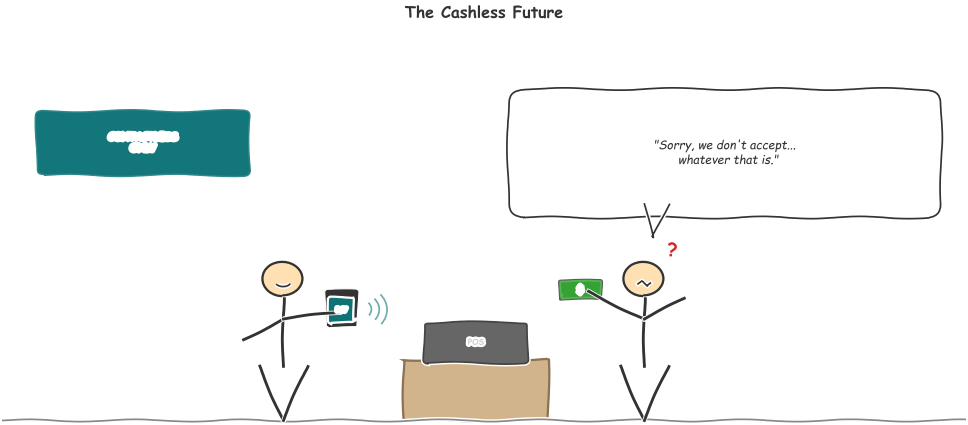
Financial Technology (FinTech)

From Cash to Digital: The Transformation of Money Movement

"Sorry, We Don't Accept That"



"Sorry, we don't accept cash anymore." — "But it's legal tender!"

Learning Objectives

By the end of this lecture you will be able to:

1. **Describe** the evolution of payment systems from barter to real-time digital rails and explain the forces driving each transition. *[Understand]*
2. **Explain** the four-party payment model and the authorization, clearing, and settlement lifecycle for card-based transactions. *[Understand]*
3. **Apply** a cost-analysis framework to compare merchant fees across payment types and evaluate the impact of interchange regulation. *[Apply]*
4. **Analyze** how cross-border payment complexity and remittance costs affect financial inclusion in developing economies. *[Analyze]*
5. **Evaluate** the design trade-offs in central bank digital currencies and stablecoins as future payment infrastructure. *[Evaluate]*

Bloom's levels covered: Understand, Apply, Analyze, Evaluate

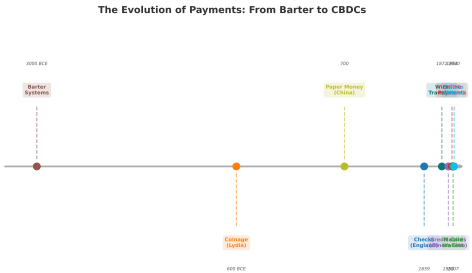
These objectives map directly to quiz and exercise assessments.

Bridge from Lecture 2

In Lecture 2 we explored the **behavioral** side of fintech: trust, nudging, choice architecture, and the inclusion-protection trade-off.

Now we apply that lens to the largest fintech vertical: **payments**.

- **Choice architecture:** Every payment interface shapes spending behavior — tap-to-pay removes the "pain of paying."
- **Trust:** Consumers entrust payment providers with every transaction. Trust failure here is existential.
- **Inclusion:** Real-time payment rails (UPI, PIX) are the most powerful inclusion infrastructure ever built.



The Pain of Paying

Think about the last time you paid for something expensive with **cash** — peeling off banknotes, watching your wallet thin. Now compare that to tapping your phone. The amount was the same. The pain was not.

Behavioral economists call this the **pain of paying** — the negative affect experienced at the moment of parting with money. Research by Prelec and Loewenstein (1998) established that payment pain is a function of three factors:

- **Salience:** Cash is tangible; digital payments are abstract. Less salience means less pain.
- **Temporal coupling:** When payment and consumption are simultaneous, pain is highest. Credit cards decouple them.
- **Form of payment:** Physical currency activates loss aversion more strongly than electronic transfers.

Quick Exercise

Check your last week of transactions. How many were cash? How many were contactless? Did you feel differently about spending in each mode?

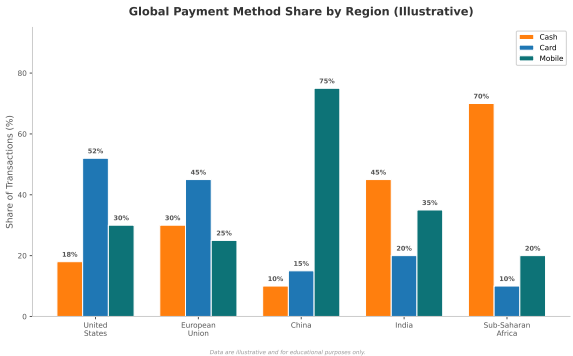
A Brief History of Payments

- **Barter** (pre-3000 BCE) — Direct exchange of goods. Requires double coincidence of wants. Fundamentally unscalable.
- **Commodity money and coinage** (c. 600 BCE) — Lydian electrum coins standardized value. Portability and divisibility enabled trade at distance.
- **Paper money** (c. 1000 CE, Song Dynasty) — Promissory notes replaced heavy metal. Trust shifted from intrinsic value to issuer credibility.
- **Checks and wire transfers** (17th–19th century) — The Bank of England (1694) and the telegraph (1872, Western Union) enabled non-physical value transfer.
- **Payment cards** (1950, Diners Club) — Intermediated credit at point of sale. Created the multi-party model that still dominates.
- **Digital and mobile payments** (2007–present) — M-Pesa, Apple Pay, UPI, PIX. From plastic to software. From batch to real-time.

The Pattern

Each transition increased abstraction, reduced friction, and shifted trust from the medium to the institution behind it.

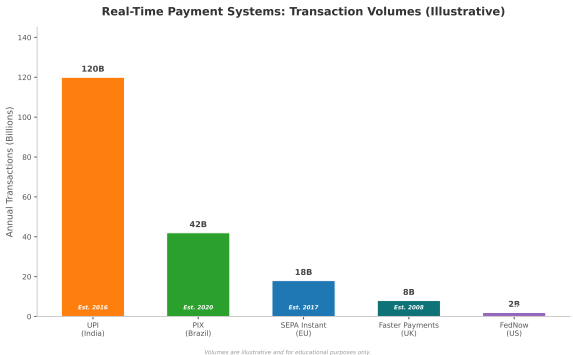
The Global Payment Landscape



Payment mix varies dramatically by region:

- **China:** Mobile payments (Alipay, WeChat Pay) dominate at over 85% of consumer transactions. Cards were leapfrogged entirely.
- **Nordics:** Card and mobile payments exceed 95% of retail volume. Cash infrastructure is actively being dismantled.
- **Germany & Japan:** Cash remains king at 50–60% of point-of-sale transactions despite high wealth and connectivity.
- **Sub-Saharan Africa:** Mobile money (M-Pesa model) serves populations with

The Rise of Real-Time Payments



Real-time payment systems have emerged as national infrastructure:

- **UPI** (India, 2016) — Unified Payments Interface. Account-to-account, interoperable, zero-fee for consumers. Over 400 million users.
- **PIX** (Brazil, 2020) — Central bank mandated. Reached 150 million users in under two years. Free for individuals.
- **FedNow** (USA, 2023) — The Federal Reserve's instant payment rail. Late entrant in a card-dominated market.
- **Faster Payments** (UK, 2008) — Pioneer of 24/7 settlement. Fifteen

Why Cash Persists

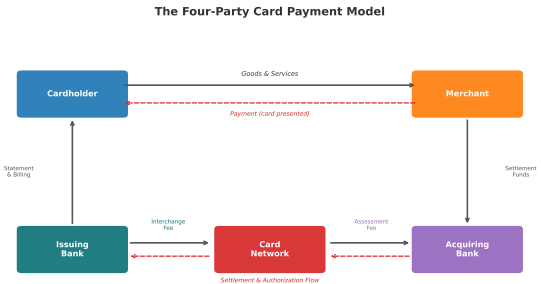
Despite the digital transition, cash remains the dominant payment method in most economies by transaction count. Four forces sustain it:

- **Anonymity and privacy** — Cash leaves no digital trail. In an era of surveillance capitalism, this is a feature, not a bug. Approximately 25% of Europeans cite privacy as a primary reason for using cash (ECB, 2022).
- **Reliability** — Cash works without electricity, internet connectivity, or functioning servers. It is the payment method of last resort during outages and disasters.
- **Zero marginal cost** — No interchange fees, no processing charges, no terminal costs. For small merchants, cash is the cheapest payment method.
- **Cultural and behavioral inertia** — Cash provides tangible budgeting (the "envelope method"), visible spending limits, and a sense of control that digital payments lack.

The Policy Tension

Eliminating cash without ensuring universal digital access creates a new form of financial exclusion — one that disproportionately affects the elderly, rural populations, and the poor.

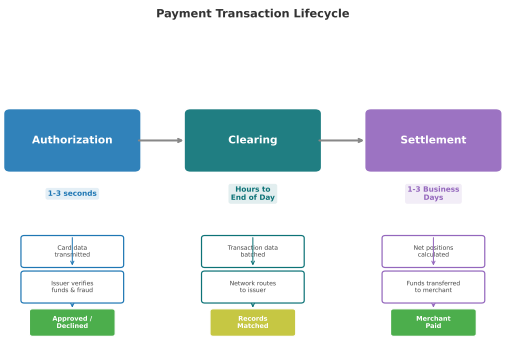
The Four-Party Payment Model



The card payment ecosystem involves four principals:

- **Cardholder** — The consumer who initiates the transaction.
- **Issuer** — The cardholder's bank. Issues the card, extends credit or debit access, bears fraud risk.
- **Acquirer** — The merchant's bank. Processes the transaction, deposits funds, manages merchant risk.
- **Network** (Visa, Mastercard) — Sets rules, routes messages, guarantees interoperability. Does not hold funds.

Authorization, Clearing, and Settlement



Every card transaction passes through three stages:

1. **Authorization** (milliseconds) — The issuer verifies the cardholder's identity, checks available funds or credit, and approves or declines. A hold is placed on the amount.
2. **Clearing** (hours to one day) — Transaction details are exchanged between acquirer and issuer via the network. Net positions are calculated.
3. **Settlement** (one to three days) — Actual funds transfer between issuer and acquirer banks. The merchant receives funds minus fees.

Batch vs. Real-Time Processing

Why does settlement still take days?

The card networks were designed in the 1960s–1970s for **batch processing**. Transactions are accumulated throughout the day and settled in bulk overnight. This architecture persists because:

- **Netting efficiency:** Batch settlement allows bilateral netting, reducing the total volume of interbank transfers by 80–90%.
- **Fraud windows:** The delay allows time for fraud detection, chargeback initiation, and dispute resolution.
- **Liquidity management:** Banks prefer predictable, scheduled settlement over

The real-time alternative:

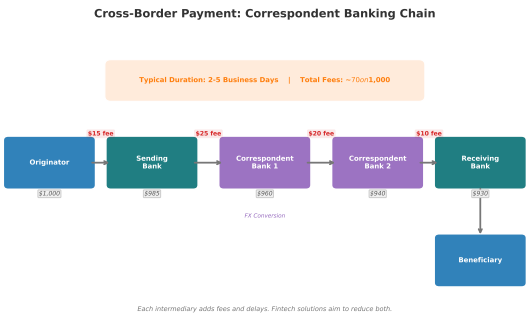
Systems like UPI and PIX settle in seconds. But real-time settlement requires:

- Pre-funded accounts or central bank liquidity facilities
- Real-time fraud detection (no chargeback window)
- 24/7/365 operational infrastructure
- Irrevocability — once settled, funds cannot be recalled through the system

Trade-off

Real-time settlement trades fraud protection and netting efficiency for speed and finality.

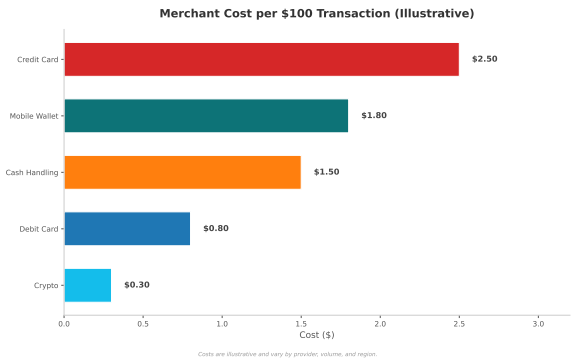
Cross-Border Payment Complexity



Cross-border payments remain the most expensive, slowest, and least transparent segment of the payment system:

- **Correspondent banking:** Most cross-border payments traverse a chain of intermediary banks, each adding fees, delays, and opacity.
- **SWIFT:** A messaging network (not a settlement system). SWIFT carries payment instructions; actual settlement occurs through nostro/vostro account relationships.
- **FX conversion:** Each hop may involve a currency conversion with opaque markup, typically 1–4% above

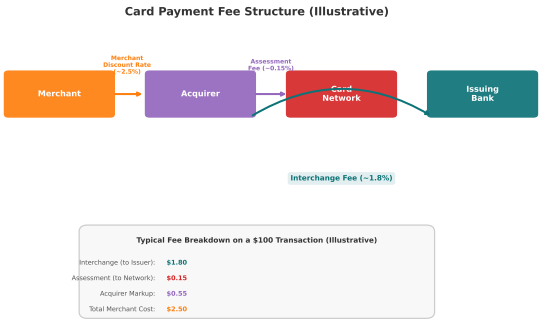
The Merchant Cost Burden



The cost of accepting payments varies dramatically by method:

- **Cash:** 0.5–1.5% (handling, security, insurance, shrinkage). Often underestimated.
- **Debit card:** 0.5–1.0% in regulated markets (EU); 0.5–1.5% in the US (post-Durbin).
- **Credit card:** 1.5–3.5% (interchange + network fees + acquirer margin). Premium and rewards cards cost more.
- **Mobile wallet:** 0–1.5%, depending on underlying funding (UPI is zero; Apple Pay passes through card fees).

Interchange Fees Explained



The interchange fee is the largest component of the merchant discount rate. It flows from the **acquirer to the issuer** on every transaction:

- **Economic rationale:** Compensates the issuer for fraud risk, interest-free period (credit cards), and the cost of maintaining the cardholder relationship.
- **Set by networks:** Visa and Mastercard publish interchange schedules with hundreds of rate categories based on card type, merchant category, and transaction method.
- **Not negotiable:** Individual merchants cannot negotiate interchange rates

Payment Facilitators and Aggregators

The traditional acquiring model requires each merchant to establish a direct relationship with an acquirer: application, underwriting, risk assessment, and a dedicated merchant account.

Payment facilitators (PayFacs) collapsed this process:

- **Stripe** (2010) — Aggregates merchants under a single master merchant account. Onboarding reduced from weeks to minutes.
- **Square** (2009) — Combined hardware (card reader) with software aggregation. Brought card acceptance to micro-merchants.

The PayFac economics:

- PayFacs charge a flat rate (e.g., 2.9% + \$0.30) regardless of card type. Simple, but often above cost.
- They absorb underwriting risk: if a sub-merchant commits fraud, the PayFac is liable.
- Revenue model: spread between blended rate charged and actual interchange plus network fees paid.

The Trade-off

PayFacs offer speed and simplicity at the cost of higher per-transaction fees. As

Small vs. Large Merchant Economics

Payment costs are **regressive**: they disproportionately burden small merchants.

Small merchants (under USD 500K annual volume):

- Pay blended rates (2.5–3.5%) with no interchange visibility
- Cannot negotiate acquirer markup
- Fixed per-transaction fees ($0.20–0.30) erode margins on small tickets
- Terminal rental, PCI compliance, and chargeback fees add fixed costs
- A coffee shop selling a CHF 4.50 latte at 2.9% + CHF 0.30 pays an effective rate of **9.6%**

Large merchants (over USD 50M annual volume):

- Negotiate interchange-plus pricing with full transparency
- Acquirer margins as low as 0.05–0.10%
- Can route transactions to lowest-cost networks
- Operate their own fraud detection, reducing chargebacks
- Effective all-in rate: 1.0–1.5%

The Inequality

The smallest merchants pay the highest

The Durbin Amendment

The **Durbin Amendment** (2010, effective 2011) was the most significant US payment regulation in decades:

- **Scope:** Capped debit interchange fees for banks with over USD 10 billion in assets at approximately 21 cents + 0.05% per transaction (plus a 1-cent fraud adjustment).
- **Pre-Durbin average:** 44 cents per transaction.
- **Post-Durbin average:** 24 cents per transaction — a 45% reduction.
- **Routing mandate:** Merchants must have access to at least two unaffiliated debit

Intended and unintended consequences:

- Intended: Lower costs for merchants, especially large retailers. Estimated annual merchant savings of USD 6–8 billion.
- Unintended: Banks eliminated free checking accounts and debit rewards programs to recover lost revenue. Small banks (exempt from the cap) saw limited benefit as merchants routed to the cheapest network regardless.
- Unintended: Credit card interchange — not covered by Durbin — actually *increased* as issuers shifted incentives

PSD2 and Open Banking

The EU's **Payment Services Directive 2** (PSD2, effective 2018) reshaped European payments through two mechanisms:

Open Banking (Access to Accounts):

- Banks must provide API access to authorized third-party providers (TPPs) — with customer consent.
- **AISPs** (Account Information Service Providers) can aggregate account data across institutions.
- **PISPs** (Payment Initiation Service Providers) can initiate payments directly from customer accounts, bypassing card networks entirely.
- Enables bank-to-bank payments at

Strong Customer Authentication (SCA):

- Two-factor authentication required for electronic payments above EUR 30 (with exemptions for trusted beneficiaries and low-risk transactions).
- Friction vs. security trade-off: conversion rates initially dropped 20–30% for e-commerce merchants before exemption strategies matured.

The Strategic Shift

Global Interchange Regulation

Interchange regulation has spread globally, but with widely varying approaches:

Jurisdiction	Debit Cap	Credit Cap
EU / EEA	0.20%	0.30%
Australia	0.08 AUD avg	0.50% avg
USA (Durbin)	21c + 0.05%	No cap
India (UPI/RuPay)	0%	0%
China	0.35% max	0.45% max
Canada	Voluntary	Voluntary
UK (post-Brexit)	0.20%	0.30%

India is the only major economy with zero interchange — subsidized by government as inclusion policy.

The regulatory dilemma:

- Pro-regulation: Interchange is a hidden tax on consumers. Caps lower prices and improve transparency.
- Anti-regulation: Caps reduce issuer revenue, leading to fewer card benefits, higher account fees, and reduced credit availability for marginal borrowers.
- **Evidence:** EU interchange regulation (IFR, 2015) reduced merchant costs by approximately EUR 5 billion annually, but consumer price pass-through has been incomplete and slow.

Real-Time Payment Systems Compared

UPI (India)

Launch: 2016 (NPCI)

Model: Account-to-account via virtual payment address (VPA). Interoperable across all banks.

Cost: Zero for consumers and merchants (government-subsidized).

Scale: 12B+ transactions/month. 400M+ users.

Lesson: Government

PIX (Brazil)

Launch: 2020 (Banco Central do Brasil)

Model: Instant payment via CPF (tax ID), phone, email, or QR code. Central bank operated.

Cost: Free for individuals. Small fee for businesses.

Scale: 150M+ users in 2 years. 3.5B+ transactions/month.

Lesson: Central bank

FedNow (USA)

Launch: 2023 (Federal Reserve)

Model: Bank-to-bank instant settlement. Voluntary bank participation.

Cost: Banks set consumer pricing. No mandated zero fee.

Scale: Fewer than 1,000 participating banks (of 10,000+) by end 2024.

Lesson: Voluntary adoption

Cross-Border Payment Corridors

Cross-border payments serve two fundamentally different markets:

Wholesale (B2B and interbank):

- SWIFT carries 45 million messages per day across 11,000+ institutions in 200+ countries
- Average transaction: USD 500,000+
- Settlement via correspondent banking (nostro/vostro accounts)
- CLS (Continuous Linked Settlement) handles FX settlement for 18 currencies, eliminating Herstatt risk

Retail (remittances):

- USD 656 billion in remittance flows to

Emerging alternatives to correspondent banking:

- **Wise (TransferWise):** Peer-to-peer matching of opposite-direction flows. Avoids correspondent chain for major corridors.
- **Ripple / XRP Ledger:** Pre-funded liquidity pools for instant cross-border settlement. Adoption limited to non-major corridors.
- **Bilateral rail links:** UPI-PayNow (India-Singapore), UPI-PIX (India-Brazil). Direct account-to-account across borders.

The Cost of Sending Money Abroad

The global average cost of sending USD 200 remains **6.2%** (World Bank, Q3 2024) — more than double the UN Sustainable Development Goal target of 3%.

Where costs are highest:

- Sub-Saharan Africa: 7.9% average (South Africa to neighboring countries exceeds 15%)
- Small Pacific Island nations: 8–10% (low volumes, limited competition)
- South-South corridors: Often 10%+ due to thin correspondent banking relationships

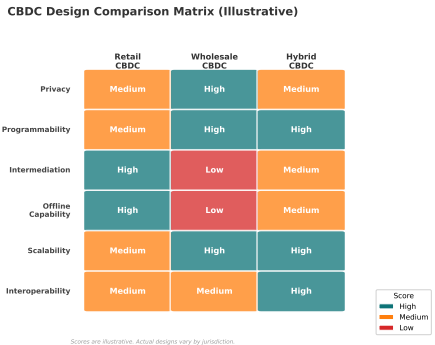
Where costs are lowest:

- UAE to India: 2.5% (high volume, strong competition)
- GCC to South Asia: 3–4% (mobile money

What drives cost?

1. **FX markup:** Typically 1–4% above mid-market rate, often hidden from the sender.
2. **Transfer fees:** Fixed and percentage components. Regressively burden small senders.
3. **Correspondent charges:** Intermediary bank fees deducted from the remitted amount, often unpredictable.
4. **Regulatory compliance:** AML/KYC costs passed to consumers, especially in

Central Bank Digital Currencies



CBDCs are digital liabilities of a central bank, available to the public or to financial institutions:

- **Retail CBDC:** Digital cash for consumers. Direct claim on the central bank. Raises questions about bank disintermediation.
- **Wholesale CBDC:** Restricted to financial institutions for interbank settlement. Less disruptive, more immediately practical.

Design dimensions:

- **Account-based vs. token-based:** Identity-linked accounts (like bank

Stablecoins and Payment Rails

Stablecoins — tokens pegged to fiat currencies — have emerged as **de facto payment infrastructure**, particularly for cross-border and crypto-native transactions:

- **USDT (Tether):** Market cap exceeding USD 95 billion (2024). Dominant in crypto trading pairs. Reserve composition has been a persistent transparency concern.
- **USDC (Circle):** USD 30 billion. Positions itself as the "regulated" stablecoin with full attestation reports and US money transmitter licenses.
- **PYUSD (PayPal):** Launched 2023. First stablecoin from a major payment company. Signals mainstream institutional entry.

Stablecoins as payment rails:

- Settlement in minutes, not days, across borders
- 24/7/365 availability (no banking hours)
- Programmable: escrow, conditional release, automated compliance
- Used for remittances in corridors with limited banking infrastructure (e.g., Turkey, Argentina, Nigeria)

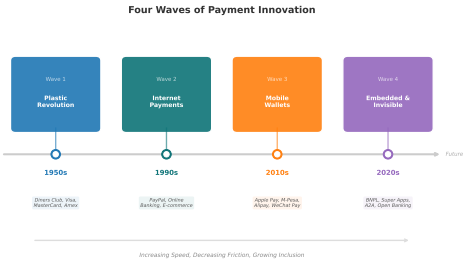
The Risk

Stablecoins are only as stable as their reserves. The TerraUSD collapse (May 2022,

Embedded and Invisible Payments

The end state of payment innovation is the **disappearance of the payment moment itself**.

- **One-click buy buttons:** Amazon's patented 1-Click (1999) eliminated the checkout flow. Conversion increased by an estimated 5% per friction step removed.
- **Ride-hailing:** Uber, Bolt, and Grab charge automatically at trip end. The passenger never "pays" — the payment is embedded in the service.
- **Subscription models:** Netflix, Spotify, and SaaS platforms collect recurring payments invisibly. Churn reduction through payment invisibility.



The Behavioral Concern

Invisible payments maximize convenience but minimize the pain of paying — the very friction that helps consumers control spending. L02's behavioral lens applies directly: *less*

A Payment Evaluation Framework

Five questions to evaluate any payment system, method, or innovation:

1. **Who bears the cost?**
   Is the cost visible to the payer, hidden in merchant prices, or subsidized by government?
2. **What is the settlement finality?**
   When does the recipient have irrevocable access to funds? Minutes, hours, or days?
3. **How does it handle failure?**
   What happens when the payment goes wrong? Who absorbs fraud losses, chargebacks, and errors?
4. **Who is excluded?**
   What prerequisites does it require — bank

Applying the framework:

Cash

Cost: payer. Finality: instant. Failure: bearer risk. Exclusion: none. Behavior: high spending awareness.

Credit Card

Cost: merchant (interchange). Finality: T+1 to T+3. Failure: chargeback (consumer protected). Exclusion: credit score required. Behavior: reduced spending pain.

What Comes Next

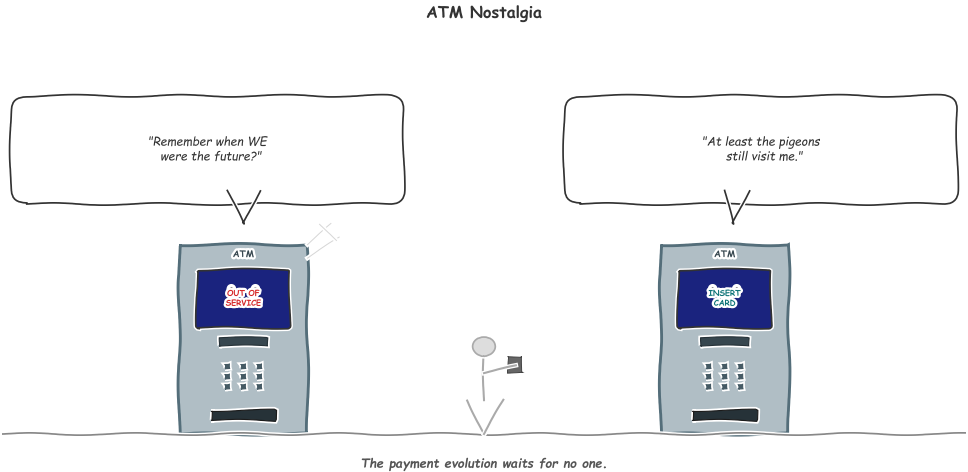
- **Next:** L04 (Fintech Security and Regulation — RegTech) — How regulators are responding to the payment innovations discussed today. AML/KYC automation, regulatory sandboxes, and the rise of supervisory technology.
- **Before L04, reflect:** Trace your last online purchase from tap to settlement. How many intermediaries touched your money? What did each one charge? Could the transaction have been routed more cheaply?
- **Workshop preparation:** Review the payment evaluation framework (Frame 27). You will use it to compare two payment systems in Workshop D.

Why Regulation Matters

Every payment innovation discussed today — real-time rails, stablecoins, CBDCs, embedded payments — exists within a regulatory framework that determines who can build it, who can use it, and who is protected when it fails. L04 examines that framework.

Course Progress

“Remember When We Were the Future?”



“Remember when we were the future?” — Two ATMs watching a customer pay with their phone

Key Takeaways

1. **Payment history is dematerialization:** Every transition — from barter to coinage to paper to digital — increased abstraction and shifted trust from the medium to the institution.
2. **The four-party model:** Card payments flow through issuer, acquirer, network, and merchant. Understanding this chain is essential to understanding payment costs.
3. **Settlement is not instant:** Authorization takes milliseconds, but traditional settlement takes days. Real-time systems (UPI, PIX) are closing this gap, with trade-offs.
4. **Payment costs are regressive:** Small merchants pay the highest effective rates. Interchange is a hidden cross-subsidy from merchants to cardholders.
5. **Cross-border payments remain broken:** Average remittance costs of 6.2% represent a multi-billion-dollar tax on the world's poorest populations.
6. **CBDCs force design choices:** Privacy vs. traceability, interest vs. non-interest, account-based vs. token-based. No single design satisfies all objectives.
7. **Invisible payments remove friction:** Embedded payments maximize convenience but eliminate the behavioral friction that supports deliberate spending.

Review question: Apply the five-question payment evaluation framework to a payment method you used today. What did you discover?

Summary and Key Vocabulary

Summary: Payment systems are the circulatory system of the financial economy — and they are undergoing their most profound transformation since the invention of the credit card. Real-time domestic rails are replacing batch settlement, open banking is challenging card network dominance, and CBDCs and stablecoins are redefining what "money" means. Yet cross-border payments remain slow and expensive, interchange economics disproportionately burden small merchants, and the progressive invisibility of payments raises behavioral concerns about consumer spending control. The central lesson of L03 is that *payment system design is not merely an engineering problem — it is a policy choice that determines who pays, who profits, and who is excluded.*

Key Vocabulary:

- Four-Party Model
- Interchange Fee
- Authorization / Clearing / Settlement
- Real-Time Payments (UPI, PIX)
- Payment Facilitator (PayFac)
- Open Banking (PSD2)
- CBDC (Retail / Wholesale)
- Stablecoin