed{\frac{\beta_b - a_b}{\varepsilon_b^u} = \frac{\beta_s - a_s}{\varepsilon_s^u}}$$

Intuition
Raising a_b changes

- Profit via markup $a_b + a_s - c$
- Quantity $T(n_b, n_s)$ via adoption elasticity $\varepsilon_b^u \uparrow$ when $a_b \uparrow$
    - Which also impacts seller side since $\varepsilon_s^u \uparrow$ given that $n_b \downarrow$
        - Which in turn would again impact the buyer side $\varepsilon_b^u \uparrow$ when $n_s \downarrow$

          → **Network Effects**

→ Optimal pricing must balance those marginal trade-offs across sides.

Implication of $\boxed{\frac{a_b}{\eta_b^a} = \frac{a_s}{\eta_s^a}}$

- The **more price-sensitive** side gets a **lower** (even negative) price
- The **less elastic** side **bears** more

In payments

- Buyers (cardholders) usually have **many alternatives**: cash, debit, bank transfer, other cards.

→ If fees rise, they can easily switch → **high elasticity**.

- Merchants face a tough choice: **refusing** cards can mean losing sales to **all card-preferring buyers**.

→ Their participation is relatively inelastic.

That's why empirically $\eta_b^a > \eta_s^a$, which in the model leads to $a_b < a_s$.

This explains why consumers (price sensitive) pay less and evend get rewards while merchant (less elastic) pay higher fees.

Discussion

Rochet & Tirole's key insight:

- Optimal pricing structure balances participation on both sides.
- Platform may subsidize one side to attract the other.

In traditional monopoly settings, the **Lerner rule** is the benchmark in industrial organization: it links **market power** in pricing (mark up) directly to demand elasticity.

$$\frac{p-c}{p} = \frac{1}{\eta}$$

where $p = a_b + a_s$ → **price level**

Intuition: price–cost margin must equal the inverse demand elasticity.

In two-sided markets:

- **Price structure** is the key!
  - What matters is **the division of fees** (who pays what), not just the total.
- The monopoly platform **must balance margins across both sides**: $\frac{a_b}{\eta_b^a} = \frac{a_s}{\eta_s^a}$
  - Each side's demand elasticity already reflects **network externalities**.
  - No single Lerner condition holds — instead, a **balancing condition** across sides emerges.
- This explains why **cardholders may receive subsidies** (negative price, rewards) while **merchants pay fees**: the platform redistributes to maximize joint adoption.

Tension: Social vs Private Optimum

- **Private platform objective:** maximize profit = transaction volume × (fees – costs).
- **Social planner objective:** maximize total welfare (consumer surplus + merchant surplus – costs).
- Distortion arises because platforms may overcharge one side or underprovide adoption.

Policy Implications

- **Regulators care** because fee structure affects adoption and social welfare.
- **Key issues:**
    - Interchange fee caps (EU, Australia).
    - Promoting access for smaller merchants.
    - Encouraging innovation while avoiding excessive merchant fees.

4. Information in Payments

In the **digital** world, payments are more than value transfers: they generate **information flows**.

- Key tension: **Privacy vs. Control**.
- Central to debates about modern money, banking, and digital finance.

Payments as Information Flows

- Each digital transaction creates a **data trail**:
  - Who pays whom
  - When, where, how much
  - Purpose of payment (explicit or inferred)
- This information has:
  - **Economic uses** (credit scoring, targeted services)
  - **Regulatory uses** (AML, taxation, supervision)
  - **Privacy implications** (surveillance, autonomy)

Centralized Ledgers

Definition: a single entity maintains official records of accounts and transactions.

- Examples:
    - Commercial bank deposit ledgers
    - Central bank RTGS systems (TARGET2, Fedwire)

Advantages

- Efficiency → one authoritative record
- Control → enforcement of rules, compliance
- Auditability → straightforward oversight

Privacy Concerns

- Centralized systems require **identity verification** (KYC/AML).
- Every transaction linked to an account holder.
- Trade-off: anonymity lost, traceability gained.
- Contrast:
    - **Token-based systems (cash, coins):** privacy by design, no ledger.
    - **Account-based systems (deposits, CBDCs):** inherently tied to identities.

Privacy Trade-Off

- **Individuals:** value privacy for autonomy, consumption, political activity.
- **States & regulators:** value transparency to combat illicit finance, tax evasion.
- **Banks & platforms:** monetize data (advertising, credit scoring).

More centralization → more control and efficiency, but less privacy.

More privacy (cash, decentralized tokens) → harder regulation, higher risk of illicit use.

Current Debates

Balance **privacy rights** with **financial integrity and security**.

Central Bank Digital Currencies (CBDC)

- Likely built on centralized or semi-centralized ledgers.
- Key design question: allow anonymity like cash, or ensure full traceability?

Cryptocurrencies

- Promise decentralization and privacy.
- In reality: pseudonymous, not anonymous.
- Exchanges pressured to apply KYC/AML.

BigTech platforms

- Centralize payment data for billions of users.
- Raise concerns about surveillance capitalism and private concentration of financial data.