Chapter 4
Foreign Exchange, Eurocurrencies, and Currency Risk Management

4.1 The Eurocurrency Market
4.2 The Foreign Exchange Market
4.3 Foreign Exchange Rates and Quotations
4.4 Exposure to Currency Risk
4.5 Hedging Transaction Exposure with Forward Contracts
4.6 The Empirical Behavior of Exchange Rates
4.7 Summary

Symbols

Upper Case Symbols = Prices
lower case symbols = changes in a price

P_t^d = price of an asset at time t in currency d
i_t^d = nominal interest rate in currency d during period t
ι_t^d = real interest rate in currency d during period t
p_t^d = inflation in currency d during period t
$S_t^{d/f}$ = spot exchange rate at time t between d and f
$s_t^{d/f}$ = change in the spot rate during period t
$F_t^{d/f}$ = forward exchange rate between d and f

The Fisher equation

$$(1+i) = (1+\iota)(1+p)$$

For domestic (d) and foreign (f) currencies

i^d and i^f = nominal interest rates in the domestic and foreign currencies

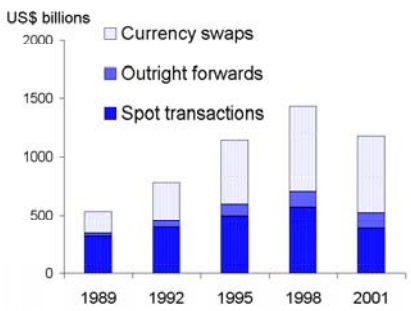
p^d and p^f = inflation rates in the domestic and foreign currencies

ι^d and ι^f = real interest rates in domestic and foreign currencies

Foreign exchange (fx) markets

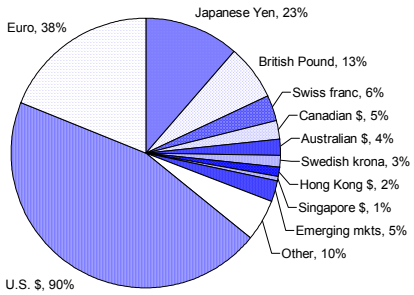
- Markets
  - Spot market
    - Trade in cash with delivery in two business days
  - Forward market
    - Trade at a pre-specified price and on a pre-specified future date
- Volume
  - $1.2 trillion average daily volume during 2001
  - 75% of trade is in the interbank market

Global foreign exchange turnover
(Average daily central bank volume during April)



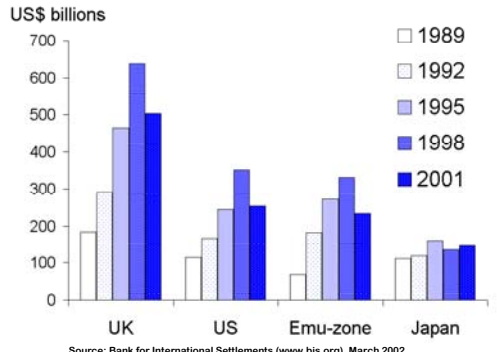
Source: *Bank for International Settlements* (BIS) triennial survey of central banks.

FX turnover by currency



Source: Bank for International Settlements (www.bis.org), March 2002.
Percentages sum to 200 because two currencies are involved in each transaction.

Major fx trading centers

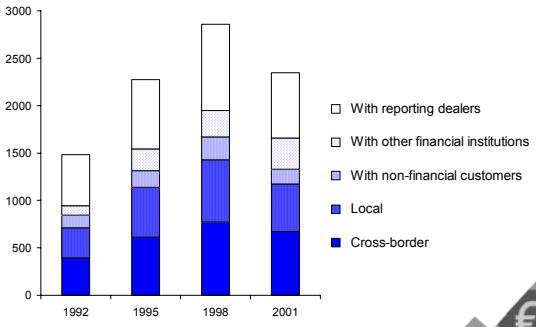


Source: Bank for International Settlements (www.bis.org), March 2002.

Participants in the fx market

- Wholesale market
  - Dealers (or market makers)
    Buy and sell at quoted bid and offer prices
  - Brokers
    Serve as matchmakers, without putting their own money at risk
- Retail market
  - Governments
  - Corporations
  - Smaller financial institutions
  - Individuals

FX turnover by counterparty



Source: Bank for International Settlements (www.bis.org), March 2002.

Two rules for multinational finance

- Rule #1 Keep track of your units
- Rule #2 Always buy or sell the currency in the denominator of a foreign exchange quote

Rule #1 Keep track of your units

A bottle of Georges de Bouef merlot

Buy 1 bottle of wine		$P^{€}$	= €40/btl
Spot exchange rate		$S^{\$/€}$	= \$0.80/€
⇔	$S^{€/\$}$	$= 1/S^{\$/€}$	= €1.25/\$

How much is this in dollars?

$P^{\$} = P^{€} S^{\$/€}$ = (€40/btl) (\$0.80/€) = \$32/btl

$= P^{€}/S^{€/\$}$ = (€40/btl) / (€1.25/\$) = \$32/btl

Rule #1 Keep track of your units

A bottle of Georges de Bouef merlot

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Spot exchange rate		$S^{\$/€}$	= \$0.80/€
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How much is this in dollars?

$P^{\$} = P^{€} S^{€/\$}$ = (€40/btl) (€1.25/\$)

= €250 / (btl-\$) ???

Keep track of your currency units!

Rule #2 Think of buying or selling the asset in the denominator

Buying and selling a bottle of wine

Buy a bottle at €40/btl and sell at €50/btl

⇒ €10/btl profit

Buying and selling euros

Buy €s at $0.80/€ and sell at $1.00/€

Buy €s at $0.80/€ ≡ Sell $s at €1.25/$

Sell €s at $1.00/€ ≡ Buy $s at €1.00/$

⇒ $0.20/€ profit ⇒ €0.25/$ profit

An example of what can go wrong

Buy $s at $0.80/€ and sell $s at $1.00/€

But, if you are buying dollars you are selling euros…

Buy $s at $0.80/€ ≡ Sell €s at €1.25/$

Sell $s at $1.00/€ ≡ Buy €s at €1.00/$

⇒ $0.20/€ loss ⇒ €0.25/$ loss

Always think of buying or selling the currency in the denominator!

FX quotation conventions (or, variations of Rule #2)

- European/American quotes for the $
  - European quotes are convenient for a European because they place the foreign currency (the $) in the denominator
    e.g. €1.25/$
  - American quotes are convenient for an American because they place the foreign currency (the €) in the denominator
    e.g. $0.80/€

FX quotation conventions (or, variations of Rule #2)

- Direct/indirect quotes for foreign currency f
  - Direct quotes are convenient for a domestic resident because they place the foreign currency in the denominator (d/f);
    e.g. ¥110.95/€ for a resident of Japan
  - Indirect quotes are inconvenient for a domestic resident because they place the foreign currency in the numerator (f/d);
    e.g. ¥110.95/€ for a resident of Europe

Percentage forward premiums or discounts

$= (F_1^{d/f} - S_0^{d/f}) / S_0^{d/f}$

- Forward premium
  - Nominal value in the forward exchange market is *higher* than in the spot exchange market
- Forward discount
  - Nominal value in the forward exchange market is *lower* than in the spot exchange market

An example of a forward premium

Suppose

$S_0^{\$/DKr}$ = $0.20/DKr and $F_1^{\$/DKr}$ = $0.25/DKr

Danish kroner forward premium

= ($0.25/DKr -$0.20/DKr)/($0.20/DKr)

= +25%

so the Danish krone is selling at a 25% forward premium

An example of a forward discount

Alternatively

$S_0^{DKr/\$} = DKr5.00/\$ \Leftrightarrow S_0^{\$/DKr} = \$0.20/DKr$

$F_1^{DKr/\$} = DKr4.00/\$ \Leftrightarrow F_1^{\$/DKr} = \$0.25/DKr$

Dollar forward premium

= (DKr4/\$-DKr5/\$)/(DKr5/\$)

= -20%

so the dollar is selling at a

20% forward discount

Exposure to currency risk

- Currency risk
  - The risk of unexpected changes in foreign exchange rates
- Exposure to currency risk
  - The MNC has an exposure to fx risk when the value of assets or liabilities can change with unexpected changes in fx rates

Percentage changes in fx rates

Percentage change in the value of a foreign currency

$= (S_1^{d/f} - S_0^{d/f}) / S_0^{d/f}$

$= s_1^{d/f}$

An example of change in a fx rate

Percentage change in the **Danish kroner**

$S_0^{\$/DKr} = \$0.20/DKr$

$S_1^{\$/DKr} = \$0.25/DKr$

$s^{\$/DKr}$ = percentage change in the kroner

$= (S_1^{\$/DKr} - S_0^{\$/DKr}) / S_0^{\$/DKr}$

= (\$0.25/DKr-\$0.20/DKr) / (\$0.20/DKr)

= +25%

An example of change in a fx rate

Percentage change in the **U.S. dollar**

$S_0^{\$/DKr} = \$0.20/DKr \Leftrightarrow S_0^{DKr/\$} = DKr5/\$$

$S_1^{\$/DKr} = \$0.25/DKr \Leftrightarrow S_1^{DKr/\$} = DKr4/\$$

$s^{DKr/\$}$ = percentage change in the dollar

$= (S_1^{DKr/\$} - S_0^{DKr/\$}) / S_0^{DKr/\$}$

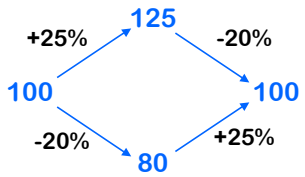
= (DKr4/\$-DKr5/\$)/(DKr5/\$)

= -20%

What goes up must come down (and vice versa)

$(1+s^{d/f}) = 1 / (1+s^{f/d})$

- Example



An example of fx exposure

- A U.S. firm expects to receive 40,000 Polish zlotys (Z) in one year
- The spot rate expected to prevail in one year is $E[S_1^{\$/Z}] = \$0.25/Z$
- What effect will an actual spot rate of $S_1^{\$/Z} = \$0.20/Z$ have on the firm?

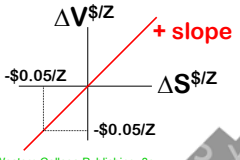
An example of fx exposure

Expected receipt at $E[S_1^{\$/Z}] = \$0.25/Z$ — +Z40,000 ⇔ +$10,000 at $0.25/Z

Actual exchange at $S_1^{\$/Z} = \$0.20/Z$ — +Z40,000 ⇔ +$8,000 at $0.20/Z

Net loss from original position — -$2,000

Risk (or payoff) profile of underlying exposure



Currency hedging with forwards

Buy $10,000 forward at $F_1^{\$/Z} = \$0.25/Z$ — +$10,000

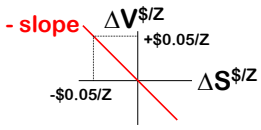
Sell Z40,000 forward — –Z40,000

Market exchange of Z for $ at $S_1^{\$/Z} = \$0.20/Z$ — +$8,000

Sell Z40,000 forward — –Z40,000

Net gain on forward — +$2,000

Risk profile of a forward contract



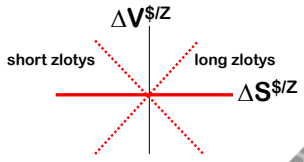
Net currency exposure

Underlying position (long zlotys) — +Z40,000

Sell zlotys forward (short zlotys and long dollars) — +$10,000 / -Z40,000

Net position — +$10,000

Net exposure



Types of exposure to currency risk

- **Economic exposure**
  Change in the value of all future cash flows from unexpected changes in exchange rates
  - **Transaction exposure**
    Change in the value of contractual cash flows from unexpected changes in exchange rates
  - **Operating exposure**
    Change in the value of noncontractual cash flows from unexpected changes in exchange rates

Types of exposure to currency risk

- **Translation (accounting) exposure**
  Change in financial statements from unexpected changes in exchange rates

Economic exposure

Monetary assets	Monetary Liabilities
Real assets	Common equity

A survey of corporate treasurers

"Managing _____ is important."

	Mean score
Transaction exposure	1.4
Operating exposure	1.8
Translation exposure	2.4

Key: 1 = strongly agree ... 3 = neutral ... 5 = strongly disagree

A survey of corporate treasurers

- **Transaction exposure** is viewed by corporate treasurers as the most important currency risk exposure

Source: Jesswein, Kwok and Folks, "Adoption of Innovative Products in Currency Risk Management: Effects of Management Orientations and Product Characteristics," *Journal of Applied Corporate Finance* (1995).

Behavior of nominal exchange rates

- Instantaneous exchange rate changes are approximately normally distributed
- At each point in time, exchange rate variance is **autoregressive** (that is, it depends on previous variances and changes in exchange rates)

Autoregressive conditional heteroscedasticity

A complicated term for a simple idea…

- Variance
  - depends on — is conditional on
  - previous — autoregressive
  - variance — heteroscedasticity

Modeling variances with GARCH

$$\sigma_t^2 = a_0 + \Sigma_i\, a_i\, \sigma_{t-i}^2 + \Sigma_j\, b_j\, s_{t-j}^2$$

The conditional estimate of variance σ_t^2 depends on previous variances (σ_{t-i}^2) and squared spot rate changes (s_{t-j}^2)

- **Persistence**: The σ_{t-i}^2 smooth the process so that it is not overly sensitive to recent changes in the spot rate
- **Sensitivity**: The s_{t-j}^2 force variance to respond to recent changes in the spot rate