Lecture 6: Hedging Economic Exposure

Reading: Eun & Resnick Ch. 9 (10th ed.)

Types of Exchange Rate Exposure: A Revisit

- Transaction Exposure – A short-term exposure that is due to transactions having to be settled in a foreign currency (*see Lecture 5*)

- Translation Exposure – arises due to the need to consolidate financial statements of foreign operations into home currency

- **Economic/Operating Exposure** – the impact of currency fluctuations on a firm's future cash flows.

The Real Exchange Rate – A Recap

- The Real exchange (E_t) is the nominal rate multiplied by the ratio of price levels (*see Lecture 3*)

$$E_t = \frac{S_t^{Actual}}{S_t^{PPP}} = \frac{S_t^{Actual}}{\frac{P_{A,t}}{P_{B,t}}} = S_t^{Actual} \times \frac{P_{B,t}}{P_{A,t}}$$

- Real exchange is 1, if **absolute** PPP holds. Why?
  - The nominal exchange rate (S_t^{Actual}) would equal the ratio of the price levels in countries A and B (i.e., $\frac{P_A}{P_B}$).
- **Example:** Suppose CPI in Australia is \$15,000 and £12,000 in the UK. If the nominal exchange rate is \$1.30/£, then

$$E_t = \frac{S_t^{Actual}}{\frac{P_{A,t}}{P_{B,t}}} = \frac{\$1.30/£}{\frac{\$15,000}{£12,000}} = 1.04$$

Implication: The GBP is overvalued; UK's competitiveness should decline.

The Change in the Real Exchange Rate

- Suppose inflation in Australia (UK) over the next year is 4% (8%). Also, the nominal exchange rate changes in line with Relative PPP predictions.

$$S_{t+1} = S_t \times \frac{(1+\pi_\$)}{(1+\pi_£)} = 1.30 \times \frac{1.04}{1.08} = {}^{\$1.2519}/_{£}$$

- The £ weakens by 3.7%

- What is the ***new*** Real Exchange Rate?

- New price levels are \$15,600 (=15,000 ×1.04) and £12,960 (= £12,960×1.08) in Australia and the UK respectively

$$E_{t+1} = \frac{{}^{\$1.2519}/_{£}}{\frac{\$15{,}600}{£12{,}960}} = 1.04$$

- Notice, the real exchange rate has **not** changed. This is because relative PPP holds. → This keeps deviations from absolute PPP constant.

Real exchange rate change

- Real exchange rate, ***E***, can change over time. This is given as

$$\Delta E = \frac{E_{t+1}^{A/B} - E_t^{A/B}}{E_t^{A/B}} = \frac{E_{t+1}^{A/B}}{E_t^{A/B}} - 1$$

$$1 + \Delta E = \frac{(1+\Delta s_{t+1}) \times (1+\pi_{B,t+1})}{(1+\pi_{A,t+1})}$$

This is derived in the appendix (slide #29)

- If the % change in *E* is positive, we have real appreciation of ***B***.
- If the % change in *E* is negative, we have real depreciation of ***B***.

- What drives *real* appreciations and depreciations?
  - This is where things get complicated.

Real Exchange Rates & Profitability (I)

- Real Exchange Rates affect *real* profitability which is the nominal profits divided by the price level.
  - Why is *real* profitability important?
- Consider the case of an Australian exporter of mangoes (M). His costs are incurred in AUD. His ***nominal profit*** is given as:

$$\$\,rev.\,from\ local\ sales + \$\,rev.\,from\ French\ sales\ - \$\,costs$$

- The exporter's revenue depends on
  1. \$ Rev. from Local Sales $= P(M,\$)\times Q(M,Aus)$
  2. **\$ Rev. from French Sales** $= \boldsymbol{P(M,€)\times Q(M,Fr)\times S(\$/€)}$
  3. \$ Cost of Production $= C(M,\$)\times[Q(M,Aus)+Q(M,Fr)]$
- The exporter's *real* revenue from sales in Australia depends on

$$= \frac{P(M,\$)\times Q(M,Aus)}{P(\$)} = \frac{P(M,\$)}{P(\$)}\times Q(M,Aus)$$

where $P(\$)$ is the Australian price level.

Relative price of mangoes

Real Exchange Rates & Profitability (II)

- ***Real*** costs for the exporter is given by:

$$= \frac{C(M,\$)}{P(\$)} \times [Q(M, Aus) + Q(M, Fra.)]$$

- The ***real*** export revenue from sales to France is:

$$\textit{Real revenue from French Sales} = \frac{P(M,€) \times Q(M,Fra.) \times S(\$/€)}{P(\$)}$$

Multiply & divide this *real* export revenue by the French price level, $P(€)$, and re-arrange

$$= \boxed{\frac{S(\$/€) \times P(€)}{P(\$)}} \times \boxed{\frac{P(M,€)}{P(€)}} \times Q(M, Fra.)$$

Real Exchange Rates & Profitability (III)

$$= \underbrace{\frac{S(\$/€) \times P(€)}{P(\$)}}_{①} \times \underbrace{\frac{P(M,€)}{P(€)}}_{②} \times \underbrace{Q(M, Fra.)}_{③}$$

- The exporter's ***real*** export revenue depends on three factors
  1. The real exchange rate;
  2. The relative price of mangoes in France; and
  3. The quantity of mangoes sold in France
- How managers respond to changes in the *real* exchange rate by altering relative prices is known as *exchange rate pass-through*.
  - Once the relative price is set, the demand curve will determine sales volume

Example: Real Exchange Rate Risk

- Malaysian firm exports mobile phones to Australia. They sell 2 million phones at \$79, and the exchange rate is \$1.25/MYR.

$$\text{Rev.} = \frac{2{,}000{,}000 \times 79.00}{\left(\$1.25/_{MYR}\right)} = MYR\ 126{,}400{,}000$$

- Inflation forecasts for Australia (Malaysia) are 5.5% (1%). So, the prediction for the exchange rate is

$$S_{t+1} = \$1.25/_{MYR} \times \left(\frac{1.055}{1.01}\right) = \$1.3057/_{MYR}$$

- If the demand curve for the phone in Australia is constant, what should the phone price be if the company wants the same sales and same real revenue?

- The phone price in Australia should increase by the Australian inflation rate (5.5%)

$$\text{Sale price} = (79.00 \times 1.055) = \$83.35$$

$$\text{Rev.} = \frac{2{,}000{,}000 \times 83.35}{\left(\$1.3057/_{MYR}\right)} = \text{MYR } 127{,}670{,}981$$

- MYR 127,670,981 is 1% higher than $MYR\ 126{,}400{,}000$

  This 1% increase in (nominal) revenue is necessary to keep the firm's real revenue constant.

- What happens if the exchange rate increases above \$1.3057/MYR?

- Does it change the price of the phone? What would be the consequence?

The Source of Economic Exposure

- Economic exposure arises when the value of the firm is affected by changes in the ***Real*** exchange rate. Exchange rates affect the value of the firm through their impact on
  - Revenues;
  - Costs; and
  - Competitive position
- It is the extent of sensitivity of the Value of a firm to an unexpected exchange to real exchange rates.

$$V_t = \sum_{t=1}^{T} \frac{CF_t}{(1+r)^t}$$

Note that if a change in the exchange rate merely reflects differential rates of inflation between countries, then relative prices would **not** change, and the value of the firm would be unaffected

An Example

- Albion Computers, a US firm, has a British subsidiary that manufactures and sells PCs in the UK.
  - Main input is Intel processors, priced in dollars ($512/unit).
  - All other costs are in British pounds (Fixed cost = £4M and Variable cost = £320/unit).
  - S_0 = $1.60/£
  - Expects to sell 50,000 PCs this year at £1,000 each.
  - Tax rate = 50%

Sales (50,000 units at £1,000/unit)	£50,000,000
Variable costs (50,000 units at £650/unit)[a]	32,500,000
Fixed overhead costs	4,000,000
Depreciation allowances	1,000,000
Net profit before tax	£12,500,000
Income tax (at 50%)	6,250,000
Profit after tax	6,250,000
Add back depreciation	1,000,000
Operating cash flow in pounds	£ 7,250,000
Operating cash flow in dollars	$ 11,600,000

Source: Exhibit 9.6 from the textbook

[a]The unit variable cost, £650, comprises £330 for the locally sourced inputs and £320 for the imported input, which is priced in dollars, i.e., $512. At the exchange rate of $1.60/£, the imported part costs £320.

Albion Computers

Sales (50,000 units at £1,000/unit)	£50,000,000
Variable costs (50,000 units at £696/unit)	34,800,000
Fixed overhead costs	4,000,000
Depreciation allowances	1,000,000
Net profit before tax	£10,200,000
Income tax (at 50%)	5,100,000
Profit after tax	5,100,000
Add back depreciation	1,000,000
Operating cash flow in pounds	£ 6,100,000
Operating cash flow in dollars	$ 8,540,000

Sales (50,000 units at £1,143/unit)	£57,150,000
Variable costs (50,000 units at £696/unit)	34,800,000
Fixed overhead costs	4,000,000
Depreciation allowances	1,000,000
Net profit before tax	£17,350,000
Income tax (at 50%)	8,675,000
Profit after tax	8,675,000
Add back depreciation	1,000,000
Operating cash flow in pounds	£ 9,675,000
Operating cash flow in dollars	$13,545,000

CASE 1

Assumes only the price of imported input changes. (Albion does not pass-through any of this higher cost. Thus, profit margins fall.)

As the £ depreciates ($1.40/ £), the input cost of imported Intel chips increases resulting in lower £ profits, and the £ operating cash flows are worth fewer $s.

CASE 2

Assumes price of imported input AND selling price increase.

Assumes Albion will sell the same number of units after passing on all (and then some) of the higher cost. Thus, assumes demand is highly inelastic.

Albion Computers – Case 3

Assumes selling price and local costs increase by 8% (local inflation rate).

Also assumes demand is elastic. Sales fall by 10,000 units at the higher selling price.

Sales (40,000 units at £1,080/unit)	£43,200,000
Variable costs (40,000 units at £722/unit)	28,880,000
Fixed overhead costs	4,000,000
Depreciation allowances	1,000,000
Net profit before tax	£ 9,320,000
Income tax (at 50%)	4,660,000
Profit after tax	4,660,000
Add back depreciation	1,000,000
Operating cash flow in pounds	£ 5,660,000
Operating cash flow in dollars	$ 7,924,000

Input costs have gone up, unit sales have fallen, and the £ operating cash flows are worth fewer $s.

Albion Computers

EXHIBIT 9.10 Summary of Operating Exposure Effect of Pound Depreciation on Albion Computers PLC

Variables	Benchmark Case	Case 1	Case 2	Case 3
Exchange rate ($/£)	1.60	1.40	1.40	1.40
Unit variable cost (£)	650	696	696	722
Unit sales price (£)	1,000	1,000	1,143	1,080
Sales volume (units)	50,000	50,000	50,000	40,000
Annual cash flow (£)	7,250,000	6,100,000	9,675,000	5,660,000
Annual cash flow ($)	11,600,000	8,540,000	13,545,000	7,924,000
Four-year present value ($)[a]	33,118,000	24,382,000	38,671,000	22,623,000
Operating gains/losses ($)[b]		−8,736,000	5,553,000	−10,495,000

[a]The discounted present value of dollar cash flows was computed over a four-year period using a 15 percent discount rate. A constant cash flow is assumed for each of four years.

[b]Operating gains or losses represent the present value of change in cash flows, which is due to pound depreciation, from the benchmark case.

Case 1: Demand elastic. To maintain market share, absorb all cost increases (no pass-through). Profit margins fall.

Case 2: Demand inelastic, pass-through all cost increases, maintain/improve margins.

Case 3: Demand elastic, absorb some of cost increase, lose both market share and profit margins.

A Real-World Example: Honda Motors

- Honda used to manufacture all its automobiles in Japan and ship them to the U.S.
- U.S. demand declined with yen appreciation

¥1,250,0000 = $10,000

  - In January 1993, exchange rate was about 125 ¥/$. By April, it fell to 113-114 ¥/$ range = **$11,062**
  - *NY Times* says that Japanese manufacturers would have to "take stern measures to reduce their costs and improve their efficiency."
  - June 1993 dollar fell to about 110 ¥/$ = **$11,364**
  - End of summer of 1993, 100 ¥/$ = **$12,500**

A Real-World Example – Honda Motors

- In July 1993, Japanese auto exports were 14% below previous year's level.
- *The New York Times* reported Japanese manufacturers were shifting production to U.S.

- Honda posted a 55% drop in pre-tax profit for quarter ending June 30, 1993.
- Honda has built manufacturing plants in the U.S. to produce automobiles for sale there.
  - *What are the benefits?*

Impact of Economic Exposure

- A strong dollar can make imports look cheap to Australian purchasers.
  - Can bring new competition for Australian producers.
- Exchange rates can affect the price a firm pays for inputs imported from foreign countries.
  - Raise prices (lower demand) or earn lower profits?
- Exchange rates can affect the foreign demand for a firm's product.
  - Weak dollar can make Australian exports attractive.
  - Increase in foreign demand can also increase Australian prices if production doesn't adjust fast enough.

Recognising Economic Exposure

- Where is the company selling? [domestic v. foreign]
- Who are the key competitors? [domestic v. foreign]
- How sensitive is demand to price?
- Where is the company producing? [domestic v. foreign]
- Where are the company's inputs coming from? [domestic v. foreign]
- How are the company's inputs or outputs priced? [world price v. domestic market]

Conduits for Economic Exposure

- Impact of Exposure can be DIRECT or INDIRECT

	HC strengthens	HC weakens
Direct Exposure		
Sales abroad	Unfavourable	Favourable
Source abroad	Favourable	Unfavourable
Profits abroad	Unfavourable	Favourable
Indirect Exposure		
Competitor sources abroad	Unfavourable	Favourable
Supplier sources abroad	Favourable	Unfavourable

HC: Home currency

Consider All Effects

- In sum, the full impact of foreign exchange changes on cash flows
  - Depends not only on first order price effects
  - But also, on indirect effects such as responses of customers, competitors, suppliers, their competitors and suppliers, and so on.
  - The more flexibility the firm has in terms of pricing its product and sourcing its inputs from wherever in the world they are cheapest, will significantly reduce any adverse impact of exchange rate changes.

Managing Economic Exposure

- Use of Marketing Strategies
  - Market Selection
  - Pricing Strategy/Product strategy
  - Promotional Strategy
  - Pricing-to-Market
- Use of Production Management
  - Input mix
  - Plant Location & Shifting production among plants
  - Raising Productivity (i.e., lowering costs)
- Financial Hedging techniques may also be used, but …
  - Example is Porsche's use of derivative contracts

Quantifying Economic Exposure

- PV of firms profits/CFs is given as

$$V = \sum_{j=1}^{T} \frac{CF_j}{(1+r)^j}$$

It measures the marginal impact on firm value by an unexpected change in the (AUD/FC) *real* exchange rate.

- This can also be written as

$$Economic\ Exposure = \frac{Unexpected\ change\ in\ CF_{T,\ in\ home\ currency}}{Unexpected\ change\ in\ real\ ex/r}$$

- Audits/Scenario Analysis: Qualitative examination of the separate elements of a firm's operating cash flow and anticipating its sensitivity to real exchange rate changes.

- Regression Analysis: $R_i = \alpha + \beta_m r_{mt} + \beta_e r_{et} + u_t$

where, r_{mt} and r_{et} are the return on the market index and return the % change in the exchange rate (change is the AUD per unit of foreign currency) resp.

Natural Hedges

- Ford shifting production to Asia

> The new and improved treasury function has a bigger voice in the boardroom too. As one example, treasury analysis of the Ford's foreign exchange exposures is being factored into big, strategic decisions, such as the location of assembly plants – where natural hedges can be achieved by manufacturing and selling in the same currency, the benefits are taken into account.
>
> Currency hedging has taken on greater significance as Ford's sales have surged in Asia, with more than one million vehicles sold in China in 2015, beating the company's own forecasts. As sales have risen, so has the company's exposure to Asian currencies, and its decision to build assembly plants in China and India last year was partly motivated by a desire to reduce currency hedging costs. *Risk.Net Corporate Risk Manager of the Year: Ford Motor Company 2016*

- Toyota has insulated itself to some extent against dollar fluctuations
  - It builds 60% of the cars sold in North America in North America
- Michelin, the world's largest tire maker, has 40% of its annual sales in North America.
  - Most of the imported raw materials used by Michelin are also priced in dollars

Exchange Rate Changes and Profit Margins: The Case of Japanese Exporters

- Klitgaard (April 1999), FRBNY, *Economic Policy Review*

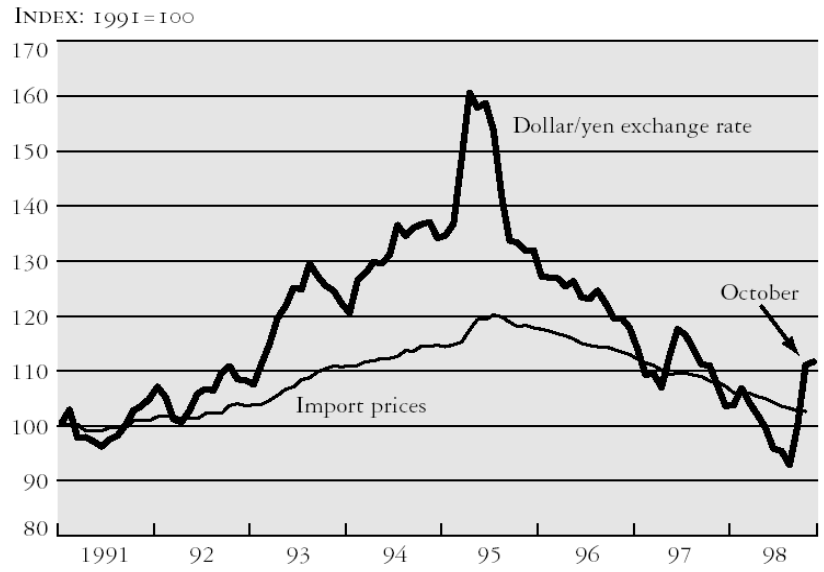
Examines statistically how Japanese exporters respond to the conflicting objectives of maintaining stable profit margins and stable export sales in the face of fluctuations in the value of the yen.

Exchange Rate Changes and Profit Margins

- Another way to state the findings is: Foreign customers do observe exchange-rate driven changes in prices, *but* the Japanese firms moderate the extent of these changes by altering their profit margins.

Chart 1

U.S. Import Prices for Japanese Goods



Sources: U.S. Department of Labor, Bureau of Labor Statistics; Federal Reserve Bank of New York.

Exchange Rate Changes and Profit Margins

- Possible responses to yen appreciation:
  - Maintain foreign price (i.e., price customer sees) at pre-appreciation level/lower yen price and profit margin
  - Raise foreign price/maintain yen price and profit margin at pre-appreciation level
  - Combination of the two: Raise foreign price, but not enough to maintain same yen profit margin.
    - Evidence suggests this combination best describes Japanese exporter pricing behavior.

Exchange Rate Changes and Profit Margins

Why would this make sense?

- A firm that has found its profit-maximizing price in each market and will attempt to keep its goods at that price. (Cares about maintaining market share.)
- Thus, firms are inclined to absorb currency swings into their profit margins to stabilize prices seen by foreign customers.

Table 1
PERCENTAGE CHANGE IN JAPANESE GOODS' EXPORT AND DOMESTIC PRICES IN JAPAN'S FOUR MAJOR EXPORTING INDUSTRIES

	1990-95		1995-98	
Industry	Export Prices	Domestic Prices	Export Prices	Domestic Prices
Industrial machinery	-6.7	-1.1	10.6	0.0
Electrical machinery	-35.0	-12.7	2.6	-14.9
Transportation equipment	-8.9	-1.9	23.3	-1.7
Precision equipment	-9.8	-1.3	13.0	-0.9

Source: Bank of Japan.

Take Aways

- The importance of real exchange rates
- What is economic exposure?
- The source of economic exposure
- How does one quantify this type of exposure?
- What approaches do firms use to hedge this risk?

Appendix: The Change in the Real Exchange Rate

- Real exchange rate, ***E***, can change over time. This is given as

(1) $$\Delta E = \frac{E_{t+1}^{A/B} - E_t^{A/B}}{E_t^{A/B}} = \frac{E_{t+1}^{A/B}}{E_t^{A/B}} - 1$$

  - If the % change in *E* is positive, we have real appreciation of ***B***.
  - If the % change in *E* is negative, we have real depreciation of ***B***.

- Substituting the definition of real exchange rate given in slide #4 into (1) we get

(2) $$1 + \Delta E = \frac{S_{t+1}^{Actual} \times P_{B,t+1}/P_{A,t+1}}{S_t^{Actual} \times P_{B,t}/P_{A,t}}$$

- Grouping the exchange rate terms and price level terms for A and B in (2) we get

$$1 + \Delta E = \frac{\left(S_{t+1}^{Actual} \Big/ S_t^{Actual}\right) \times \left(P_{B,t+1}/P_{B,t}\right)}{\left(P_{A,t+1}/P_{A,t}\right)}$$

- Plugging in definitions of ratios of variables at t+1, we get

$$1 + \Delta E = \frac{(1 + \Delta s_{t+1}) \times \left(1 + \pi_{B,t+1}\right)}{\left(1 + \pi_{A,t+1}\right)}$$

- **LHS:** 1 + % change in the real exchange rate
- **RHS:** (1+% change in the nominal exchange rate) × (1+inflation in country B), divided by (1+inflation in country A)