Handout #4 Draft as of Aug 10, 2009
Measuring and Managing the Risk in International Financial Positions

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# Reading Assignments

<table>
<thead>
<tr>
<th>Levich</th>
<th>Chap 16</th>
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</tr>
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</tr>
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</tr>
</tbody>
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Topic 9: International Finance Cases

Exchange Rates and Firms.
Case—Foreign Exchange Hedging Strategies at General Motors: Transactional and Translational Exposures.

Case—Foreign Exchange Hedging Strategies at General Motors: Competitive Exposures.

Financing Decisions within the Firm.
Case—The Refinancing of Shanghai General Motors.

Valuing Cross-Border Investments.
Case—Valuing a Cross-Border LBO: Bidding on the Yell Group.
How should a multinational firm manage foreign exchange exposures? Examines transactional and translational exposures and alternative responses to these exposures by analyzing two specific hedging decisions by General Motors. Describes General Motors' corporate hedging policies, its risk management structure, and how accounting rules impact hedging decisions. Although the overall corporate hedging policy provides a consistent approach to the foreign exchange risks that General Motors must manage, the company also has to consider deviations from prescribed policies. Describes two such situations: a significant exposure to the Canadian dollar with adverse accounting consequences and GM's exposure to the Argentinean currency when devaluation is widely anticipated. Students must evaluate the risks General Motors faces in each situation and consider which hedging strategy--if any--might be appropriate. Additionally, asks students to analyze the financial costs and accounting treatment of alternative derivative transactions for hedging purposes. A rewritten version of an earlier case.
Learning Objective:
To analyze foreign exchange hedging decisions, the appropriate design of risk management policies, and multinational financial management.

Subjects Covered:

Setting:
New York, NY; Automotive industry; $177.3 billion revenues; 365,000 employees; 2001
Topic 9: International Finance Cases

Exchange Rates and Firms.
Case—Foreign Exchange Hedging Strategies at General Motors: Transactional and Translational Exposures.

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Case—The Refinancing of Shanghai General Motors.

Valuing Cross-Border Investments.
Case—Valuing a Cross-Border LBO: Bidding on the Yell Group.
Description: How can a multinational firm analyze and manage currency risks that arise from competitive exposures? General Motors has a substantial competitive exposure to the Japanese yen. Although the risks GM faces from the depreciating yen are widely acknowledged, the company's corporate hedging policy does not provide any guidelines on managing such competitive exposures. Eric Feldstein, treasurer and vice-president of finance, has to quantify GM's yen exposure and recommend a way for GM to manage the risks that arise from its competitive exposure. Students must analyze the impact of a yen depreciation on GM sales and profits.

Learning Objective: To analyze competitive exposures and appropriate hedging policies.


Setting: New York, NY; Automotive industry; $177.3 billion revenues; 365,000 employees; 2001
 Totally Optional Readings for Global Association of (Finance) Risk Professionals

Wednesday July 2, 2008

Risk Budgeting: Portfolio Problem Solving with Value-at-Risk

Chapter 2—Value-at-Risk of a Simple Equity Portfolio.

Chapter 9—Stress Testing.

International Asset Portfolios and Financial Risk Management
Measuring and Managing the Risk in International Financial Positions

MS&E 247S International Investments
Yee-Tien Fu
Learning Objectives

1. Understand that exposure to risk can be viewed as a sensitivity measure relating changes in the market value of a firm or portfolio changes in the price of another asset.

2. Realize that the sources of a firm’s exposure can be direct (from actual positions) or indirect (because the firm competes with other firms).

Learning Objectives (continued)

4. Be familiar with several techniques for measuring economic exposure to currency risk including the regression approach and the scenario approach.

5. Understand how a firm can select a financial hedging strategy based on its currency profile and cash flow characteristics.

6. Be familiar with the value-at-risk approach for measuring the risk of financial positions.
Introduction

• In this chapter, we will examine how variability in exchange rates and interest rates affects the market value of a firm.

• We will evaluate the link between the market value $MV$ of either a firm or a financial portfolio and a financial price, say the spot exchange rate $S$. This produces another sensitivity measure, $\frac{\partial MV}{\partial S}$, which we define as the firm’s or portfolio’s exposure to foreign exchange risk.

• We will also focus on financial hedging techniques that involve financial market transactions.
Introduction

• An investment manager or trader can assess the sensitivity of an entire portfolio to changes in exchange rates, interest rates, and other financial variables.

• International business operations and foreign exchange transactions have often been treated separately. In this chapter, we argue that the distinction is exaggerated. The risks faced by firms with domestic operations and firms with foreign operations are similar in many aspects.
Introduction

• An international firm operating in an open economy faces price risks on its inputs and outputs plus an important additional price risk. A change in the real exchange rate can signify an especially important relative price change because it influences the relative cost of all inputs used by competitors and the relative price of all outputs purchased by consumers around the world.

• The sensitivity of a firm’s cash flows, and hence its market value, to changes in real exchange rates is an example of foreign exchange exposure.
Introduction

• A firm also faces interest rate risk if the cost of financing is an important component of the purchase price of its products.

• By extension, a hypothetical international firm faces domestic and foreign currency interest rate risk when the values of the firm’s financial assets, financial liabilities, or cash flows from operations change in response to interest rate changes.
Introduction

• Recall the interplay between exchange rate changes and macroeconomic activity from the standpoint of a nation.

• Trade theory predicts that a US$ depreciation will lead to an expansion of the export goods sector, a transformation of the nontraded goods sector to include some goods that were formerly imported, and a contraction in those sectors that relied on imports as intermediate inputs.
Introduction

• The impact that exchange rate changes may have on patterns of employment, production, and corporate profitability at the national level actually reflects the impact that is felt on individual firms - the firm’s foreign exchange exposure.

• The effects of current and prospective exchange rate changes can be felt across financial assets denominated in a particular currency (such as when a prospective SFr devaluation leads to a rise in all SFr interest rates) or across financial claims for a particular country (such as when a prospective Mexican peso devaluation reduces lending to all Mexican firms).
While our definition of exposure applies equally to the market value of a portfolio of securities or a firm, in this section we focus on the firm’s exposure to foreign exchange risk.
The Market Value of the Firm & Channels of Risk

• Let us now examine the channels through which the impact of exchange rate changes are felt.

• The market value of the firm at time \( t \), \( MV_t \), is the summation of the firm’s cash flows \( CF \) over time discounted back to their present value by an appropriate discount factor \( i \):

\[
MV_t = \sum_{t=0}^{T} \frac{CF_t}{(1 + i_t)^t} \quad (16.1)
\]
The Market Value of the Firm & Channels of Risk

• Since the cash flows are composed of flows of various currencies, the market value of the firm in US$ is:

\[ MV_t = \sum_{t=0}^{T} \frac{CF_{\$,t}}{(1+i_{\$,t})^t} + \sum_{t=0}^{T} \frac{CF_{\£,t} S_{\$,\£,t}}{(1+i_{\£,t})^t} + \sum_{t=0}^{T} \frac{CF_{\text{Euro},t} S_{\$,\text{Euro},t}}{(1+i_{\text{Euro},t})^t} + \ldots \] (16.2)

• Cash flows in any of the currencies can be divided into revenues and costs. Consider, for example, € cash flows:

\[ CF_{\text{Euro},t} = \text{REVENUES}_{\text{Euro},t} - \text{COSTS}_{\text{Euro},t} \] (16.3)
The Market Value of the Firm & Channels of Risk

- Revenues in € can be defined as:

\[
REVENUES_{\text{Euro},t} = PRICE_{\text{Euro},t} \times QUANTITY_{\text{Euro},t} \quad (16.4)
\]

- Costs in € can be defined as:

\[
COSTS_{\text{Euro},t} = FIXED_{\text{Euro},t} + VARIABLE_{\text{Euro},t} \times NUMBER_{\text{Euro},t} \quad (16.5)
\]

- Exchange rate exposure, the sensitivity of the market value of the firm to a change in the $/€ exchange rate, can be expressed as:

\[
\frac{\partial MV}{\partial S_{\$/\text{Euro}}} 
\]

(16.6)
The Market Value of the Firm

• The sensitivity of the market value of the firm to a change in an exchange rate measures exchange rate exposure.

• For the $/€ exchange rate, the sensitivity measure can be expressed as:

$$\frac{\partial MV}{\partial S_{\$/€}}$$
Direct and Indirect Economic Exposure

The discussion so far suggests that the firm’s exposure to exchange rate risk depends heavily on the impact that the exchange rate has on prices and quantities of inputs and outputs.

Some of these effects are the direct result of the firm’s decisions on where to locate production, whether to alter its own output prices after an exchange rate change, and so on.
Direct and Indirect Economic Exposure

John Pringle and Robert Connolly (1993) argued that the overall impact on a firm from exchange rate changes depends not only on how the firm reacts, but also on how the firm’s competitors, customers, and suppliers react.

The direct and indirect effects are summarized in Table 16.1.
## Channels of Exposure to Foreign Exchange Risk

### Direct Exposure

<table>
<thead>
<tr>
<th>Source Abroad (e.g., Singapore)</th>
<th>Home Currency Strengthens</th>
<th>Home Currency Weakens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales Abroad (e.g., China, India)</td>
<td>Unfavorable Revenue worth less in home currency terms</td>
<td>Favorable Revenue worth more</td>
</tr>
<tr>
<td>Profits Abroad (e.g., US multinationals)</td>
<td>Unfavorable Profits worth less</td>
<td>Favorable Profits worth more</td>
</tr>
<tr>
<td>Source Abroad (e.g., Singapore)</td>
<td>Favorable Inputs cheaper in home currency terms</td>
<td>Unfavorable Inputs more expensive</td>
</tr>
</tbody>
</table>

Table 16.1
## Channels of Exposure to Foreign Exchange Risk

### Indirect Exposure

<table>
<thead>
<tr>
<th>Indirect Economic Exposure</th>
<th>Home Currency Strengthens</th>
<th>Home Currency Weakens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competitor that sources abroad</td>
<td>Unfavorable</td>
<td>Favorable</td>
</tr>
<tr>
<td></td>
<td>Competitor’s margins improve</td>
<td>Competitor’s margins decrease</td>
</tr>
<tr>
<td>Supplier that sources abroad</td>
<td>Favorable</td>
<td>Unfavorable</td>
</tr>
<tr>
<td></td>
<td>Supplier’s margins improve</td>
<td>Supplier’s margins decrease</td>
</tr>
<tr>
<td>Customer that sells abroad</td>
<td>Unfavorable</td>
<td>Favorable</td>
</tr>
<tr>
<td></td>
<td>Customer’s margins decrease</td>
<td>Customer’s margins improve</td>
</tr>
<tr>
<td>Customer that sources abroad</td>
<td>Favorable</td>
<td>Unfavorable</td>
</tr>
<tr>
<td></td>
<td>Customer’s margins improve</td>
<td>Customer’s margins decrease</td>
</tr>
</tbody>
</table>

Table 16.1
The “Five Forces” Framework for Industry Analysis

**New Entrants**

Entry Barriers:
- Economies of scale
- Brand identity
- Capital requirements
- Proprietary product differences
- Switching costs
- Access to distribution
- Proprietary learning curve
- Access to necessary inputs
- Low-cost product design
- Government policy
- Expected retaliation

**Suppliers**

Sources of Bargaining Power:
- Switching costs
- Supplier concentration
- Importance of volume to suppliers
- Impact of inputs on cost or differentiation
- Threat of forward/backward integration
- Cost relative to total purchases in industry

**Industry Competitors**

Factors Affecting Rivalry:
- Industry growth
- Concentration and balance
- Fixed costs/value added
- Intermittent overcapacity
- Product differences
- Brand identity
- Switching costs
- Informational complexity
- Diversity of competitors
- Corporate stakes
- Exit barriers

**Substitutes**

Threat Determined by:
- Relative price performance of substitutes
- Switching costs
- Buyer propensity to substitute

**Buyers**

Bargaining Power of Buyers:
- Buyer concentration
- Switching costs
- Buyer profits
- Pull-through
- Price/total purchases
- Brand identity
- Impact on quality/performance
- Buyer volume
- Buyer information
- Substitute products
- Price sensitivity
- Product differences
- Ability to backward integrate
- Decision makers’ incentives
The Value Net

The Range of Firms Facing Exchange Rate Exposure

• Our definition of exposure to exchange rate changes, $\frac{\partial MV}{\partial S}$, extends to a wide range of firms. Even “domestic firms” can be exposed to exchange rate risk.

• Consider a theme park in the U.S. that is staffed completely with American workers and financed completely in US$. A strong US$ could encourage American tourists to vacation abroad and discourage foreign tourists from visiting the U.S.
The Range of Firms Facing Exchange Rate Exposure

• Taking this point to the extreme, virtually any domestic business could be exposed to exchange rate risk through a financial channel.

• For example, a weak US$ (weakened from inflationary fears) may lead the Federal Reserve to raise interest rates. And higher interest rates, ceteris paribus, lower the market valuation of firms.
Economic Measures of Foreign Exchange Exposure

- Economic exposure captures the entire range of effects on the future cash flows of the firm, including the effects of exchange rate changes on customers, suppliers, and competitors.

- $\frac{\partial MVI}{\partial S}$ reflects economic exposure. Two approaches for measuring economic exposure are the regression approach and the scenario approach.
The Regression Approach

- The regression approach directly measures the exposure of a firm to exchange rate changes by estimating the relationship between the firm’s market value at time $t$ ($MV_t$) and the spot rate ($S_t$) using the equation:

$$MV_t = a + b \ S_t + e_t$$

- The coefficient $b$ measures the sensitivity of the market value of the firm to the exchange rate.
The Regression Approach

• To interpret the regression analysis, three results need to be examined:
  ① The magnitude of \( b \).
    - \( b > 0 \) ⇒ an asset exposure in the foreign currency
    - \( b < 0 \) ⇒ a liability exposure
    - \( b = 0 \) ⇒ no exposure to the exchange rate
  ② The \( t \)-statistic of \( b \).
    - Statistical significance is necessary for confidence in the results.
  ③ The \( R^2 \) of the regression.
    - \( R^2 \) measures the percentage of variation in the market value explained by the exchange rate.
Types of Regression Models

1 Explanatory Variable

- Simple
  - Linear
  - Non-Linear

2+ Explanatory Variables

- Multiple
  - Linear
  - Non-Linear
Model and Required Conditions

• We allow for $k$ independent variables to potentially be related to the dependent variable

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k + \varepsilon$$
- **Excel output**

This is the sample regression equation (sometimes called the prediction equation)

\[
\text{MARGIN} = 72.455 - 0.008\text{ROOMS} - 1.646\text{NEAREST} + 0.02\text{OFFICE} + 0.212\text{COLLEGE} - 0.413\text{INCOME} + 0.225\text{DISTTWN}
\]

Let us assess this equation
• **Standard error of estimate**
  
  - We need to estimate the standard error of estimate
  
  $s_{\varepsilon} = \sqrt{\frac{\text{SSE}}{n - k - 1}}$

  - Compare $s_{\varepsilon}$ to the mean value of $y$
    - From the printout, Standard Error = 5.5121
    - Calculating the mean value of $y$ we have $\bar{y} = 45.739$

  - It seems $s_{\varepsilon}$ is not particularly small.

  - Can we conclude the model does not fit the data well?
• Coefficient of determination
  - The definition is
    \[ R^2 = 1 - \frac{\text{SSE}}{\sum(y_i - \bar{y})^2} \]
  - From the printout, \( R^2 = 0.5251 \)
  - 52.51% of the variation in the measure of profitability is explained by the linear regression model formulated above.
  - When adjusted for degrees of freedom, Adjusted \( R^2 = 1 - \frac{\text{SSE}/(n-k-1)}{\text{SS(Total)/(n-1)}} \) = 49.44%
• Testing the validity of the model
  - We pose the question:
    Is there at least one independent variable linearly related to the dependent variable?
  - To answer the question we test the hypothesis
    \[ H_0: \beta_1 = \beta_2 = \ldots = \beta_k = 0 \]
    \[ H_1: \text{At least one } \beta_i \text{ is not equal to zero.} \]
  - If at least one \( \beta_i \) is not equal to zero, the model is valid.
• To test these hypotheses we perform an analysis of variance procedure.

• The F test
  - Construct the F statistic
  \[ F = \frac{MSR}{MSE} \]

  \([\text{Variation in } y] = \text{SSR} + \text{SSE. Large } F \text{ results from a large SSR. Then, much of the variation in } y \text{ is explained by the regression model. The null hypothesis should be rejected; thus, the model is valid.}\]

  - Rejection region
  \[ F > F_{\alpha,k,n-k-1} \]

  Required conditions must be satisfied.
Example - continued

- **Excel provides the following ANOVA results**

<table>
<thead>
<tr>
<th>ANOVA</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>Significance F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regressor</td>
<td>6</td>
<td>3123.832</td>
<td>520.6387</td>
<td>17.13581</td>
<td>3.03382E-13</td>
</tr>
<tr>
<td>Residual</td>
<td>93</td>
<td>2825.626</td>
<td>30.38307</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>99</td>
<td>5949.458</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**SS**, **MS**, **SSR**, **MSE**, **MSR**, **SSE**, **MSR/MSE**
Example – continued

• Excel provides the following ANOVA results

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<td>99</td>
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</tr>
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</table>

\[ F_{\alpha, k, n-k-1} = F_{0.05, 6, 100-6-1} = 2.17, \quad F = 17.14 > 2.17 \]  
Also, the p-value (Significance F) = 3.03382(10)^{-13}  
Clearly, \( \alpha = 0.05 > 3.03382(10)^{-13} \), and the null hypothesis is rejected.  

The p-statistic \( \text{(Significance F)} \) answers this question: How likely is it that we would get an estimate of the regression coefficient at least this large (either positive or negative) if, in fact, the true value of the regression coefficient were zero (all the true regression coefficients were zero)?

**Conclusion:** There is sufficient evidence to reject the null hypothesis in favor of the alternative hypothesis.  
At least one of the \( \beta_i \) is not equal to zero. Thus, at least one independent variable is linearly related to \( y \).  

This linear regression model is valid.


• **Testing the coefficients**

  ‧ The hypothesis for each $\beta_i$

  \[
  H_0: \beta_i = 0 \\
  H_1: \beta_i \neq 0
  \]

  Test statistic

  \[
  t = \frac{b_i - \beta_i}{s_{b_i}}
  \]

  d.f. = n - k - 1

  ‧ Excel printout

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Coefficient Standard Error</th>
<th>t Stat</th>
<th>P-value</th>
<th>Lower 95%</th>
<th>Upper 95%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>72.45461</td>
<td>7.893104</td>
<td>9.179483</td>
<td>1.11E-14</td>
<td>56.78048735</td>
</tr>
<tr>
<td>ROOMS</td>
<td>-0.00762</td>
<td>0.001255</td>
<td>-6.06871</td>
<td>2.77E-08</td>
<td>-0.010110582</td>
</tr>
<tr>
<td>NEAREST</td>
<td>-1.64624</td>
<td>0.632837</td>
<td>-2.60136</td>
<td>0.010803</td>
<td>-2.902924523</td>
</tr>
<tr>
<td>OFFICE</td>
<td>0.019766</td>
<td>0.00341</td>
<td>5.795594</td>
<td>9.24E-08</td>
<td>0.012993085</td>
</tr>
<tr>
<td>COLLEGE</td>
<td>0.211783</td>
<td>0.133428</td>
<td>1.587246</td>
<td>0.115851</td>
<td>-0.053178229</td>
</tr>
<tr>
<td>INCOME</td>
<td>-0.41312</td>
<td>0.139552</td>
<td>-2.96034</td>
<td>0.003899</td>
<td>-0.690245235</td>
</tr>
<tr>
<td>DISTTWN</td>
<td>0.225258</td>
<td>0.178709</td>
<td>1.260475</td>
<td>0.210651</td>
<td>-0.12962198</td>
</tr>
</tbody>
</table>

Econometrics Reference: Jeffrey M. Wooldridge’s *Introductory Econometrics: A Modern Approach*
The Regression Approach

- To measure the firm’s exposure to multiple exchange rates, a multiple regression can be estimated:

\[ MV_t = a + b_1 S_{$/\varepsilon, t} + b_2 S_{$/\text{\pounds}, t} + b_3 S_{$/¥, t} + e_t \]

- If the firm has data on cash flows at the level of a subsidiary or project, the exposure of these smaller units can also be measured:

\[ CF_t = a + b S_t + e_t \]
The Regression Approach

- Note that exposure tends to be lower in the long run due to PPP (which tends to hold better in the longer run) and the ability of firms to make adjustments in response to exchange rate changes.
The Scenario Approach to Estimating Exchange Rate Exposure

• A scenario is a detailed set of assumptions concerning how the firm (and its suppliers, customers, and competitors) will respond conditionally on a change in the path of an exchange rate.

• Given a scenario, we can estimate the firm’s cash flows (and its market value) conditional on an exchange rate path.
The Scenario Approach to Estimating Exchange Rate Exposure

• The scenario approach is well suited to a spreadsheet analysis where one is encouraged to ask a variety of “what-if” questions.

• The spreadsheet software then allows the user to estimate the value of the firm based on a particular scenario and conditional on an exchange rate path.
The Scenario Approach to Estimating Exchange Rate Exposure

An Example

A U.S. firm manufactures kitchen food processors.
Half of products - sold in U.S.; rest - exported to Australia.
All fixed costs + 80% variable costs - incurred in U.S.;
rest - parts imported from Canada and Australia.
Sold 100,000 units in U.S. at an average of $150/unit.
Sold 100,000 units in Australia at an average of
A$240/unit; average exchange rate - $0.6250/A$.
The firm expects 5% growth in sales per year; with price
increases averaging 4% in U.S. and 9% in Australia in line with inflation.
Assume that $/A$ follows PPP, so exchange rate should
depreciate by about 5% (approximately, US$ is expected to appreciate at about 5% a year).
Discount rate used to value future cash flows = 17.5%.
The Usefulness of Parity Conditions in International Financial Markets

1a. Purchasing Power Parity

Absolute Version

The price of a market basket of U.S. goods equals the price of a market basket of foreign goods when multiplied by the exchange rate.

\[ P_{US}(\text{US$}) = P_{Aussie}(\text{A$}) \times \text{Spot} \left( \frac{\text{US$}}{\text{A$}} \right) \]

Driven by arbitrage in goods.
The Usefulness of Parity Conditions in International Financial Markets

1b. Purchasing Power Parity

Relative Version

The percentage change in the exchange rate equals the percentage change in U.S. goods prices less the percentage change in foreign goods prices.

\[ \Delta \text{Spot} = \Delta P_{\text{US}} - \Delta P_{\text{Aussie}} \]

Driven by arbitrage in goods.
The Scenario Approach to Estimating Exchange Rate Exposure

The present value of future operating cash flows is $39.577 million.

The assumptions made establish the base case scenario.

Figure 16.2
The Scenario Approach to Estimating Exchange Rate Exposure

• To examine how the value of the firm is affected by an exchange rate change, consider the impact of a permanent 5% appreciation of the US$, holding all other factors constant.

• To implement this change, divide the period zero exchange rate $/A$ by 1.05. Divide $/A$ exchange rate by (1+5%) to show a (roughly) 5% appreciation of the US$.

The present value of cash flows falls to $35.222 million, reflecting the fact that Australian sales now equate to fewer US$ revenues, although the cost of imported inputs has also declined somewhat.
The Scenario Approach to Estimating Exchange Rate Exposure

• The solid curve in Figure 16.2 traces the present value of the firm’s cash flows under the base case scenario (A) and different assumptions about the $/A$ exchange rate.

• The curvature of the solid line ($AOA^*$) immediately indicates the presence of exchange rate exposure, since the present value of future cash flows varies along with the exchange rate under scenario A.

• To estimate the exposure of the firm, we rely on the definition of exposure, $\partial MV / \partial S$, replacing $MV$ with the present value of cash flows. The slope of the solid line ($AOA^*$) thus measures the exposure of the firm at the initial exchange rate.
The Scenario Approach to Estimating Exchange Rate Exposure

• In our base case scenario (A), the firm suffers a decline in value as the US$ strengthens against the A$.

• Now, consider a new scenario (B) where the firm is able to increase the A$ price of its food processors by 0.5% for every 1.0% decrease in the value of A$. Suppose further that the firm suffers no decline in sales volume following the decision to pass-through 50% of the exchange rate change into the local sales price.

• Naturally, the firm is better off now that the Aussie customer bears some of the cost of the weak A$. We see this improvement in Figure 16.3 with the locus of cash flows marked BO.
The Scenario Approach to Estimating Exchange Rate Exposure

Figure 16.3

Present Value of Cash Flows (Millions)

$/A$ $0.5435$ $0.5682$ $0.5952$ $0.6250$ $0.6563$ $0.6875$ $0.7188$

The Scenario Approach
to Estimating Exchange Rate Exposure

• How will the firm respond if the US$ weakens from the initial $0.625 rate? The firm will like to keep its unit prices in Australia at the original A$240 level. If it succeeds, the line BOA* traces the present value of cash flows. But as the US$ devalues, the firm may come under pressure to reduce its A$ prices (Law of One Price).

• If the firm cannot maintain its A$240/unit price, it must pass through to consumers some of the benefits of a stronger A$, thus lowering the firm’s value relative to the base case.

• Under scenario B with a 50% pass-through of both stronger and weaker exchange rates, the value of the firm is traced by the curve BOB*.
The Scenario Approach
to Estimating Exchange Rate Exposure

• Notice that the slope of $BOB^*$ is flatter than $AOA^*$ in the base case. This indicates that the firm has less exposure under scenario B than in scenario A. Under scenario B, we assumed that the firm can pass along part of the exchange rate change to Aussie customers, who now bear part of the exposure to exchange rate risk.

• Imagine another scenario (C) where all of the exchange rate change was passed along to the final customers, and the volume of sales is unaffected. If this were the case, then the value of the firm would flatten out still further as indicated in Figure 16.4 with curve $COC^*$. 
The Scenario Approach to Estimating Exchange Rate Exposure

Figure 16.4

Present Value of Cash Flows (Millions)

$/A$ $0.5435$ $0.5682$ $0.5952$ $0.6250$ $0.6563$ $0.6875$ $0.7188$

A$/A$ $A$ $A$ $A$ $A$ $A$ $A$ $A$

$A$/A$ $1.84$ $1.76$ $1.68$ $1.60$ $1.5238$ $1.4545$ $1.3913$

Figure 16.4
The Scenario Approach to Estimating Exchange Rate Exposure

- Under scenario C, the firm bears little exposure to exchange risk. With full exchange-rate pass-through, the firm is effectively using its domestic currency as the invoice currency for its product. The firm sets a price of $150/unit and the Australian price is determined by taking $150 times the A$/S$ exchange rate.

- These scenarios show that the ability to pass-through adverse exchange rate movements onto local prices provides a *natural hedge*. In other words, a reduction in variability of cash flows that comes from the “normal way” the firm does business.
The Scenario Approach to Estimating Exchange Rate Exposure

- If the firm can segment its market, and charge higher prices when the US$ weakens but pass-through exchange rate changes when the US$ strengthens, its value curve develops a “kinked” shape (COA* curve in Figure 16.4) resembling that of an option contract.
The Building Blocks of Contingent Decisions

(a) Purchase of Right to Buy at a Fixed Price

(b) Purchase of Right to Sell at a Fixed Price

Option Payoff

Value of Underlying Asset at Decision Date

(c) Sell Right to Buy at a Fixed Price

(d) Sell Right to Sell at a Fixed Price

$0

Real Options: Amram & Kulatilaka  Figure 4.1
Theory and Practice of International Financial Management

Foreign Direct Investment
International Capital Flows

Having developed a basic understanding of why capital flows between countries, notice that these flows can take three main forms:

Portfolio Investment (PI) - ownership of corporate stocks, bonds, government bonds, and other bonds.

Intermediated Investment (II) - short and long-term bank lending and deposit-taking activity.

Foreign Direct Investment - investment obtaining ownership of greater than 10% of voting shares in a foreign firm.

Why FDI? Why do we need multinationals?
1. FDI has grown rapidly since W.W.II and especially in the last 15 years. FDI stock, by host country, $bn:
2. Developing countries account for an increasing share of inflows:

- in 1995 developing countries received a record $100 of $315 billion in inflows.

- excluding intra-European flows, developing countries received 60% of all flows in 1995 - up from 17% in 1989.

3. Most FDI flows (97%) originate in developed countries.

4. Much two-way FDI flows (‘cross-hauling’) takes place between pairs of developed countries - even at industry level.
Empirical Facts (cont’d)

5. Most FDI production is sold in recipient country.

6. Degree of FDI varies widely across and within industry. (examples Pepsi vs. Coke and Banks vs. Food).

7. Multinationals tend to have:
   - high levels of R&D
   - large share of professional and technical workers
   - products that are new or technically complex
   - high levels of advertising and product differentiation.
   - high values of intangible assets vs. market value.
Empirical Facts (cont’d)

8. Most of US corporations’ international exposure is through FDI - not exports:
   - In-country sales of US foreign affiliates were $1.8 trillion in 1995 vs $576 billion in exports.
   - US foreign affiliates exported more than the US domestic operations in 1995: $580 vs. $576.

9. 80% of US FDI is via M&A - not greenfield investment.

10. US FDI:
    1. Europe - 50%
    2. Latin America - 18.1%
    3. Canada - 11.5%
    4. Japan, Australia, NZ - 9.3%
    5. Rest of Asia - 9%
## Emerging Market FDI: Top Recipients

<table>
<thead>
<tr>
<th>Year</th>
<th>Country</th>
<th>Year</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2. South Africa</td>
<td></td>
<td>2. Mexico</td>
</tr>
<tr>
<td></td>
<td>3. Indonesia</td>
<td></td>
<td>3. Singapore</td>
</tr>
<tr>
<td></td>
<td>4. Mexico</td>
<td></td>
<td>4. Indonesia</td>
</tr>
<tr>
<td></td>
<td>5. Singapore</td>
<td></td>
<td>5. Brazil</td>
</tr>
<tr>
<td></td>
<td>6. Argentina</td>
<td></td>
<td>6. Malaysia</td>
</tr>
<tr>
<td></td>
<td>7. Malaysia</td>
<td></td>
<td>7. Argentina</td>
</tr>
<tr>
<td></td>
<td>8. Greece</td>
<td></td>
<td>8. Hong Kong</td>
</tr>
<tr>
<td></td>
<td>9. Taiwan</td>
<td></td>
<td>9. Greece</td>
</tr>
<tr>
<td></td>
<td>10. Venezuela</td>
<td></td>
<td>10. Thailand</td>
</tr>
</tbody>
</table>
Three Questions:

1. What explains locational patterns of FDI? Why do some countries tend to be host countries and some source countries?

2. Why is FDI undertaken instead of portfolio investment (PI) or intermediated investment (II)? What ‘overcompensating’ ownership advantage do foreigners have over domestic investors?

3. Why does cross-hauling exist? Why do some countries invest directly in each other?
What Explains Locational Patterns of FDI?

What are some reasons certain countries are chosen over others as targets for multinational investment?

1. Labor costs
2. Access to resources
3. Government policies
4. Expanding markets
5. Currency values
6. Tax advantages
7. Investment climates
Why FDI over Portfolio or Intermediated Investment?

For FDI to be considered, the foreign investor must view:

\[ r^*_{FDI} > r^*_{PI,II} \]

From the perspective of the host country, it must be the case that:

\[ r^*_{FDI} > r^*_{local investment} \]

But these inequalities are the same, since local investors will equate:

\[ r^*_{PI,II} = r^*_{local investment} \]
What Makes the Return on FDI greater than those from Portfolio or Intermediated Investment?

In other words, how do foreign corporations outperform domestic ones on the latter’s home turf?

Especially considering the foreign firm must incur additional costs of travel, communication, and monitoring...

...and the foreign firm must contend with unfamiliar legal, distributing, and accounting systems.

Thus, an understanding of FDI must identify what ‘overcompensating advantage’ a foreign firm has over domestic competition, making returns to FDI greater than those to Portfolio or Intermediated Investment.
In 1996, Samsung, and many other companies in South Korea, Hong Kong, Singapore, Taiwan, and Thailand, were faced with ‘going multinational in order to survive’.

For many firms of the ‘Asian Tigers’, domestic labor costs have become too high to make low-tech manufacturing economical.

They look to outsource production or product assembly in lower-cost countries.

Example: Samsung of South Korea
Example: Samsung of South Korea

Samsung pays its average worker in Seoul $12.70/hour.

Similar work could be performed in Malaysia for $2/hour and in China for $.85/hour.

In outsourcing production to Malaysia, Samsung must become a multinational - and invest directly in Malaysian production facilities.

Why?
As a multinational, Samsung feels it can more efficiently:

1. invest directly in Malaysia
2. raise needed capital in Hong Kong
3. safely transfer patented technology to foreign affiliates
4. efficiently ship parts between assembly plants
5. sell products throughout region

Example: Samsung of South Korea
Firm-specific advantages include:

1. Proprietary technology and patent protection
2. Proprietary information
3. Production secrets
4. Superior management organization
5. Brand-name recognition or trademark protection
6. Marketing skills
...

Major Theories of FDI:
1. Technological Advantages
2. Product Cycle Theory

Product development is characterized by different stages:

Stage 1: Production in industrialized countries
- feedback from customers
- skilled labor
- high demand (for new product) covers high labor costs.

Stage 2: Production in developing countries for export
- Product faces more competitors, tougher price competition.
- Production has become standardized; production can move to markets with plentiful, cheap unskilled labor for export.

...
3. Oligopoly Models

Firms gain benefits from being sufficiently large to operate multinationally:

A. Firms ‘think internationally’ when designing new products in order to capture economies of scale (i.e. absorb high R&D expenditures).

B. Local production improves foreign market penetration beyond that achieved through exporting.

C. Local production to obtain knowledge-transfers from competitors.

...
4. Internalization Theory

Based on theory of firm developed by Ronald Coase.

Firms integrate across borders when use of market is costly and inefficient for certain transactions:

- Enforceability of contracts
- Taxes paid on market transactions
- Difficulty defining prices
- Default risks associated with contracts.

Of course, internalization is costly as well.

...
5. Imperfections in Securities Markets

When organized markets for equity and debt are illiquid or non-existent, FDI is a substitute for PI.

FDI obtains otherwise inaccessible high returns in markets with no organized securities markets.

FDI offers some (albeit weak) direct diversification benefits.

...
6. Exchange Risk Theory

Investors are risk-averse.

As a result, they do not entirely arbitrage real returns across countries via portfolio and intermediated investment.

With FDI, management can structure operations (i.e. via multiple sourcing) to reduce currency risks below those of PI and II.

Other option-type benefits exist with respect to interest rate and labor cost fluctuations.

...
1. FDI flows are growing at tremendous rate - especially those directed towards emerging markets.

2. For investors to consider an overseas project (FDI), there must exist some ‘overcompensating advantage’ so that:
   - returns are higher than those obtained by local competition
   - returns from FDI exceed those of Portfolio or Intermediated Investment

   in order to compensate for costs of doing business trans-nationally.

3. A number of theories of FDI identify sources of these ‘overcompensating advantages.’
Sovereign Wealth Funds

A sovereign wealth fund (SWF) is a state-owned investment fund composed of financial assets such as stocks, bonds, property or other financial instruments. Sovereign wealth funds have gained world-wide exposure by investing in several Wall Street financial firms including Citigroup, Morgan Stanley, and Merrill Lynch. These firms needed a cash infusion due to losses resulting from the credit crunch. Some sovereign wealth funds are held solely by central banks, who accumulate the funds in the course of their fiscal management of a nation's banking system; this type of fund is usually of major economic and fiscal importance. Other sovereign wealth funds are simply the state savings which are invested by various entities for the purposes of investment return, and which may not have significant role in fiscal management.
Sovereign Wealth Funds

Nature and purpose

SWFs are typically created when governments have budgetary surpluses and have little or no international debt. This excess liquidity is not always possible or desirable to hold as money or to channel it into consumption immediately. This is especially the case when a nation depends on raw material exports like oil, copper or diamonds. To reduce the volatility of government revenues, counter the boom-bust cycles' adverse effect on government spending and the national economy or build up savings for future generations, SWFs may be created. One example of such a fund is The Government Pension Fund of Norway.
Sovereign Wealth Funds

Nature and purpose

Other reasons for creating SWFs may be economical, or strategic, such as war chests for uncertain times. For example, the Kuwait Investment Authority during the Gulf war managed excess reserves above the level needed for currency reserves (although many central banks do that now). The Government of Singapore Investment Corporation and Temasek Holdings are partially the expression of a desire to bolster Singapore's standing as an international financial centre. The Korea Investment Corporation has since been similarly managed.
# Sovereign Wealth Funds

<table>
<thead>
<tr>
<th>Country</th>
<th>Abbreviation</th>
<th>Fund</th>
<th>Assets $Billion</th>
<th>Inception</th>
<th>Origin</th>
<th>Approx wealth per citizen</th>
</tr>
</thead>
<tbody>
<tr>
<td>United Arab (Emirate)</td>
<td>ADIA</td>
<td>Abu Dhabi Investment</td>
<td>$875</td>
<td>1976</td>
<td>Oil</td>
<td>$1,000,000</td>
</tr>
<tr>
<td>Kuwait</td>
<td>KIA</td>
<td>Kuwait Investment Authority</td>
<td>$264.4 [8]</td>
<td>1953</td>
<td>Oil</td>
<td>$80,000</td>
</tr>
<tr>
<td>Qatar</td>
<td>QIA</td>
<td>Qatar Investment Authority</td>
<td>$60[11]</td>
<td>2005</td>
<td>Oil</td>
<td>$250,000</td>
</tr>
<tr>
<td>United States (Alaska)</td>
<td>APFC</td>
<td>Alaska Permanent Fund</td>
<td>$40.1</td>
<td>1976</td>
<td>Oil</td>
<td>$61,000</td>
</tr>
</tbody>
</table>
## Sovereign Wealth Funds

<table>
<thead>
<tr>
<th>Region</th>
<th>Agency</th>
<th>Fund Name</th>
<th>Size (US$)</th>
<th>Year</th>
<th>Industry</th>
<th>Total Value (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Libya</td>
<td>Libyan Investment Authority</td>
<td>$50</td>
<td>2007</td>
<td>Oil</td>
<td>$7,200</td>
<td></td>
</tr>
<tr>
<td>Russia</td>
<td>RNWF</td>
<td>Russian National Wealth Fund</td>
<td>$32.85 [12]</td>
<td>2008</td>
<td>Oil</td>
<td>n/a</td>
</tr>
<tr>
<td>Brunei</td>
<td>BIA</td>
<td>Brunei Investment Agency</td>
<td>$30</td>
<td>1983</td>
<td>Oil</td>
<td>$90,100</td>
</tr>
<tr>
<td>South Korea</td>
<td>KIC</td>
<td>Korea Investment Corporation</td>
<td>$30</td>
<td>2005</td>
<td>Non-commodity</td>
<td>$417</td>
</tr>
<tr>
<td>Malaysia</td>
<td>KN</td>
<td>Khazanah Nasional</td>
<td>$18.3</td>
<td>1993</td>
<td>Non-commodity</td>
<td>$658</td>
</tr>
<tr>
<td>Kazakhstan</td>
<td>KNF</td>
<td>Kazakhstan National Fund</td>
<td>$23.0</td>
<td>2000</td>
<td>Oil</td>
<td>$1170</td>
</tr>
<tr>
<td>China</td>
<td>SAFE</td>
<td>State Administration of Foreign Exchange</td>
<td>n/a</td>
<td>n/a</td>
<td>Non-commodity</td>
<td>n/a</td>
</tr>
<tr>
<td>Taiwan</td>
<td>NSF</td>
<td>National Stabilisation Fund</td>
<td>$15</td>
<td>2000</td>
<td>Non-commodity</td>
<td>$652</td>
</tr>
<tr>
<td>Canada (Alberta)</td>
<td>AHF</td>
<td>Alberta Heritage Fund</td>
<td>$16.6</td>
<td>1976</td>
<td>Oil &amp; Gas</td>
<td>$5000</td>
</tr>
<tr>
<td>Iran</td>
<td>OSF</td>
<td>Oil Stabilisation Fund</td>
<td>$12.9</td>
<td>1999</td>
<td>Oil</td>
<td>$174</td>
</tr>
<tr>
<td>United Arab Emirates (Dubai Emirate)</td>
<td>Istithmar</td>
<td>n/a</td>
<td>2003</td>
<td>Oil</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>Saudi Arabia Sovereign Wealth Fund</td>
<td>$5.2[^13]</td>
<td>2008</td>
<td>Oil</td>
<td>n/a</td>
<td></td>
</tr>
</tbody>
</table>
Sovereign Wealth Funds

What is "Sony" worth as a whole as of July 2, 2007?

Market Value: Sony's market cap is hovering around $40 billion according to Morningstar's website. That number is derived from Sony's $40/share price x its 1 billion outstanding shares.

Book Value: You can determine Sony's book value by going to its website, downloading its financial statements, and then subtracting total liabilities from total assets in the balance sheet section.
The Value at Risk (VAR) Approach

- The VAR approach is a relatively new approach for measuring the exposure of financial assets.
- It can be applied to any portfolio of assets (and liabilities) whose market values are available on a periodic basis and whose price volatilities ($\sigma$) can be estimated.
- Assuming normal price distributions, calculate the loss in value of the portfolio if an unlikely (say, 5% chance) adverse price movement occurs. The result of this calculation is the value at risk.
Dennis Weatherstone, former chairman of J. P. Morgan, is an example of a senior manager who felt that **a single measure of the overall risk** should be calculated. He demanded that a one-page report be delivered to him after the close of business each day, summarizing the company’s global exposure and providing an estimate of potential losses over the next 24 hours.

The result was J. P. Morgan’s famous “4.15 Report” (so-called because it was delivered to Weatherstone at 4:15 P.M. each day) and the beginning of an amazingly successful risk management tool known as value at risk.
The Worst Case Scenario

A VaR calculation is aimed at making a statement of the following form: “We are $X$ percent certain that we will not lose more than $V$ dollars in the next $N$ days.”

One attractive feature of VaR is that it is easy to understand. In essence, it asks the simple question “How bad can things get?”

The variable $V$ is the VaR of the portfolio. It is a function of two parameters: $N$, the time horizon, and $X$, the confidence level.

In calculating a bank’s capital, regulators use $N = 10$ and $X = 99$. They are therefore considering losses over a 10-day period that are expected to happen only 1 percent of the time.
Time Horizon

• Instead of calculating the 10-day, 99% VaR directly, analysts usually calculate a 1-day 99% VaR and assume

\[ 10\text{-day VaR} = \sqrt{10} \times 1\text{-day VaR} \]

• This is exactly true when portfolio changes on successive days come from independent identically distributed normal distributions.
The Model-Building Approach

• The main alternative to historical simulation is to make assumptions about the probability distributions of return on the market variables and calculate the probability distribution of the change in the value of the portfolio analytically.

• This is known as the model building approach or the variance-covariance approach.

\[ \sigma_p^2 = \sum_{i=1}^{n} \sum_{j=1}^{n} w_i w_j \sigma_i \sigma_j \rho_{ij} \quad (16.13) \]
Daily Volatilities

• In option pricing we measure volatility “per year”
• In VaR calculations we measure volatility “per day”

\[ \sigma_{\text{day}} = \frac{\sigma_{\text{year}}}{\sqrt{252}} \]
Daily Volatility continued

• Strictly speaking we should define $\sigma_{\text{day}}$ as the standard deviation of the continuously compounded return in one day

• In practice we assume that it is the standard deviation of the percentage change in one day
Microsoft Example (page 440 of Hull)

• We have a position worth $10 million in Microsoft shares
• The volatility of Microsoft is 2% per day (about 32% per year, or 2% x SQRT of 252)
• We use $N=10$ and $X=99$
Microsoft Example (page 440)

• We have a position worth $10 million in Microsoft shares
• The volatility of Microsoft is 2% per day (about 32% per year)
• We use $N=10$ and $X=99$
Microsoft Example continued

• The standard deviation of the change in the portfolio in 1 day is $200,000
• The standard deviation of the change in 10 days is

\[200,000 \sqrt{10} = $632,456\]
Microsoft Example continued

- We assume that the expected change in the value of the portfolio is zero (This is OK for short time periods)
- We assume that the change in the value of the portfolio is normally distributed
- Since $N(-2.33)=0.01$, the VaR is

$$2.33 \times 632,456 = \$1,473,621$$
AT&T Example (page 441 of Hull)

- Consider a position of $5 million in AT&T
- The daily volatility of AT&T is 1% (approx 16% per year, or 1% x SQRT of 252)
- The S.D. per 10 days is \( 50,000 \sqrt{10} = 158,144 \)
- The VaR is

\[
158,114 \times 2.33 = 368,405
\]
Portfolio

• Now consider a portfolio consisting of both Microsoft and AT&T
• Suppose that the correlation between the returns is 0.3
S.D. of Portfolio

• A standard result in statistics states that

\[
\sigma_{X+Y} = \sqrt{\sigma_X^2 + \sigma_Y^2 + 2\rho \sigma_X \sigma_Y}
\]

• In this case \( \sigma_X = 200,000 \) and \( \sigma_Y = 50,000 \) and \( \rho = 0.3 \). The standard deviation of the change in the portfolio value in one day is therefore 220,227
VaR for Portfolio

• The 10-day 99% VaR for the portfolio is
  \[ 220,227 \times \sqrt{10} \times 2.33 = \$1,622,657 \]

• The benefits of diversification are
  \[ (1,473,621+368,405)–1,622,657=$219,369 \]

• What is the incremental effect of the AT&T holding on VaR?
The Linear Model

We assume

• The daily change in the value of a portfolio is linearly related to the daily returns from market variables

• The returns from the market variables are normally distributed
The General Linear Model continued (equations 18.1 and 18.2 of Hull)

\[ \Delta P = \sum_{i=1}^{n} \alpha_i \Delta x_i \]

\[ \sigma_p^2 = \sum_{i=1}^{n} \sum_{j=1}^{n} \alpha_i \alpha_j \sigma_i \sigma_j \rho_{ij} \]

\[ \sigma_p^2 = \sum_{i=1}^{n} \alpha_i^2 \sigma_i^2 + 2 \sum_{i<j} \alpha_i \alpha_j \sigma_i \sigma_j \rho_{ij} \]

where \( \sigma_i \) is the volatility of variable \( i \)
and \( \sigma_p \) is the portfolio's standard deviation.
Handling Interest Rates: Cash Flow Mapping

• We choose as market variables bond prices with standard maturities (1mth, 3mth, 6mth, 1yr, 2yr, 5yr, 7yr, 10yr, 30yr)
• Suppose that the 5yr rate is 6% and the 7yr rate is 7% and we will receive a cash flow of $10,000 in 6.5 years.
• The volatilities per day of the 5yr and 7yr bonds are 0.50% and 0.58% respectively
Consider a portfolio with one asset valued at $6,500,000 -- namely a DM10 million position with the spot rate at $0.65/DM.

Suppose that the historical data suggesting that exchange rate volatility is $\sigma_{DM} = 6.0$ percent per month and price changes are normally distributed.

For the normal distribution, a 90 percent confidence band includes the range $(\mu - 1.65 \sigma_{DM}, \mu + 1.65 \sigma_{DM})$. With 90 percent confidence, we can say that the value of our position at the end of one month will be in the range $(6,500,000 - 1.65 \times 6\% \times 6,500,000; 6,500,000 + 1.65 \times 6\% \times 6,500,000)$, or $(5,856,500; 7,143,500)$. 

Levich 1E Chapter 16

Measuring and Managing the Risk in International Financial Positions -- The Value at Risk Approach (pp. 596-599 for 1E; pp. 633-636 for 2E)
Thus, there is a 5 percent chance that we will lose at least $1.65 \times 6\% \times \text{DM}10,000,000 \times \$0.65/\text{DM}$ or $643,500$ over the next month.

Cumulative Normal Distribution
<table>
<thead>
<tr>
<th>Currency</th>
<th>Position (US$ equivalent)</th>
<th>Weight (%)</th>
<th>Volatility (%)</th>
<th>Amount at Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canadian dollar</td>
<td>$ 60,000</td>
<td>60.0%</td>
<td>1.2</td>
<td>1188</td>
</tr>
<tr>
<td>French frank</td>
<td>-20,000</td>
<td>-20.0</td>
<td>3.2</td>
<td>1056</td>
</tr>
<tr>
<td>Deutsche mark</td>
<td>25,000</td>
<td>25.0</td>
<td>3.2</td>
<td>1320</td>
</tr>
<tr>
<td>Japanese yen</td>
<td>25,000</td>
<td>25.0</td>
<td>3.2</td>
<td>1320</td>
</tr>
<tr>
<td>Swiss frank</td>
<td>10,000</td>
<td>10.0</td>
<td>3.5</td>
<td>577.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$100,000</strong></td>
<td><strong>100.0%</strong></td>
<td><strong>Gross Var-&gt; 5461.5</strong></td>
<td></td>
</tr>
</tbody>
</table>
To measure *gross values at risk*, multiply the absolute amount of the position in each currency times $1.65\sigma$, and add the results across all currencies.

Using $1.65\sigma$ yields a 95 percent (one-tailed) measure of the value of risk; that is, in 5 out of any 100 months, our portfolio is predicted to decline in value by as much as (or more) than the gross VAR.

Note that gross VAR is a conservative measure of exposure. Gross VAR measures the impact of an adverse $1.65\sigma$ move in all exchange rates, at once, against the US$.

Note that in our example, “adverse” means a $1.65\sigma$ depreciation of the DM versus the US$ and a $1.65\sigma$ appreciation of the FFr versus the US$. However, this combination is unlikely as long as the FFr and DM are linked to each other.
Net VAR takes account of two types of portfolio diversification effects: the impact of short and long positions, and the impact of imperfect correlation among financial price changes.

Net VAR is measured using the volatility of the portfolio \( \sigma_p \) instead of the volatility of each individual asset or liability. The formula for the volatility of portfolio returns is:

\[
\sigma_p^2 = \sum_{i=1}^{n} \sum_{j=1}^{n} w_i w_j \sigma_i \sigma_j \rho_{ij} \quad (16.13)
\]

where \( w \) is the % weight of each asset in the portfolio, \( \sigma \) is the volatility of each asset in the portfolio, and \( \rho_{ij} \) is the correlation of price changes across assets \( i \) and \( j \).

It should be clear the \( \rho_{ij} \) constitutes another set of parameters that must be estimated, and that there are many ways to calculate the correlation of exchange rate changes using the monthly data from 1990-1996 we developed earlier.
Currency and Correlation ($\rho$) of price changes: 1990-1996

<table>
<thead>
<tr>
<th></th>
<th>C$</th>
<th>FFr</th>
<th>DM</th>
<th>JY</th>
<th>SFr</th>
</tr>
</thead>
<tbody>
<tr>
<td>C$</td>
<td>1</td>
<td>-0.05</td>
<td>-0.03</td>
<td>-0.13</td>
<td>-0.04</td>
</tr>
<tr>
<td>FFr</td>
<td>1</td>
<td>0.98</td>
<td>0.48</td>
<td>0.93</td>
<td></td>
</tr>
<tr>
<td>DM</td>
<td>1</td>
<td>0.52</td>
<td>0.94</td>
<td></td>
<td></td>
</tr>
<tr>
<td>JY</td>
<td>1</td>
<td>0.54</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SFr</td>
<td></td>
<td></td>
<td></td>
<td>0.54</td>
<td>1</td>
</tr>
</tbody>
</table>

The table shows only a weak correlation between the C$ and the other currencies in the portfolio.

On the other hand, the correlation between the FFr and DM is nearly perfect.
Using equation (16.13), the estimated portfolio variance is 0.0001755; the square root of this number is $\sigma_p = 0.0132476$, or about 1.3%.

A 95 percent net VAR calculation for the portfolio is computed by multiplying the portfolio’s size ($100,000) times $\sigma_p$ times 1.65 or $2,185.85.

Note that the net VAR is smaller than the gross VAR. This relationship will always be the case because of the portfolio effects.

In our example, net VAR is only 40 percent as large as gross VAR, primarily because the FFr and DM are highly correlated and the portfolio holds nearly equal and offsetting positions in these two currencies.
Many companies and consulting firms are in the business of providing ready-made and continuously updated estimates of $\sigma$ and $\rho$ for many financial assets.

For example, J. P. Morgan supplies both daily and monthly volatility and correlation estimates on more than 420 financial series, including foreign exchange, government bonds, swap and equity markets.

http://www.riskmetrics.com
Stress Testing

- This involves testing how well a portfolio performs under some of the most extreme market moves seen in the last 10 to 20 years
Back-Testing

- Tests how well VaR estimates would have performed in the past
- We could ask the question: How often was the actual 10-day loss greater than the 99%/10 day VaR?
Principal Components Analysis for Interest Rates (Tables 18.3 and 18.4 on page 451 of Hull, and Exhibit 22-4 on page 524 of Fabozzi)

- The first factor is a roughly parallel shift (83.1% of variation explained)
- The second factor is a twist (10% of variation explained)
- The third factor is a bowing (2.8% of variation explained)
Solved Questions

Question 6. Describe how the regression approach is used for measuring a firm’s foreign exchange exposure.

Answer: Economic exposure measures the sensitivity of the firm's value to a change in the exchange rate. This has the same interpretation as a regression coefficient in a regression of the firm's value \( (V) \) against an exchange rate \( (S) \).
Question 7. Explain the limitations of the regression method for measuring a firm’s foreign exchange exposure.

Answer: The regression method depends on a stable relationship between V and S and sufficient historical data to accurately estimate the value of the regression coefficient. To be meaningful, this regression should produce a significant $R^2$, otherwise there is no economic exposure when $R^2=0$. The relationship between V and S must be stable in the future to use as a management tool.
Solved Questions

Question 8. What are the advantages of the scenario approach for measuring a firm’s foreign exchange exposure?

Answer: The scenario approach may allow managers to use specific information about the expected reactions of domestic financial markets, customers, suppliers, and competitors when there is an exchange rate change. Managers may not have enough historical experience or confidence about stability to use the regression approach. However, the managers own planning models may contain information for calculating economic exposure.