Lesson 1.1 Exercises: Anatomy of a Payment

Module 1: The Cost Problem

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Digital Finance — BSc Course

Exercise 1: Trace the Payment Flow

Scenario: A customer buys a €45 meal at a restaurant using a contactless credit card.

Tasks:

a. List, in order, every intermediary that the transaction passes through during the **authorization** phase (from tap to approval). Name at least 5 entities.

b. For each intermediary, write one sentence describing its role.

c. Explain why the customer sees "Approved" in under 2 seconds, even though 5+ entities are involved.

Difficulty: Introductory — tests recall and understanding of the payment chain.

Exercise 2: MDR Calculation

Scenario: A bookshop accepts credit cards with the following fee schedule (all values synthetic):

Fee Component	Rate
Interchange	1.55% + \$0.10
Network assessment	0.14%
Processor fee	0.08% + \$0.05
Acquirer markup	0.20%
Gateway fee	\$0.04

Tasks:

a. Calculate the total fee (in dollars) for a \$25.00 purchase.

b. Calculate the effective MDR (as a percentage) for the \$25.00 purchase.

c. Calculate the effective MDR for a \$5.00 purchase with the same fee schedule.

d. Explain why the effective MDR differs between (b) and (c).

Difficulty: Intermediate — requires arithmetic and interpretation.

Exercise 3: Multilateral Netting

Scenario: At the end of a business day, three banks have the following gross obligations (synthetic data):

From \ To	Bank A	Bank B	Bank C
Bank A	—	$400,000	$150,000
Bank B	$300,000	—	$250,000
Bank C	$200,000	$100,000	—

Tasks:

a. Calculate the **total gross transfers** if each obligation were settled individually.

b. Calculate each bank's **net position** (total owed to others minus total owed by others to it).

c. Determine the **minimum number of net transfers** needed to settle all obligations.

d. By what percentage does multilateral netting reduce the total transfer volume?

Difficulty: Intermediate — requires multi-step calculation.

Exercise 4: Settlement Delay and Working Capital

Scenario: A retail shop processes card payments with the following characteristics:

- Average daily card revenue: \$12,000
- Credit card settlement: T+2
- The shop's bank offers a merchant cash advance at 15% annual interest (APR) to cover the settlement gap

Tasks:

a) Calculate the amount of working capital perpetually "locked" in the settlement pipeline.

b) If the merchant borrows this amount at 15% APR to cover the cash flow gap, what is the **annual interest cost**?

c) A new real-time payment system offers T+0 (instant) settlement with no per-transaction fee, but charges a flat monthly fee of \$200. Should the merchant switch? Show your reasoning.

d) What **qualitative factors** (beyond cost) should the merchant consider?

Difficulty: Intermediate–Advanced — requires financial reasoning.

Exercise 5: Flat-Rate vs. Interchange-Plus Pricing

Scenario: A food truck considers two payment processors:

	Processor Alpha	**Processor Beta**
Pricing model	Flat rate	Interchange-plus
Fee	2.75%	Interchange + 0.50% + \$0.10
Average interchange	(bundled)	1.60%
Monthly fee	\$0	\$15

The food truck processes 600 transactions/month, averaging \$15/transaction.

Tasks:

a. Calculate the total monthly cost with Processor Alpha.

b. Calculate the total monthly cost with Processor Beta.

c. At what monthly transaction volume do the two processors break even?

d. Which processor should the food truck choose, and why?

Difficulty: Advanced — requires modeling and break-even analysis.

Exercise 6: Cross-Border Payment Analysis

Scenario: A European e-commerce merchant sells a €80 product to a customer in the United States. The payment goes through:

Fee Layer	Cost
Domestic MDR (EU acquirer)	1.80%
Cross-border interchange surcharge	0.80%
Network cross-border assessment	0.40%
FX conversion spread	2.00%
Correspondent bank fee	€0.50 flat

Tasks:

a. Calculate the total fee the merchant pays on this €80 transaction.

b. Express the total cost as an effective MDR percentage.

c. Compare this to a domestic MDR of 1.80%. By what factor is the cross-border payment more expensive?

d. Propose two specific ways a FinTech could reduce the cost of this cross-border payment. For each, identify which fee layer is targeted.

Difficulty: Advanced — requires computation + creative analysis.

Exercise 7: Mapping FinTech Disruption

Scenario: Consider the following three FinTech approaches to payments:

1. **Approach A:** A mobile app that enables peer-to-peer bank transfers in real time with no intermediary fees.
2. **Approach B:** A payment processor that bundles gateway, processing, and acquiring into a single platform with a flat 1.9% + \$0.05 fee.
3. **Approach C:** A blockchain-based system where merchants accept stablecoin payments with 0.1% fees and T+0 settlement.

Tasks:

a) For each approach, identify which intermediaries in the traditional payment value chain are **eliminated** or **replaced**.

b) For each approach, identify one **limitation** or risk that could slow adoption.

c) Which approach do you consider most likely to achieve mass adoption within 5 years? Justify your answer using the S-curve adoption framework.

Difficulty: Advanced — requires synthesis and evaluation.

Exercise 8: Comprehensive Case – Coffee Chain Payments

Scenario: A coffee chain with 50 locations processes 2,000 transactions per day per location. Average ticket: \$6.50. Current fee structure: 2.10% + \$0.10 per transaction. Settlement: T+2.

Tasks:

a) Calculate the chain's **total annual payment processing cost** (assume 360 operating days/year).

b) Calculate the **effective MDR** at the \$6.50 average ticket.

c) Calculate the working capital **locked in the settlement pipeline** at any given time.

d) The chain is offered a real-time payment system: 0.5% flat fee, no fixed per-transaction fee, T+0 settlement, but only 30% of customers currently use it. Calculate the **blended annual cost** if 30% of transactions shift to the new system.

e) Write a one-paragraph recommendation to the CFO: should the chain adopt the real-time system alongside cards? Consider cost, adoption rate, and working capital.

Difficulty: Advanced–Integrative — combines all lesson concepts.

Answer Key

Exercise 2:

(a) Interchange: \$25 × 1.55% + \$0.10 = \$0.4875 + \$0.10 = \$0.5875. Network: \$25 × 0.14% = \$0.035. Processor: \$25 × 0.08% + \$0.05 = \$0.02 + \$0.05 = \$0.07. Acquirer: \$25 × 0.20% = \$0.05. Gateway: \$0.04. **Total = \$0.7825.**

(b) Effective MDR = \$0.7825/\$25 = **3.13%**.

(c) Interchange: \$5 × 1.55% + \$0.10 = \$0.1775. Network: \$0.007. Processor: \$0.054. Acquirer: \$0.01. Gateway: \$0.04. Total = \$0.2885. Effective MDR = \$0.2885/\$5 = **5.77%**.

(d) Fixed fees (\$0.10 + \$0.05 + \$0.04 = \$0.19) are spread over a smaller transaction, raising the effective rate.

Exercise 3:

(a) Gross = 400 + 150 + 300 + 250 + 200 + 100 = **\$1,400,000**.

(b) A: owes 550, owed 500 $\Rightarrow$ net -50. B: owes 550, owed 500 $\Rightarrow$ net -50. C: owes 300, owed 400 $\Rightarrow$ net $+100$.

(c) A pays C: \$50. B pays C: \$50. **Two transfers totaling \$100.**

(d) Reduction = (1,400,000 − 100,000)/1,400,000 = **92.9%**.

Answer Key (continued)

Exercise 4:

(a) Locked capital = $\$12{,}000 \times 2 = \mathbf{\$24{,}000}$.

(b) Interest = $\$24{,}000 \times 15\% = \mathbf{\$3{,}600/year}$.

(c) Real-time: $\$200 \times 12 = \$2{,}400$/year, plus eliminates $\$3{,}600$ interest cost. Net saving = $\$3{,}600 - \$2{,}400 = \mathbf{\$1{,}200/year}$. Yes, switch.

(d) Consumer adoption, chargeback protection, customer preference, integration effort.

Exercise 5:

(a) Alpha: $600 \times \$15 \times 2.75\% = \$9{,}000 \times 2.75\% = \mathbf{\$247.50}$.

(b) Beta: $600 \times (\$15 \times 2.10\% + \$0.10) + \$15 = 600 \times (\$0.315 + \$0.10) + \$15 = 600 \times \$0.415 + \$15 = \$249 + \$15 = \mathbf{\$264.00}$.

(c) Let n = transactions. Alpha: $n \times 15 \times 0.0275$. Beta: $n \times (15 \times 0.021 + 0.10) + 15$. Solve: $0.4125n = 0.415n + 15 \Rightarrow -0.0025n = 15 \Rightarrow n = 6{,}000$. At 6,000 transactions/month, they break even. Below 6,000, Alpha is cheaper.

(d) At 600 transactions, Alpha ($\$247.50$) beats Beta ($\$264.00$). Choose Alpha.

Exercise 6:

(a) Percentage fees: $(1.80+0.80+0.40+2.00)\% \times €80 = 5.00\% \times €80 = €4.00$. Flat: €0.50. **Total = €4.50.**

(b) €4.50 / €80 = **5.63%**.

(c) 5.63% / 1.80% = **3.1× more expensive**.

Answer Key (continued)

Exercise 8:

(a) Daily transactions: $50 \times 2{,}000 = 100{,}000$. Daily revenue: $100{,}000 \times \$6.50 = \$650{,}000$. Daily fee: $100{,}000 \times (\$6.50 \times 2.10\% + \$0.10) = 100{,}000 \times (\$0.1365 + \$0.10) = 100{,}000 \times \$0.2365 = \$23{,}650$. Annual: $\$23{,}650 \times 360 = \mathbf{\$8{,}514{,}000}$.

(b) Effective MDR $= \$0.2365/\$6.50 = \mathbf{3.64\%}$.

(c) Locked capital $= \$650{,}000 \times 2 = \mathbf{\$1{,}300{,}000}$.

(d) 70% via cards: $70{,}000 \times \$0.2365 \times 360 = \$5{,}959{,}800$. 30% via real-time: $30{,}000 \times \$6.50 \times 0.5\% \times 360 = \$1{,}053{,}000$. **Blended total = \$7,012,800**. Saving vs. current: $\$8{,}514{,}000 - \$7{,}012{,}800 = \mathbf{\$1{,}501{,}200/year}$ (17.6% reduction).

(e) The chain should adopt the real-time system. Even at 30% adoption, it saves $1.5M annually. As adoption grows, savings increase further. The freed working capital ($390,000 from 30% of pipeline) also reduces financing costs. Risk: if real-time adoption stalls, integration costs may not be recouped quickly.