International Finance

Measuring and Managing Exchange Rate Exposure

Main issues

- Exchange rate risk vs. exchange rate exposure

- Three types of exposure: transaction, translation, operating

- The exposure regression: $V = a + bS + u$

- Operating exposure examples and measurement

- Hedging with forwards: transaction and operating exposure

- Multiple FC cash flows: aggregation and hedging

- Overview of hedging instruments

Recap and transition

Lecture 6 established:

- Under M&M, hedging is irrelevant

- In reality, hedging adds value through: distress costs, tax convexity, agency costs, information asymmetries

But to hedge, you first need to measure what you're exposed to.

This lecture answers: What is exposure, how do we measure it, and how do we hedge it?

Risk vs. exposure

Exchange rate risk = uncertainty about the future spot rate.

- Same for all firms. Determined by the market.

Exchange rate exposure = how much firm value changes per unit change in the exchange rate.

- Firm-specific. Depends on the firm's business, contracts, and competitive position.

Two firms in the same country, facing the same FX risk, can have **very different exposures** — one may benefit from a depreciation while the other is harmed by it.

Overview

1. **Transaction exposure:** known FC-denominated contractual cash flows

2. **Translation exposure:** accounting consolidation effects

3. **Operating (economic) exposure:** how FX changes affect competitive position, margins, volumes

The **exposure regression** captures all three:

$$\Delta V = \alpha + \beta \cdot \Delta S + \varepsilon$$

β measures total exposure — regardless of whether it comes from contracts, accounting, or competitive effects.

Transaction exposure

Arises from **existing contracts** denominated in foreign currency:

- Accounts receivable / payable in FC

- FC-denominated debt service

- Dividends from foreign subsidiaries

- Contractual purchase or sale commitments in FC

Easy to identify (it's in the contracts) and **easy to hedge** (known amount, known date).

This is what most firms think of when they think "FX exposure" — but it is only part of the picture.

Translation exposure

Arises from **consolidating** foreign subsidiary financial statements into the parent's reporting currency.

- Assets and liabilities translated at current exchange rate

- Income statement items at average rate over the period

- Creates accounting gains/losses on the balance sheet

Key question: Does translation exposure reflect *economic* exposure?

- Often no — it is an accounting convention, not a cash flow

- Many firms **do not hedge** translation exposure

Operating (economic) exposure

How FX changes affect **future operating cash flows** through competitive effects:

- Revenues, costs, margins, and market share all respond to FX

- Often **larger** than transaction exposure

- **Much harder to measure** — requires understanding competitive dynamics

- Cannot always be hedged with financial instruments alone

This is the most important type of exposure for strategic decision-making.

The key insight

A firm with zero transaction exposure can still have massive operating exposure.

Example: A US ski resort in Colorado.

- All revenues in USD. All costs in USD. No foreign currency cash flows.

- Zero transaction exposure.

But: When the USD appreciates, European ski tourists find Colorado expensive relative to the Alps. Fewer Europeans visit. Revenue falls.

- Operating exposure is **positive** (benefits from USD depreciation)

- This exposure is **invisible** if you only look at contracts
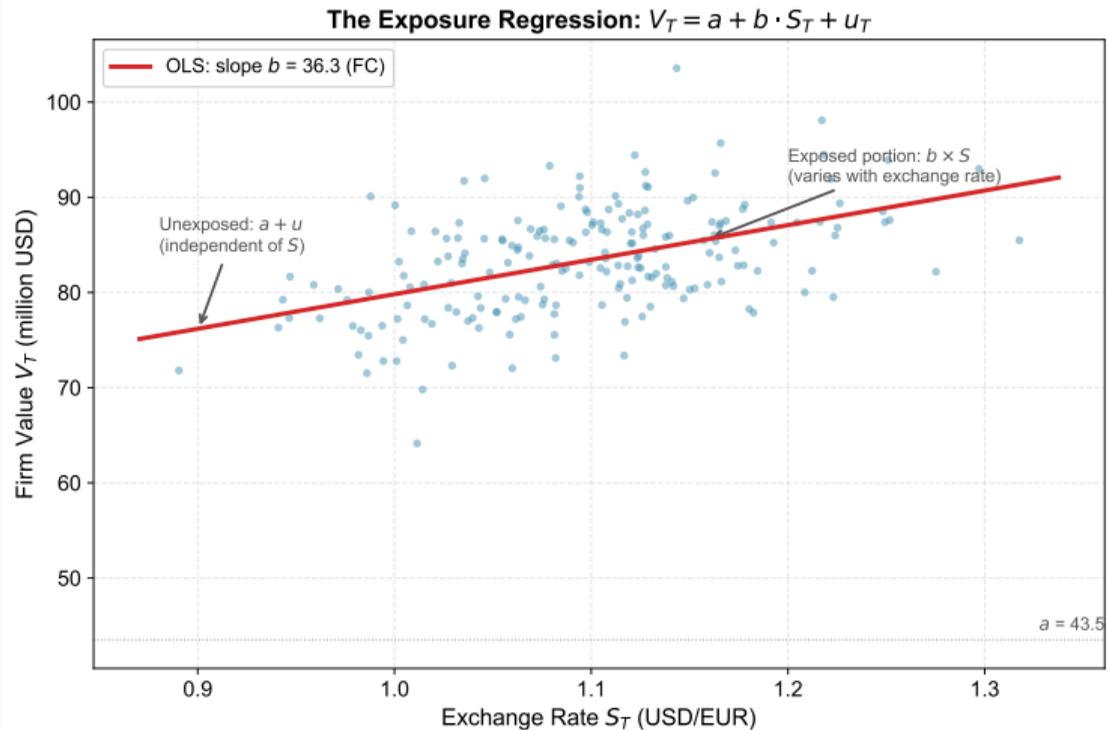
Measuring exposure

The fundamental framework:

$$\tilde{V}_T = a + b \cdot \tilde{S}_T + \tilde{u}_T$$

where:

- V_T = firm value (or cash flow) at time T, in home currency

- S_T = spot exchange rate (HC/FC)

- b = **exposure** (in FC units)

- a = unexposed component (HC, independent of S)

- u_T = residual (firm-specific risk, uncorrelated with S)

The exposure regression: illustration

The Exposure Regression: $V_T = a + b \cdot S_T + u_T$

OLS: slope b = 36.3 (FC)

Unexposed: $a + u$
(independent of S)

Exposed portion: $b \times S$
(varies with exchange rate)

a = 43.5

Firm Value V_T (million USD)

Exchange Rate S_T (USD/EUR)

Decomposition

$$V_T = \underbrace{b \times S_T}_{\text{Exposed}} + \underbrace{a + u_T}_{\text{Unexposed}}$$

- **Exposed portion** ($b \times S_T$): varies with the exchange rate. Can be hedged.

- **Unexposed portion** ($a + u_T$): independent of the exchange rate. Cannot be hedged with FX instruments.

Units:

V_T	a	b	S_T	u_T
HC	HC	**FC**	HC/FC	HC

Interpreting the exposure coefficient

- $b > 0$: firm benefits from FC appreciation (net exporter profile, long FC)

- $b < 0$: firm benefits from FC depreciation (net importer profile, short FC)

- $b = 0$: firm is not exposed to this exchange rate

Estimating b in practice:

- **Regression approach:** regress stock returns on FX changes:
  $r_{i,t} = \alpha + \beta \cdot \Delta s_t + \varepsilon_t$

- **Scenario analysis:** project cash flows under different FX assumptions

The regression approach captures **all channels** (transaction + translation + operating).
But β may be noisy, time-varying, and affected by existing hedges.

Net exporter

- Revenue in FC, costs in HC

- HC depreciation ($S \uparrow$): FC revenues worth more in HC terms $\Rightarrow$ profits rise

- **Exposure** $b > 0$ (long FC)

Profit function:

$$\Pi(S) = b \cdot S - C_{\text{HC}}$$

Example: European pharmaceutical company selling drugs in USD. EUR revenues are fixed costs; USD revenues increase in EUR terms when EUR depreciates.

Net importer

- Revenue in HC, costs in FC

- HC depreciation ($S \uparrow$): FC costs rise in HC terms $\Rightarrow$ profits fall

- **Exposure** $b < 0$ (short FC)

Profit function:

$$\Pi(S) = R_{\text{HC}} - b_{\text{cost}} \cdot S$$

Example: US retailer sourcing products from Asia. Revenues are in USD; costs increase in USD terms when USD depreciates against Asian currencies.

Import competitor: the subtle case

- Both revenues AND costs in HC — **no explicit FC cash flows**

- But: competes with foreign firms whose costs are in FC

- HC appreciation ($S \downarrow$): foreign competitors become cheaper $\Rightarrow$ domestic firm **loses market share**

Exposure $b > 0$ even though the firm has **zero transaction exposure**.

Example: US steel producer competing with Korean imports. All costs and revenues in USD. But when USD appreciates, Korean steel becomes cheaper in USD, taking market share.

This is pure operating exposure — invisible if you only look at contracts.

Profit functions

Operating Exposure: How Profits Respond to Exchange Rate Changes
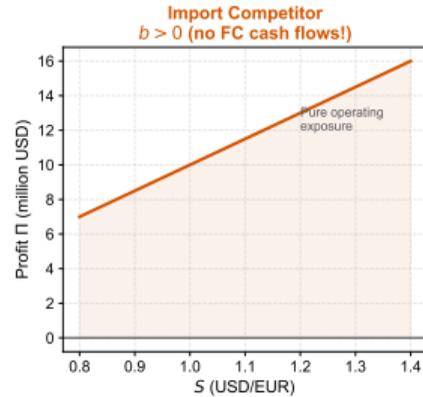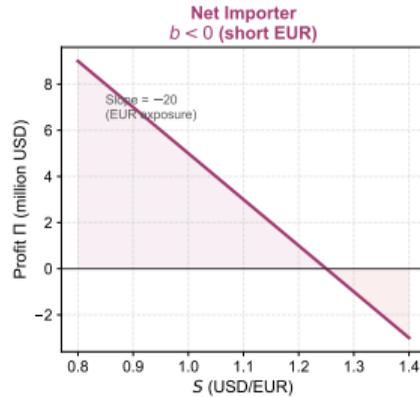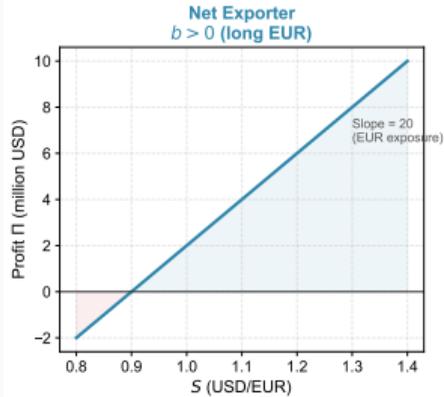
What determines the magnitude of operating exposure?

- **Pricing power:** Can the firm pass through FX changes to customers?

- **Market structure:** How competitive is the industry? More competition $\Rightarrow$ larger operating exposure.

- **Cost structure:** Domestic vs. imported inputs

- **Strategic flexibility:** Can the firm shift production, sourcing, or pricing?

- **Time horizon:** Operating exposure generally **grows** with the horizon

Firms with high pricing power and flexible operations have **lower** operating exposure. Commodity-like industries with intense competition have **higher** operating exposure.

Hedging transaction exposure

Setup: You will receive FC X at time T.

- Exposure = X (in FC)

- Hedge: sell FC X forward at rate $F_{t,T}$

Hedged value:

$$V_T^H = X \times F_{t,T}$$

This is known today — no FX risk remains.

This is the simplest case. The forward contract exactly offsets the exposure because

Hedging operating exposure

From the regression: exposure = b (in FC units).

Hedge: sell FC b forward at rate $F_{t,T}$.

Hedged value:

$$V_T^H = a + b \times F_{t,T} + u_T$$

- The FX risk ($b \times S_T$) is replaced by a **known quantity** ($b \times F_{t,T}$)

- **Residual risk** u_T remains — it cannot be hedged with FX instruments

Warnings about hedging operating exposure

- Exposure b is **estimated**, not observed $\Rightarrow$ hedge is approximate

- Exposure **changes over time** $\Rightarrow$ hedge needs updating (dynamic hedging)

- Residual risk u_T can be **substantial**

- Financial hedging alone may be **insufficient** for operating exposure

Operational hedges may be needed:

- Diversify production locations (match FC costs with FC revenues)

- Diversify sourcing across currencies

- Build flexibility into pricing and contracts

Aggregating exposure across maturities

A firm may have FC cash flows at different dates:

$$X_1 \text{ at } T_1, \quad X_2 \text{ at } T_2, \quad \dots, \quad X_n \text{ at } T_n$$

Cannot simply add them — different maturities have different present values.

Aggregate exposure = present value of all FC cash flows:

$$\text{PV}_{\text{FC}} = \sum_{k=1}^{n} \frac{X_k}{(1 + r_k^*)^{T_k}}$$

where r_k^* is the FC interest rate for maturity T_k.

Hedging strategies for multiple cash flows

Approach 1: Hedge each cash flow individually

- Match each X_k with a forward at maturity T_k. Most precise, but requires managing many positions.

Approach 2: PV hedge with a single forward

- Compute PV_{FC} and hedge with one forward. Simpler, but introduces maturity mismatch risk.

Approach 3: Duration matching

- Match both PV and duration of the hedge to the exposure. Better precision than a single forward, fewer positions than individual hedges.

Worked example

US firm receives GBP cash flows over three years:

Year	Cash flow (GBP M)	PV factor (at 5%)	PV (GBP M)
1	10	0.952	9.52
2	15	0.907	13.61
3	20	0.864	17.28
Total	45		40.41

Duration $= \frac{9.52 \times 1 + 13.61 \times 2 + 17.28 \times 3}{40.41} = \frac{88.58}{40.41} \approx 2.19$ years

Hedge options: (a) three separate GBP forwards, or (b) one forward for GBP 40.41M at ~ 2.19 years.

The toolkit

- **Forwards** (primary tool): OTC, fully customizable (amount, date, currency), no upfront cost, counterparty credit risk

- **Futures** (exchange-traded): standardized sizes and dates, margin requirements, daily marking-to-market, no counterparty risk (clearinghouse)

- **Natural hedges**: match FC revenues with FC costs — borrow in FC, source inputs in FC, locate production abroad

- **NDFs** (non-deliverable forwards): for currencies with capital controls (CNY, BRL, INR, KRW). Cash-settled in USD at a reference fixing rate.

Preview: Options provide nonlinear protection — useful when exposure is uncertain or asymmetric. Full treatment in a later lecture.

Matching instrument to exposure type

Exposure type	Primary instruments	Notes
Transaction	Forwards, futures	Known amount, known date
Operating	Forwards (for estimated b) + operational hedges	b is estimated; combine financial and strategic responses
Translation	Often unhedged	Accounting, not economic; if hedged: balance sheet hedges

Key principle: The instrument should match the exposure.

Summary

- **Risk $\neq$ exposure.** Risk is market-wide; exposure is firm-specific.

- Three types: transaction (easy), translation (mostly ignore), operating (hardest, often largest)

- The exposure regression $V = a + bS + u$ is the **unifying framework**

  - b = exposure (FC units); hedge by selling FC b forward
  - u = residual risk that FX hedging cannot eliminate

- Operating exposure can exist **even with zero FC-denominated cash flows**

- Multiple FC cash flows: aggregate via PV, hedge with matching forwards

Next: Nonlinear exposure and FX options — when forwards are not enough.