

Lesson 6.1 Exercises: Payment Rails and Clearing Infrastructure

Module 6: The Infrastructure Problem

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Digital Finance — BSc Course

Exercise 1: Trace a Cross-Border Payment

Scenario: A company in Brazil needs to pay a supplier in Japan \$500,000. The Brazilian bank does not have a direct correspondent relationship with the Japanese bank.

Tasks:

- a) Draw the chain of institutions involved, from the Brazilian company to the Japanese supplier. Include at least 4 intermediaries.
- b) For each intermediary, identify whether it performs **messaging**, **clearing**, or **settlement** (or a combination).
- c) Identify where **nostro/vostro accounts** are used in the chain and explain why they must be pre-funded.
- d) Explain the Herstatt risk window in this transaction and which time-zone mismatch creates the exposure.

Difficulty: Introductory — tests understanding of correspondent banking and payment stages.

Exercise 2: Bilateral and Multilateral Netting

Scenario: Four banks have the following end-of-day gross obligations (synthetic data, in \$ millions):

From \ To	Bank A	Bank B	Bank C	Bank D
Bank A	—	120	80	40
Bank B	90	—	60	30
Bank C	50	70	—	100
Bank D	30	20	40	—

Tasks:

- Calculate the **total gross obligations** (sum of all entries).
- Calculate each bank's **net position** (total payable minus total receivable).
- Determine the **minimum net transfers** needed to settle all obligations.
- Calculate the **netting efficiency** (percentage reduction from gross to net).
- If a CCP were introduced, explain how it would simplify the netting further.

Difficulty: Intermediate — requires multi-step calculation.

Exercise 3: RTGS Liquidity Cost

Scenario: A mid-sized bank participates in an RTGS system. On a typical day, it processes the following large-value payments:

- **Outgoing payments:** \$2.5 billion (spread evenly across the day)
- **Incoming payments:** \$2.4 billion (spread evenly, but arriving on average 2 hours after outgoing payments are sent)
- **Cost of intraday liquidity:** The central bank charges 10 basis points (annualized) on peak intraday overdrafts

Tasks:

- Explain why the 2-hour timing mismatch between outgoing and incoming payments creates a liquidity problem.
- Estimate the bank's peak intraday liquidity shortfall (assume 8 operating hours per day, linear payment flow).
- Calculate the **annual cost** of this intraday liquidity if the bank relies on central bank overdraft facilities (assume 250 business days).
- Propose two strategies the bank could use to **reduce** its peak intraday liquidity need without reducing payment volumes.

Difficulty: Intermediate–Advanced — requires financial reasoning and estimation.

Exercise 4: CCP Default Waterfall Analysis

Scenario: A CCP clears interest rate swaps for 20 clearing members. A major member defaults with uncovered losses of \$800 million. The CCP's default waterfall is structured as follows (synthetic data):

Layer	Resource	Amount
1	Defaulter's initial margin	\$350M
2	Defaulter's default fund contribution	\$150M
3	CCP's skin in the game	\$50M
4	Non-defaulting members' fund (19 members, equal shares)	\$380M total
5	CCP's remaining equity	\$100M

Tasks:

- a How far through the waterfall does the \$800M loss reach? Which layer absorbs the final portion?
- b How much does each non-defaulting member lose from their default fund contribution?
- c If the loss had been \$1.2 billion instead, would the waterfall be sufficient? If not, what happens next?
- d Critically evaluate: Does the CCP waterfall **eliminate** systemic risk or **redistribute** it? Justify your answer.

Difficulty: Advanced — requires computation and critical analysis.

Exercise 5: DvP vs. Non-DvP Settlement

Scenario: Two scenarios for a bond trade worth \$50 million between Bank X (seller) and Bank Y (buyer).

Scenario A (Without DvP): Bank X delivers bonds on Tuesday morning. Bank Y is scheduled to pay on Tuesday afternoon. At noon, Bank Y is placed into insolvency.

Scenario B (With DvP): The trade is settled through a CSD using DvP. The same insolvency occurs at noon.

Tasks:

- a. In Scenario A, what is Bank X's loss? Explain why.
- b. In Scenario B, what is Bank X's loss? Explain the DvP mechanism that protects it.
- c. Calculate the **risk reduction** achieved by DvP in percentage terms.
- d. Research: What are the three **models** of DvP defined by the BIS (Bank for International Settlements)? Briefly describe each.

Difficulty: Intermediate–Advanced — requires understanding of settlement mechanics.

Exercise 6: T+2 vs. T+1 – Impact Analysis

Scenario: A European asset manager trades US equities. Under T+2, the manager had 2 days to arrange FX conversion (EUR to USD) and confirm trades. Under T+1 (effective May 2024), this window is compressed to 1 day.

Tasks:

- a) Explain why the T+1 transition is particularly challenging for **non-US investors** compared to US-based investors.
- b) A European fund trades US equities at 3:30 PM New York time (9:30 PM CET). Under T+1, by when must the FX conversion be arranged? Is this feasible within European business hours?
- c) Calculate the **margin savings** if a clearing house reduces initial margin requirements by 30% due to the shorter settlement cycle. Assume the fund has \$500 million in unsettled US equity trades at any given time and the current margin rate is 3%.
- d) Identify two **operational changes** the European fund must make to comply with T+1.

Difficulty: Advanced — requires understanding of global settlement logistics.

Exercise 7: Designing a National Payment System

Scenario: You are advising a small, developing country that currently has no electronic interbank payment system. All interbank settlements are done manually via physical checks cleared through the central bank.

The country's characteristics:

- Population: 5 million; GDP: \$20 billion
- 12 commercial banks, 3 foreign bank branches
- Limited IT infrastructure; unreliable internet in rural areas
- Goal: Support mobile money, government salary payments, and tax collection

Tasks:

- a) Should the country implement RTGS, DNS (ACH-like), or both? Justify with the trade-offs discussed in class.
- b) What role should the central bank play: operator, overseer, or both?
- c) How should the system handle mobile money operator (MMO) settlement? Should MMOs participate directly in the RTGS?
- d) Propose a 3-phase implementation roadmap, specifying which capabilities to build in each phase.

Difficulty: Advanced–Integrative — requires synthesis and policy judgment.

Exercise 8: Infrastructure Failure – Lehman and the CCP

Scenario: When Lehman Brothers filed for bankruptcy on 15 September 2008, it was a major clearing member at multiple CCPs worldwide (LCH, CME, ICE, etc.).

Facts (simplified):

- Lehman's portfolio at LCH SwapClear: \$9 trillion notional in interest rate swaps
- Lehman's initial margin at LCH: \$2 billion
- LCH hedged and auctioned Lehman's portfolio within 3 weeks
- Final loss borne by LCH from Lehman's default: **\$0** (margin was sufficient)

Tasks:

- Explain how the CCP model (novation + margin + default waterfall) protected Lehman's counterparties.
- Why was the initial margin of \$2 billion sufficient to cover a \$9 trillion notional portfolio? What does this tell you about the relationship between notional value and actual risk?
- If Lehman's trades had been **bilateral** (no CCP), what would the likely outcome have been for its 100+ counterparties?
- Critically evaluate: Does the Lehman case prove that CCPs always work, or were there unique circumstances?

Difficulty: Advanced–Integrative — combines CCP mechanics, risk management, and historical analysis.

Exercise 2:

- (a) $Gross = 120+80+40+90+60+30+50+70+100+30+20+40 = \mathbf{\$730M}$.
- (b) Net positions: A pays 240, receives 170 \Rightarrow net -70 . B pays 180, receives 210 \Rightarrow net $+30$. C pays 220, receives 180 \Rightarrow net -40 . D pays 90, receives 170 \Rightarrow net $+80$.
- (c) A pays 70 to CCP. C pays 40 to CCP. CCP pays 30 to B. CCP pays 80 to D. Two inflows, two outflows = **4 transfers (or 2 net with CCP)**, total **\\$110M**.
- (d) Netting efficiency = $(730 - 110) / 730 = \mathbf{84.9\%}$.
- (e) With a CCP, each bank has one net position vs. the CCP (not bilateral nets). The CCP calculates all positions simultaneously, achieving maximum netting.

Exercise 3:

- (a) Outgoing payments run ahead of incoming by 2 hours. During those 2 hours, the bank has paid out but not yet received — creating a liquidity gap.
- (b) Outgoing rate: $\mathbf{\$2.5B} / 8h = \mathbf{\$312.5M/h}$. In the 2-hour gap, the bank sends **\\$625M** more than it receives. Peak shortfall $\approx \mathbf{\$625M}$.
- (c) Intraday cost: $\mathbf{\$625M} \times 10 \text{ bps} / 365 \times 250 \text{ days} \approx \mathbf{\$625M} \times 0.001 \times (250/365) = \mathbf{\$428,000/year}$.
- (d) (1) Delay outgoing payments to better align with incoming (payment throttling). (2) Use intraday repos or securities pledged to the central bank for collateralized overdrafts.

Answer Key (continued)

Exercise 4:

- (a) Layer 1: **\$350M** absorbed. Remaining: **\$450M**. Layer 2: **\$150M** absorbed. Remaining: **\$300M**. Layer 3: **\$50M** absorbed. Remaining: **\$250M**. Layer 4: **\$250M** absorbed from the **\$380M** pool. **Loss reaches Layer 4** (non-defaulting members' fund).
- (b) **\$250M** shared among 19 members = **\$13.2M each** (assuming equal shares).
- (c) **\$1.2B** loss: Layers 1–4 absorb $\$350+150+50+380 = \930M . Layer 5: **\$100M**. Total waterfall = **\$1,030M**. Shortfall = **\$1.2B** – **\$1.03B** = **\$170M gap**. The CCP would need to invoke recovery tools (assessment powers, position tear-up) or enter resolution.
- (d) The CCP does not eliminate systemic risk — it **redistributes** it. Non-defaulting members bear losses via the mutualized fund. If the waterfall is exhausted, the risk flows back to the broader financial system through assessments or resolution. The CCP is a risk transformer, not a risk eliminator.

Exercise 5:

- (a) Bank X loses **\$50M** — it delivered the bonds but Bank Y cannot pay due to insolvency. This is principal risk.
- (b) Bank X loses **\$0**. Under DvP, the CSD holds both the bonds and the cash instruction. Since Bank Y cannot deliver cash, the CSD does not release the bonds. The trade fails, but Bank X retains its bonds.
- (c) Risk reduction = $(\$50\text{M} - \$0) / \$50\text{M} = 100\%$ of principal risk eliminated.

Answer Key (continued)

Exercise 6:

- (a) Non-US investors face a time-zone disadvantage. When US markets close (4 PM ET), it is already 10 PM in London and later in Asia. Under T+1, all trade confirmations, allocations, and FX conversions must be completed within hours after US market close — mostly outside European business hours.
- (b) The trade at 3:30 PM ET occurs at 9:30 PM CET. Under T+1, FX must be arranged by the next morning for settlement. This is outside European business hours, requiring either pre-funding in USD, automated FX processing, or overnight trading desks.
- (c) Current margin: $\$500M \times 3\% = \$15M$. Reduction: $\$15M \times 30\% = \$4.5M$ freed up. With T+1, less is at risk, so the clearing house requires less margin.
- (d) (1) Automate trade affirmation/confirmation to near-real-time (no manual matching). (2) Pre-fund USD accounts or establish automated FX facilities that operate outside European business hours.

Exercise 8:

- (a) Via novation, all Lehman counterparties faced LCH, not Lehman. LCH held Lehman's margin, hedged the portfolio, and auctioned positions to other members. Counterparties continued to receive their payments from LCH.
- (b) Notional value ($\$9T$) is the reference amount, not the amount at risk. The actual risk (net market value of the portfolio) was far smaller — margin of $\$2B$ covered the replacement cost with surplus. This illustrates that notional value is a poor measure of risk.
- (c) Without a CCP, each of Lehman's 100+ counterparties would have needed to individually close out or replace their bilateral positions, competing in the same market simultaneously, likely driving up costs and causing further market disruption.