L01: FinTech Fundamentals & Payment Systems

Extended Slides – BSc Digital Finance Course

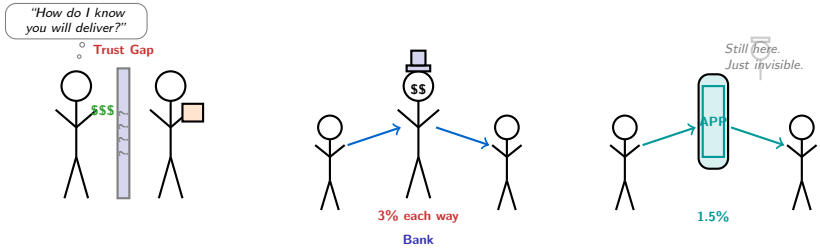
Digital Finance

What Will You Be Able to Do After This Lecture?

1. Formalize the three functions of financial intermediation (information asymmetry, transaction costs, risk transformation) using economic models
2. Derive and interpret Metcalfe's Law for two-sided FinTech platforms and calculate network value thresholds
3. Implement a payment fee calculator in Python that models the four-party card payment flow
4. Build an interchange fee simulation to analyze the impact of EU IFR regulation on merchant costs
5. Construct a cross-border payment cost model comparing SWIFT/correspondent banking vs. FinTech alternatives
6. Evaluate FinTech business models by mapping revenue sources to the three fundamental intermediation problems

Prerequisites: Python (pandas, numpy, matplotlib), basic microeconomics, basic statistics.

These six objectives span theory (1–2), implementation (3–5), and evaluation (6).



The trust gap didn't close. It got an app.

The intermediation paradox: technology changed the cost of trust, not the need for it.

Why Do Lenders Charge Higher Rates Than They Should – and How Does FinTech Fix It?

Akerlof's Lemons Model (1970):

Borrowers have quality $q \sim U[0,1]$. Lender observes noisy signal $s = q + \epsilon$.

Traditional lender sets rate r for pool:

$$r = r_f + \frac{1 - E[q \mid s]}{E[q \mid s]} \cdot \lambda$$

Adverse selection: at rate r, only borrowers with $q < q^*(r)$ accept. The pool deteriorates:

$$q^*(r) = \{q : \text{benefit of loan} > r \cdot \text{cost}\}$$

FinTech improvement – better signal reduces $\text{Var}(\epsilon)$:

$$s_{\text{FinTech}} = q + \epsilon', \quad \text{Var}(\epsilon') < \text{Var}(\epsilon)$$

Result: tighter signal → better pool segmentation → lower rates for good borrowers, appropriate rates for risky borrowers.

Intuition

Traditional banks use 5–10 variables (income, employment, credit history) to assess creditworthiness.

FinTech lenders use 100–1000+ variables (transaction patterns, social data, device metadata, behavioral signals).

More variables = lower signal noise = better separation of good and bad borrowers.

The adverse selection spiral is broken: good borrowers get lower rates, so they stay in the pool.

Connection to intermediation paradox: the FinTech lender IS still an intermediary – but with better information technology.

Akerlof's insight (Nobel 2001): markets with information asymmetry can collapse. FinTech addresses this by reducing signal noise, not by removing intermediation.

When Does It Cost More to Use a Market Than to Build a Firm?

Coase Theorem (1937) applied to financial services:

Cost of market transaction:

$$C_{\text{market}} = C_{\text{search}} + C_{\text{negotiate}} + C_{\text{enforce}}$$

Cost of intermediated transaction:

$$C_{\text{intermed}} = C_{\text{fixed}}/N + C_{\text{variable}}$$

Intermediation efficient when:

$$C_{\text{intermed}} < C_{\text{market}} \iff N > \frac{C_{\text{fixed}}}{C_{\text{market}} - C_{\text{variable}}}$$

FinTech reduces C_{fixed} (cloud, APIs) and C_{variable} (automation), lowering the threshold N^* at which intermediation becomes viable.

Result: FinTech enables viable intermediation at smaller scale, creating MORE intermediaries (niche platforms) rather than fewer.

Intuition

Coase explained why firms exist: to avoid market transaction costs.

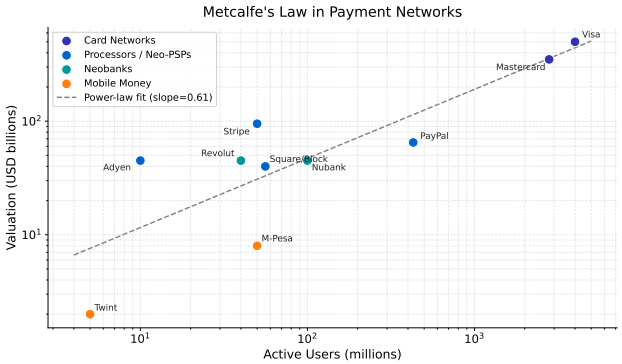
Banks exist for the same reason: finding a borrower, assessing risk, and enforcing repayment is cheaper through a bank than individually.

FinTech platforms reduce the FIXED cost of intermediation (no branches, no legacy IT) – so smaller, more specialized intermediaries become viable.

This explains the FinTech explosion: not fewer intermediaries, but many small specialized ones (Stripe for payments, Plaid for data, Lemonade for insurance).

Coase predicted FinTech: when transaction costs fall, firm boundaries shift. Technology did not kill intermediaries – it made smaller, specialized ones viable.

Why Is a Payment Network With 10 Million Users Worth 100x More Than One With 1 Million?



Metcalfe's Law:

$$V(n) = k \cdot n^2$$

For two-sided platforms (buyers + sellers):

$$V(n_b, n_s) = k \cdot n_b \cdot n_s$$

Critical mass threshold – platform viable when:

$$V(n) > C_{\text{fixed}} + C_{\text{variable}} \cdot n$$

$$k \cdot n^2 > F + c \cdot n \implies n > n^* = \frac{c + \sqrt{c^2 + 4kF}}{2k}$$

Winner-take-most: Once $n > n^*$, the network's value grows faster than its cost. Incumbents with large n are nearly impossible to displace.

Real data: Visa: 4B+ cards, ∼$500B valuation. PayPal: 430M accounts, ∼$65B. The ratio scales approximately as $n^{1.5}$.

Metcalfe's Law explains why FinTech markets are winner-take-most: the first platform past critical mass captures disproportionate value.

Why Do Banks Exist – and Why Are They Inherently Fragile?

Diamond-Dybvig (1983):

Depositors have uncertain liquidity needs. At t=0, invest I. At t=1, fraction π need early withdrawal. At t=2, remaining $(1-\pi)$ collect returns.

Long-term asset return: $R > 1$ at t=2, but liquidation at t=1 yields $L < 1$.

Bank as risk transformer:

$$\text{Deposit contract: } d_1 = 1 \text{ at } t{=}1,\ d_2 = \frac{R(1-\pi d_1)}{1-\pi} \text{ at } t{=}2$$

Bank run equilibrium: If ALL depositors withdraw at t=1:

$$N \cdot d_1 > L \cdot I \implies \text{bank insolvent}$$

Two Nash equilibria: (1) only impatient withdraw (stable), (2) everyone withdraws (bank run).

FinTech connection: P2P lending, tokenization, and money market funds attempt to provide liquidity transformation WITHOUT maturity mismatch.

Intuition

Banks solve a real problem: you want to withdraw anytime, borrowers need long-term loans.

This maturity mismatch is inherently fragile – if everyone withdraws at once, the bank fails.

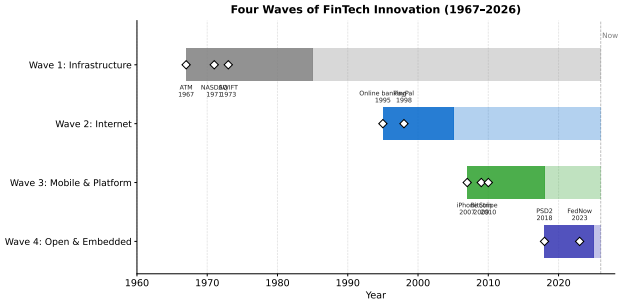
Deposit insurance (FDIC, ESISUISSE) solves bank runs but creates moral hazard.

FinTech alternatives: P2P platforms match lenders directly to borrowers (no maturity mismatch), but sacrifice liquidity (you cannot withdraw early).

The paradox: bank fragility IS the cost of liquidity transformation. FinTech "solves" fragility by sacrificing the service banks provide.

Diamond-Dybvig (Nobel 2022): banks are inherently fragile because they transform illiquid assets into liquid deposits. FinTech must choose: provide liquidity or avoid fragility.

Which Technology Breakthrough Triggered Each Wave of Financial Innovation?



- **Wave 1 (1967–1990):** Infrastructure. ATM (1967), SWIFT (1973), electronic trading (1971 NASDAQ). Digitized back-office. Cost reduction: batch processing.
- **Wave 2 (1995–2008):** Internet. Online banking (1995), PayPal (1998), algorithmic trading. Eliminated geographic barriers. Cost reduction: self-service.
- **Wave 3 (2008–2018):** Mobile & Platform. iPhone (2007), Bitcoin (2009), platform lending. Smartphone = bank in pocket. Cost reduction: real-time access.
- **Wave 4 (2018–present):** Open & Embedded. PSD2 (2018), embedded finance, BaaS. APIs = finance as a feature. Cost reduction: zero marginal distribution.

Each wave lowered a specific transaction cost: processing (W1), access (W2), convenience (W3), distribution (W4).

Each wave corresponds to a technology that lowered a specific type of transaction cost. The progression is: batch → online → mobile → embedded.

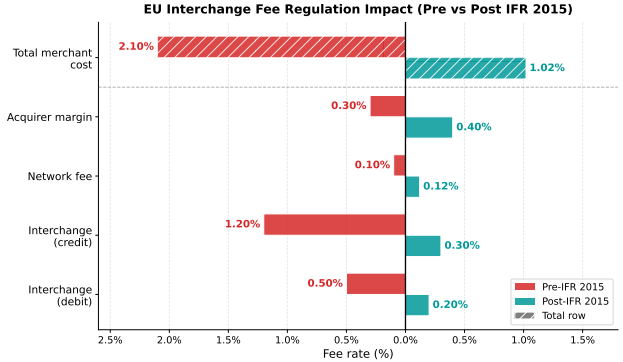
Building a Four-Party Payment Fee Model in Python

```python
import numpy as np

def calculate_payment_fees(amount, region='EU', card_type='consumer_debit'):
    """Model the four-party card payment fee breakdown."""
    # Interchange Fee Regulation (EU) vs market rates (US)
    interchange_rates = {
        'EU': {'consumer_debit': 0.002, 'consumer_credit': 0.003,
               'commercial': 0.015},
        'US': {'consumer_debit': 0.0005 + 0.21/amount, # Durbin
               'consumer_credit': 0.018, 'commercial': 0.025},
    }
    interchange = amount * interchange_rates[region][card_type]
    network_fee = amount * 0.001    # Visa/MC assessment
    acquirer_margin = amount * 0.002 # Acquirer markup
    processor_fee = amount * 0.005 + 0.25 # Stripe-like pricing

    total_merchant_cost = interchange + network_fee + acquirer_margin
    total_with_processor = total_merchant_cost + processor_fee

    return {
        'interchange': round(interchange, 4),
        'network_fee': round(network_fee, 4),
        'acquirer_margin': round(acquirer_margin, 4),
        'processor_fee': round(processor_fee, 4),
        'total_merchant_cost': round(total_merchant_cost, 4),
        'total_with_processor': round(total_with_processor, 4),
        'effective_rate_pct': round(total_with_processor / amount * 100, 2),
    }
```

EU interchange caps (IFR 2015): 0.2% debit, 0.3% credit. US Durbin Amendment: $0.21 + 0.05% for debit.

The EU IFR reduced interchange fees by 40–60%. This model captures why European merchants pay less than American ones.

Did Capping Interchange Fees Actually Reduce What Merchants Pay?



- EU IFR (2015): capped interchange at 0.2% (debit), 0.3% (credit). Immediate impact: interchange dropped 40–60%.
- But total merchant fees dropped only 10–20%. Why? Acquirers and networks absorbed some savings as margin. The "waterbed effect": reduce one fee, others rise.
- Winners: large merchants with bargaining power negotiated lower total rates. Small merchants saw limited benefit.
- US comparison: no interchange cap for credit cards. US merchant fees average 2.2% vs EU 1.0%.
- The intermediation lesson: fee regulation shifts value between intermediaries but rarely removes intermediation itself.

The EU IFR cut interchange by 50%, but total merchant fees fell only 10–20%. Fee regulation redistributes value between intermediaries – it does not eliminate intermediation.

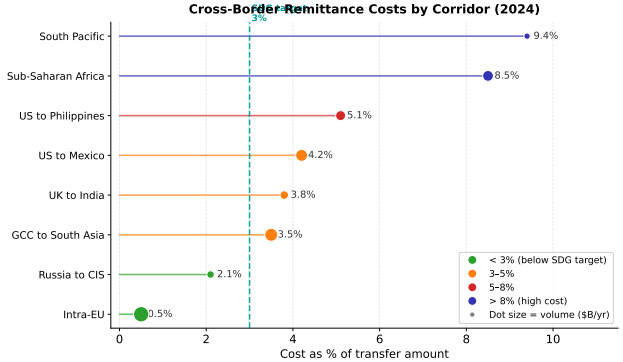
Modeling Cross-Border Payment Costs: SWIFT vs. Wise vs. Stablecoin

```python
def cross_border_cost(amount, currency_pair, method='swift'):
    """Compare cross-border payment costs across methods."""
    fx_spreads = { # Above mid-market rate
        'swift': 0.025,  # 2.5% typical bank spread
        'wise': 0.005,   # 0.5% mid-market + transparent
        'stablecoin': 0.001, # 0.1% DEX slippage
    }
    fixed_fees = { # Per-transaction fixed costs
        'swift': 35.0,   # SWIFT messaging + correspondent fees
        'wise': 1.5,     # Flat fee component
        'stablecoin': 2.0, # Gas fee (L2) + on/off-ramp
    }
    time_hours = {'swift': 72, 'wise': 4, 'stablecoin': 0.1}
    fx_cost = amount * fx_spreads[method]
    total = fx_cost + fixed_fees[method]
    effective_rate = total / amount * 100

    return {
        'method': method, 'amount': amount,
        'fx_cost': round(fx_cost, 2),
        'fixed_fee': fixed_fees[method],
        'total_cost': round(total, 2),
        'effective_rate_pct': round(effective_rate, 2),
        'time_hours': time_hours[method],
        'cost_per_speed': round(total / max(time_hours[method], 0.1), 2),
    }
```

EUR 1,000 transfer: SWIFT EUR 60 (6.0%, 3 days), Wise EUR 6.50 (0.65%, 4h), stablecoin EUR 3 (0.3%, 6 min).

SWIFT uses 5+ intermediaries; Wise uses 2; stablecoins use 0. Cost scales with intermediary count.

How Does the Cost of Sending $200 Home Vary Across Corridors and Methods?



- World Bank SDG target: reduce remittance costs to 3% by 2030. Current global average: 6.2% (2024).
- Cheapest corridors: GCC to South Asia (3.5%), intra-EU (0.5%). Most expensive: Sub-Saharan Africa (8.5%), South Pacific (9.4%).
- Cost drivers: number of intermediaries, FX liquidity, regulatory burden, last-mile infrastructure.
- FinTech impact: Wise reduced UK–India from 5.5% to 0.7%. M-Pesa reduced Kenya–Tanzania from 15% to 3%.
- The “last mile” problem: FinTech can optimize digital rails. But if the recipient needs physical cash, the last mile requires a human agent – an intermediary.

The UN SDG target is 3% for remittances by 2030. Current global average: 6.2%. FinTech excels on digital corridors but struggles with the physical last mile.

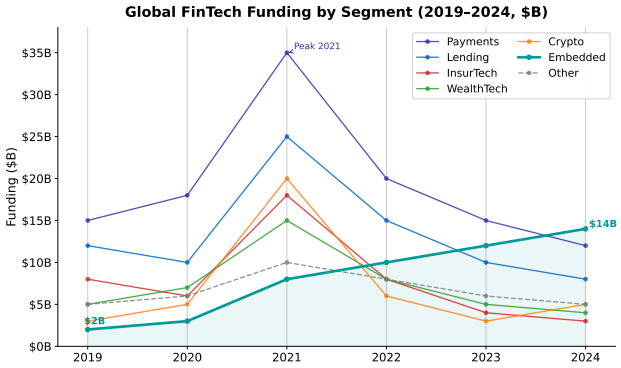
Simulating Winner-Take-Most Dynamics in Two-Sided Markets

```python
import numpy as np

def simulate_platform_competition(n_periods=50, n_platforms=3):
    """Simulate network effects in competing payment platforms."""
    np.random.seed(42)
    users = np.ones((n_platforms, n_periods)) * 100 # Start equal

    for t in range(1, n_periods):
        values = users[:, t-1] ** 2        # Metcalfe: value ~ n^2
        probs = values / values.sum()      # Join probability
        new_users = 50 + np.random.poisson(20) # Market growth
        allocation = np.random.multinomial(new_users, probs)
        churn = np.where(probs < 0.2, 0.02 * users[:, t-1], 0)
        users[:, t] = users[:, t-1] + allocation - churn

    final_shares = users[:, -1] / users[:, -1].sum()
    hhi = (final_shares ** 2).sum() * 10_000 # Herfindahl-Hirschman

    return {
        'users': users, 'final_shares': final_shares,
        'hhi': round(hhi), 'winner': int(np.argmax(final_shares)),
    }
```

From equal shares, network effects drive HHI above 5,000 within 30 periods – well above the "highly concentrated" threshold of 2,500.

Network effects produce concentration. This simulation shows why FinTech markets converge to 1–2 dominant platforms within a decade.

Where Is Venture Capital Betting – and Where Has It Already Left?



- 2021 peak: $131B in global FinTech funding. 2024: $39B (70% decline). The "FinTech winter" is a repricing, not a collapse.
- Payments: still largest ($12B in 2024) but declining. Market is maturing; exits via IPO/acquisition are harder.
- Embedded finance: fastest growth segment (3× since 2021). BaaS enables any company to offer financial products.
- InsurTech: sharp correction (80% decline). High loss ratios and unit economics challenges.
- Crypto/DeFi: recovered from 2022 crash. Institutional adoption (Bitcoin ETFs) driving renewed interest.
- Key insight: VC funding reveals which intermediation problems investors believe have unsolved solutions.

Global FinTech funding fell 70% from peak ($131B to $39B). But embedded finance grew 3× – the intermediation is moving deeper into software.

Which Revenue Model Reveals Which Intermediation Problem a FinTech Solves?

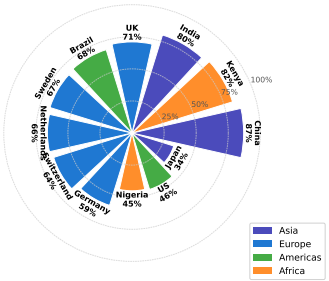
```python
import pandas as pd

def analyze_fintech_revenue_model(company_data):
    """Map FinTech revenue sources to intermediation problems."""
    problem_mapping = {
        'transaction_fee': 'transaction_costs',
        'interchange':     'transaction_costs',
        'fx_spread':       'transaction_costs',
        'subscription':    'information_asymmetry',
        'data_licensing':  'information_asymmetry',
        'credit_scoring':  'information_asymmetry',
        'net_interest':    'risk_transformation',
        'insurance_premium':'risk_transformation',
        'pfof':            'transaction_costs', # hidden
    }
    results = []
    for company in company_data:
        revenue_mix = company['revenue_sources']
        problems_solved = {}
        for source, pct in revenue_mix.items():
            problem = problem_mapping.get(source, 'other')
            problems_solved[problem] = problems_solved.get(problem, 0) + pct
        primary = max(problems_solved, key=problems_solved.get)
        results.append({
            'company': company['name'], 'primary_problem': primary,
            'intermediation_pct': sum(revenue_mix.values()),
            'is_intermediary': sum(revenue_mix.values()) > 50,
        })
    return pd.DataFrame(results)
```

Every FinTech that earns transaction fees IS an intermediary by definition. This function makes the intermediation explicit.

Revenue models are the truth serum of FinTech. Transaction fees = intermediation. "Free" = hidden intermediation. Follow the money.

Why Does China Have 87% FinTech Adoption While Switzerland Has 64%?

Global FinTech Adoption Rates (%, 2024)

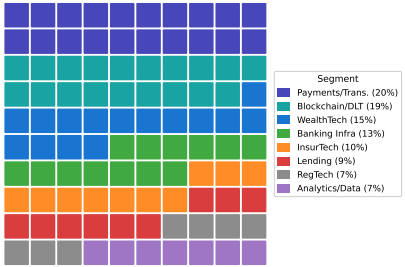


- **China:** Weak legacy banking + WeChat/Alipay dominance = 87%.
- **India:** Government-built UPI + 190M unbanked + Aadhaar identity = 80%.
- **Switzerland:** Strong legacy banking + high trust in banks = 64%.
- **Key pattern:** Adoption is HIGHEST where traditional banking is WEAKEST.
- **Implication:** In developed markets, FinTech adds layers. In developing markets, it provides first-ever access.

FinTech adoption is inversely correlated with legacy banking quality. Where banks are strong, FinTech wraps around them. Where absent, it replaces them.

What Makes Switzerland Both a Banking Fortress and a FinTech Laboratory?

Swiss FinTech Ecosystem by Segment (430 Companies, 2025)



1 square ≈ 4.3 companies | Total: 430 companies

- 430+ FinTech companies (2025). Zurich: 55%, Zug: 20% (Crypto Valley), Geneva: 15%.
- **Regulatory advantage:** FINMA sandbox (up to CHF 1M without license), DLT Act 2021, FinTech license.
- **Key segments:** Payments (Twint, 5M+ users), Digital banking (Neon, Yapeal), WealthTech, Blockchain (Ethereum Foundation, Tezos).
- **The Swiss paradox:** Strong incumbent banks + permissive FinTech regulation = FinTech as COMPLEMENT, not competitor. Swiss FinTechs sell TO banks, not AGAINST them.

Switzerland has 430+ FinTech firms AND the world's strongest traditional banking sector. The Swiss model is coexistence, not disruption.

How Much Liquidity Does a Bank Need – and Does the Settlement Method Change the Answer?

RTGS liquidity requirement:

$$L_{\text{RTGS}} = \sum_{i=1}^{N} p_i \quad \text{(gross settlement: full amount)}$$

DNS liquidity requirement (netting):

$$L_{\text{DNS}} = \max\left(0,\ \sum_{i \in \text{out}} p_i - \sum_{j \in \text{in}} p_j\right)$$

Netting efficiency:

$$\eta = 1 - \frac{L_{\text{DNS}}}{L_{\text{RTGS}}}$$

Settlement risk (Herstatt risk):

$$\text{Risk}_{\text{DNS}} = P(\text{default during batch}) \times L_{\text{DNS}}$$

$$\text{Risk}_{\text{RTGS}} \approx 0 \quad \text{(real-time finality)}$$

Tradeoff:

RTGS: low risk, high liquidity cost

DNS: high risk, low liquidity cost

Worked Example – Bank A's Daily Flows:

Outgoing: CHF 500M (to B), CHF 300M (to C), CHF 200M (to D) = CHF 1B total.

Incoming: CHF 400M (from B), CHF 350M (from C), CHF 150M (from D) = CHF 900M total.

RTGS: Need **CHF 1B** in liquidity buffer.

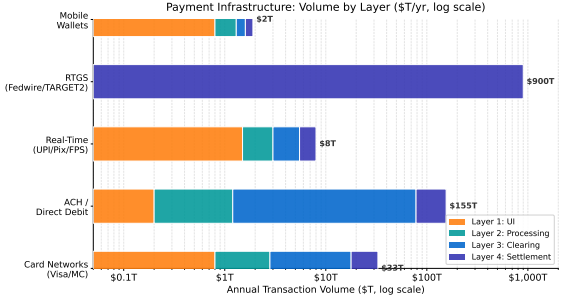
DNS: Need CHF 1B − CHF 900M = **CHF 100M** net.

Netting efficiency: $\eta = 1 - 100\text{M}/1\text{B} = 90\%$

Switzerland's SIC: RTGS system processing CHF 200B+ daily. Banks hold large liquidity buffers at SNB.

Switzerland chose RTGS (SIC) for payment finality and zero settlement risk. The cost: banks must hold large liquidity buffers at the SNB.

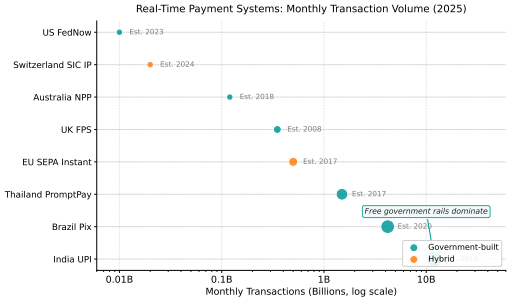
What Invisible Layers Carry Every Payment – and Where Can FinTech Innovate?



- **Layer 1 (UI):** Apple Pay, Revolut, Twint. Lowest barrier but least defensible moat.
- **Layer 2 (Processing):** Stripe, Adyen, Square. Medium barrier, strong network effects.
- **Layer 3 (Clearing):** ACH, SEPA, CHIPS. Institutional, high barrier, regulated.
- **Layer 4 (Settlement):** RTGS systems (SIC, Fedwire, TARGET2). Central bank operated, sovereign control.
- FinTech innovation is concentrated in layers 1–2. Layers 3–4 remain institutional/sovereign.
- ISO 20022 migration (2022–2025): richer data enables smarter processing at every level.

FinTech innovates at layers 1–2 (interface + processing) while relying on layers 3–4 (clearing + settlement). Innovation at the top, infrastructure at the bottom.

Which Countries Leapfrogged Cards and Went Straight to Real-Time Mobile Payments?



- **India UPI:** 12B+ txn/month (2025). Government-built, zero-fee, bank-to-bank.
- **Brazil Pix:** 4B+ txn/month. Central bank built. Free for consumers. 150M users in 3 years.
- **UK Faster Payments:** 4B+ txn/year. Bank-operated but open. Foundation for open banking.
- **US FedNow:** Launched 2023, still ramping. The US is 10–15 years behind on real-time payments.
- **Twint (Switzerland):** 5M+ users, QR-based, runs on SIC.
- **Key pattern:** Government-built systems (UPI, Pix) are the only ones that reduced costs to near-zero.

India's UPI processes 12B+ transactions/month at near-zero cost. Government-built rails are the only proven path to genuine disintermediation at scale.

Who Actually Pays When You "Buy Now, Pay Later"?

BNPL merchant fee model:

Merchant pays BNPL provider:

$$f_{\text{BNPL}} = f_{\text{base}} + f_{\text{risk}} + f_{\text{margin}}$$

Typical: $f_{\text{BNPL}} = 3\text{–}8\%$ (vs card interchange 0.3–1.5%)

Consumer NPV (4 installments, 0% interest):

$$\text{NPV}_{\text{consumer}} = P \cdot \left(1 - \frac{3}{4} \cdot \frac{r_d}{4}\right) \approx P \cdot (1 - 0.01)$$

Consumer saves $\sim$1% via time value of money. Merchant pays 3–8%.

BNPL provider economics:

$$\text{Revenue} = f_{\text{merchant}} \cdot \text{GMV}$$

$$\text{Cost} = \text{funding cost} + \text{defaults} + \text{operations}$$

$$\text{Default rate} \approx 2\text{–}4\% \text{ (vs credit cards 1.5\%)}$$

Breakeven:

$$f_{\text{merchant}} > \text{cost of funds} + \text{default rate} + \text{CAC/GMV}$$

Analysis

BNPL unbundles credit from payments. The consumer gets interest-free installments. The merchant pays a premium for higher conversion rates.

Who wins: consumers (free credit), merchants with high margins (fashion, where 5% BNPL fee is worth a 20% conversion lift).

Who loses: merchants with low margins (groceries cannot absorb 5% fee), consumers who overspend (40% of BNPL users report spending more than planned).

Regulatory risk: UK, EU, and Australia now regulate BNPL as credit. Affordability checks required.

Intermediation lesson: BNPL is a NEW intermediary between consumer and merchant.

BNPL merchants pay 3–8% vs 0.3–1.5% for card interchange. The "free" installments for consumers are funded by higher merchant fees – which are priced into goods.

How Do the 50 Largest FinTechs Actually Make Money?

Business Model	Example Companies	Revenue Source	Problem Solved	% Top 50
Payment processing	Stripe, Adyen, Square	Transaction fee (2–3%)	Transaction costs	28%
Digital banking	Revolut, Chime, N26	Interchange + subscription	Txn costs + info asymmetry	18%
Lending platform	SoFi, Upstart, Funding Circle	Net interest + origination	Info asymmetry + risk transf.	16%
InsurTech	Lemonade, Root, wefox	Premiums + reinsurance	Risk transformation	10%
WealthTech	Robinhood, eToro, Betterment	PFOF + margin + subscription	Info asymmetry	10%
Embedded finance/BaaS	Plaid, Marqeta, Unit	API fees + per-call pricing	Transaction costs	8%
Crypto/DeFi	Coinbase, Circle, Chainalysis	Trading fees + custody	Transaction costs	6%
RegTech	Chainalysis, Onfido, ComplyAdv.	SaaS subscription	Info asymmetry	4%

Key insight: **100% of the top 50 FinTechs are intermediaries** by economic definition. ZERO operate a truly peer-to-peer model at scale.

100% of the top 50 FinTechs earn revenue through intermediation. "Disrupting banks" means becoming a different kind of bank – not eliminating banking.

When Every App Becomes a Bank, Who Is Actually Doing the Banking?

Embedded Finance: Financial services integrated into non-financial platforms.

- **Shopify Capital:** Lending to merchants based on sales data (Shopify IS the lender)
- **Uber driver payouts:** Uber embeds banking (Marqeta provides the rails)
- **Apple Savings:** Apple offers 4.5% APY (Goldman Sachs holds the deposits)
- **Tesla Insurance:** Tesla uses driving data for pricing (underwritten by licensed insurers)

Economics: Embedded finance doubles the addressable market by distributing financial products at point of need, not point of search.

Banking as a Service (BaaS): The infrastructure layer enabling embedded finance.

- Licensed banks (Bancorp, Cross River, Solarisbank) provide the banking charter
- FinTech platforms (Plaid, Marqeta, Unit) provide APIs
- Non-financial companies (Shopify, Uber) embed the products

The intermediation stack deepens:

1. Consumer uses Shopify
2. Shopify uses Marqeta
3. Marqeta uses Cross River Bank
4. Cross River uses Fed ACH/Fedwire

Four intermediaries where previously there was one. More intermediation, not less – but each layer is thinner.

Embedded finance adds intermediation layers but makes each one invisible. The consumer sees Shopify. Behind it: Marqeta, Cross River Bank, and the Fed.

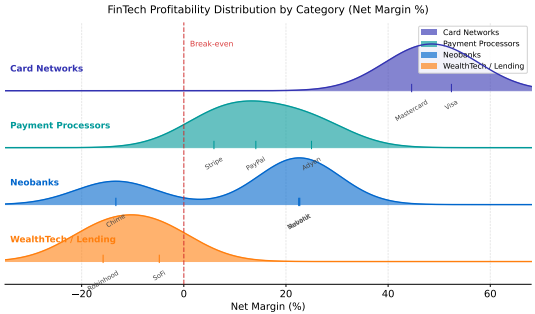
Analyzing Two-Sided Platform Pricing and Subsidy Strategies

```python
import numpy as np

def platform_pricing(n_buyers, n_sellers, elasticity_b=-1.5,
                     elasticity_s=-0.8, marginal_cost=0.02):
    """Optimal pricing for two-sided payment platform.
    Rochet-Tirole (2003): subsidize the more elastic side."""
    total_fee = marginal_cost * 2 # Total fee to cover costs
    ratio = abs(elasticity_s) / (abs(elasticity_b) + abs(elasticity_s))
    fee_buyer = total_fee * ratio    # More elastic -> lower fee
    fee_seller = total_fee * (1 - ratio) # Less elastic -> higher fee

    network_value = 0.001 * n_buyers * n_sellers # Metcalfe
    revenue = fee_buyer * n_buyers + fee_seller * n_sellers
    costs = marginal_cost * (n_buyers + n_sellers) + 1_000_000
    subsidy_needed = max(0, costs - revenue)

    return {
        'fee_buyer_pct': round(fee_buyer * 100, 2),
        'fee_seller_pct': round(fee_seller * 100, 2),
        'network_value': round(network_value),
        'revenue': round(revenue * (n_buyers + n_sellers)),
        'subsidy_needed': round(subsidy_needed),
        'profitable': subsidy_needed == 0,
    }
```

Rochet-Tirole (Nobel 2014): two-sided platforms subsidize the more elastic side. FinTech is "free" for consumers because consumers are more price-sensitive.

Platform economics explains why FinTech is "free" for consumers: the platform subsidizes the elastic side and charges the inelastic side (merchants).

Why Can a FinTech Grow Revenue 50% Per Year and Still Lose Money?



- **The profitability paradox:** rapid revenue growth coexists with sustained losses. Revolut: profitable in 2023 after 8 years. Nubank: profitable after 10 years.
- **Why:** CAC exceeds short-term revenue. FinTechs spend **$**50–200 to acquire a customer generating **$**5–20/year initially.
- **Path to profitability:** cross-sell (add lending, insurance, investing). This is REBUNDLING.
- **Rebundling IS re-intermediation:** a FinTech offering payments + lending + insurance + investing is a bank with better technology.
- **Full circle:** FinTechs unbundled banks, acquired users cheaply, then rebundled to become banks again.

Revolut took 8 years to reach profitability. The path: unbundle to acquire users, then rebundle to monetize them. The intermediary returns, wearing new clothes.

Why Has the Cost of Financial Intermediation Stayed at 2% for 130 Years?

Philippon (2015) – Unit Cost of Financial Intermediation:

$$u_t = \frac{Y_t^{\text{finance}}}{Q_t}$$

Where:

- Y_t^{finance} = total income of the financial sector
- Q_t = total quantity of financial assets intermediated

Empirical finding (US, 1886–2012):

$$u_t \approx 0.02 \quad \text{(remarkably stable at } \sim 2\%\text{)}$$

Despite: ATMs (1967), electronic trading (1971), internet banking (1995), mobile payments (2007), FinTech explosion (2015+).

Possible explanations:

$$u_t = u_{\text{necessary}} + u_{\text{rent}}$$

If technology reduces $u_{\text{necessary}}$, but intermediaries capture savings as u_{rent}, then u_t stays constant.

Interpretation

Philippon's finding is the academic expression of the intermediation paradox: despite massive technological improvement, the TOTAL cost of financial intermediation has not fallen.

Three hypotheses:

1. Finance is inherently 2% – the real cost of trust
2. Intermediaries capture efficiency gains as profit
3. New services offset savings in old services

Counter-evidence: individual transaction costs DID fall. But new forms of intermediation (PFOF, data monetization) emerged.

Implication: FinTech may not reduce the total cost of finance. It may redistribute it, make it more accessible, and make it less visible.

Philippon (2015): the unit cost of US financial intermediation has been $\sim$2% of assets for 130 years. Technology changed the experience. It has not changed the price.

Is Finance Moving Toward Zero Intermediation or Infinite Intermediation?

Scenario	Technology	Intermediation	Likely?
Zero intermediation	DeFi, P2P, blockchain	No middlemen, full self-sovereignty	Unlikely at scale
Invisible intermediation	Embedded finance, BaaS	Many intermediaries, all invisible	Most likely (2025–2030)
Re-intermediation	Super-apps, neobank rebundling	New mega-intermediaries replace old	Already happening
Government rails	CBDC, UPI, Pix	Government as sole intermediary	Expanding in dev. markets
Hybrid	Open banking + traditional	Banks and FinTechs coexist via APIs	Current reality in EU/CH

The most likely future is NOT zero intermediation. It is **invisible intermediation** – more layers, each thinner, each faster, each cheaper, but MORE of them. The total stack deepens while the total cost stays constant (Philippon).

The future of finance is not fewer intermediaries but invisible ones. More layers, thinner margins, better experience – but intermediation all the way down.

Key Takeaways

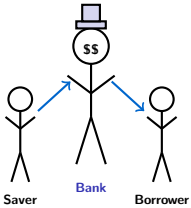
1. Financial intermediaries solve three eternal problems: **information asymmetry** (screening), **transaction costs** (matching), and **risk transformation** (liquidity). FinTech targets these same problems with better technology – but whoever solves them IS the intermediary.
2. **Metcalfe's Law** ($V \propto n^2$) and two-sided platform economics explain winner-take-most dynamics. Network effects make incumbent platforms nearly impossible to displace.
3. The **four-party card payment model** adds layers of intermediation. FinTech processors (Stripe, Square) add a FIFTH party – but total merchant cost fell. More intermediation can mean lower cost.
4. **Cross-border payments** remain the clearest intermediation bottleneck: 5+ intermediaries, 6.2% average cost. Wise and stablecoins demonstrate that reducing intermediary COUNT directly reduces cost.
5. The **Philippon puzzle**: the unit cost of financial intermediation has been $\sim$2% of assets for 130 years despite massive technology gains.
6. The **intermediation paradox resolution**: technology did not kill the middleman. It made intermediation cheaper, faster, and invisible. The question is not WHETHER intermediaries exist, but who controls the rails.

Next: Lesson 02 – Neobanks and Open Banking. How digital challengers try to become the new intermediary – and whether incumbent banks can fight back.

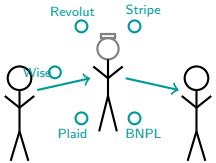
References and Further Reading

- Philippon, T. (2015). "Has the US Finance Industry Become Less Efficient?" *American Economic Review* 105(4): 1408–1438.
- Diamond, D. W. & Dybvig, P. H. (1983). "Bank Runs, Deposit Insurance, and Liquidity." *Journal of Political Economy* 91(3): 401–419.
- Rochet, J.-C. & Tirole, J. (2003). "Platform Competition in Two-Sided Markets." *Journal of the European Economic Association* 1(4): 990–1029.
- Akerlof, G. A. (1970). "The Market for Lemons." *Quarterly Journal of Economics* 84(3): 488–500.
- Coase, R. H. (1937). "The Nature of the Firm." *Economica* 4(16): 386–405.
- World Bank (2024). *Remittance Prices Worldwide*. `https://remittanceprices.worldbank.org/`
- BIS (2024). *Annual Economic Report*. Chapters on digital payments and CBDC.

These references span 85 years of economic thought – from Coase (1937) to the latest BIS digital payments report. The questions are old. The answers keep changing.



1900: The middleman was the only game.



2025: More middlemen. Each one smaller.

2035: Invisible. Still everywhere.

Technology changed the cost of trust. It did not change the need for it.

The intermediation paradox: from one visible middleman to many invisible ones. The cost fell. The structure deepened. The need remains.