Reading Assignments

Levich Chap 16 Pages
Luenberger Chap Pages
Krugman & Obstfeld Chap Pages
Shapiro Chap Pages
Mankiw 5e Chap 5 Open Economy
http://www.bfwpub.com/pdfs/mankiw/0716752379_05.pdf

Homework Policy

Homeworks are due in class on the Friday of the week after the book chapter has been covered. You will have the opportunity to ask questions in class as well as during the problem session.

For example, if a chapter is completely covered on Wednesday, the homework based on that chapter will be due on the Friday of the next week.

You can hand in one homework late for this quarter. In addition, the least favorable of your scores will be dropped.

Problem Set Hints

Please note that the hints of each problem set will be provided on the class web site
http://www.stanford.edu/class/msande247s
If you have studied the material and read the hints but still need assistance, please see your instructor or CA during their office hours.

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MW 4:00-5:30 pm
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Tuesday Problem Sessions
Skilling 193 1:15 - 2:05 pm
Live Broadcast on Channel E 2
Thursday office hrs 2-5 pm
Terman 475, (650) 736-2117

Please send us an e-mail at your convenience so that we will know if you intend to take International Investments this summer. We will also like to know your opinion and feedback about the arrangements we have made for this course. In particular, we need to know how many copies of the handouts to prepare for the next meeting. Thanks for your cooperation.

Ted Fu’s e-mail address is: ffuy@Stanford.edu
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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).

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.

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
• 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.
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.

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.

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 FFr devaluation leads to a rise in all FFr 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 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 \( i \):

\[
MV_t = \sum_{t=0}^{T} \frac{CF_t}{(1+i_t)^t}
\]

(16.1)

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

\[
CF_{DM,t} = REVENUES_{DM,t} - COSTS_{DM,t}
\]

(16.3)
The Market Value of the Firm & Channels of Risk

- Revenues in DM can be defined as:
  \[ \text{REVENUES}_{DM,t} = \text{PRICE}_{DM,t} \times \text{QUANTITY}_{DM,t} \]  
  \( (16.4) \)

- Costs in DM can be defined as:
  \[ \text{COSTS}_{DM,t} = \text{FIXED}_{DM,t} + \text{VARIABLE}_{DM,t} \times \text{NUMBER}_{DM,t} \]  
  \( (16.5) \)

- Exchange rate exposure, the sensitivity of the market value of the firm to a change in the $/DM exchange rate, can be expressed as:
  \[ \frac{\partial \text{MV}}{\partial S_{DM}} \]  
  \( (16.6) \)

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.

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.

<table>
<thead>
<tr>
<th>Channels of Exposure to Foreign Exchange Risk</th>
<th>Direct Exposure</th>
<th>Indirect Exposure</th>
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</thead>
<tbody>
<tr>
<td><strong>Direct Economic Exposure</strong></td>
<td></td>
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</tr>
<tr>
<td>Sales Abroad</td>
<td>Unfavorable</td>
<td>Favorable</td>
</tr>
<tr>
<td></td>
<td>Revenue worth</td>
<td>Revenue worth</td>
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<td>less in home</td>
<td>more</td>
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<td>currency terms</td>
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<tr>
<td>Source Abroad</td>
<td>Favorable</td>
<td>Unfavorable</td>
</tr>
<tr>
<td></td>
<td>Inputs cheaper</td>
<td>Inputs more</td>
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<tr>
<td></td>
<td>in home currency terms</td>
<td>expensive</td>
</tr>
<tr>
<td>Profits Abroad</td>
<td>Unfavorable</td>
<td>Favorable</td>
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<td></td>
<td>Profits worth</td>
<td>Profits worth</td>
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<td>less</td>
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</tbody>
</table>

Table 16.1
### The “Five Forces” Framework for Industry Analysis

- **Buyers:**
  - Buyer concentration
  - Buyer power
  - Buyer volume
  - Buyer propensity to substitute
  - Buyer information

- **Suppliers:**
  - Supplier concentration
  - Supplier power
  - Supplier volume
  - Supplier concentration
  - Supplier information

- **Threat of New Entrants:**
  - High barriers to entry
  - Potential for profitability
  - Speed of entry

- **Rivalry:**
  - Competitor concentration
  - Competitor volume
  - Competitor information

- **Supplier Power:**
  - Cost relative to total purchases
  - Importance of volume to suppliers
  - Supplier concentration

- **Buyer Power:**
  - Pull-through
  - Price sensitivity
  - Buyer concentration

- **Rivalry:**
  - Industry growth
  - Concentration and balance

- **Threat of New Entrants:**
  - Exit barriers
  - Diversity of competitors

### 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.

- ∂MV/∂S reflects economic exposure. Two approaches for measuring economic exposure are the regression approach and the scenario approach.

### The Range of Firms Facing Exchange Rate Exposure

- Our definition of exposure to exchange rate changes, ∂MV/∂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 Value Net

- **Customers**
- **Company**
- **Suppliers**
- **Competitors**
- **Complementors**

### 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.

### 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:

$$MV_t = a + bS_t + e_t$$

- 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 $b$.
     - $b > 0$ ⇒ asset exposure in the foreign currency
     - $b < 0$ ⇒ 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

![Regression Equation Diagram]

Model: $y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k + \epsilon$

- Coefficients
- Random error variable
- Dependent variable
- Independent variables

![Excel Output]

- Standard error of estimate
  - We need to estimate the standard error of estimate
    $$\sigma = \sqrt{\frac{SSE}{n-k-1}}$$
  - Compare $\sigma$ 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 $\sigma$ is not particularly small.
  - Can we conclude the model does not fit the data well?

- Coefficient of determination
  - The definition is
    $$R^2 = 1 - \frac{SSE}{\sum(y_i - \bar{y})^2}$$
  - 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, $Adjusted\ R^2 = 1 - \frac{SSE/(n-k-1)}{SS(Total)/(n-1)} = 49.44\%$
• 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
      \[ F = \frac{MSR}{MSE} = \frac{SSR/k}{SSE/(n-k-1)} \]
    ◦ Rejection region
      \[ F > F_{\alpha,k,n-k-1} \]
    ◦ Required conditions must be satisfied.

Example 18.1 - continued
• Excel provides the following ANOVA results

Econometrics Refresher
Section 4.2 Testing Hypotheses about a Single Population Parameter: the t Test
(Pages 116-123, Jeffrey M. Wooldridge’s Introductory Econometrics: A Modern Approach)
or-
Keller 5E Chapter 17 Simple Regression and Chapter 18 Multiple Linear Regression
(Detailed PowerPoint slides can be found at course web site http://www.stanford.edu/class/msande247s)
The Regression Approach

- To measure the firm's exposure to multiple exchange rates, a multiple regression can be estimated:
  \[ MV_t = a + b_1 S/€,t + b_2 S/£,t + b_3 S/¥,t + e_t \]
- 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 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 conditional 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 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.

\[ P_{US} (USS) = P_{UK} (UK£) \times \text{Spot} \left( \frac{USS}{UK£} \right) \]

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.

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

Driven by arbitrage in goods.

---

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% depreciation of the US$, holding all other factors constant.
- To implement this change, divide the period zero exchange rate by 1.05.
- Multiply $/DM exchange rate (say, 0.6250) by (1+5%) to show a 5% appreciation of the US$, and divide $/DM exchange rate by (1+5%) to show a (roughly) 5% depreciation of the US$.
- The present value of cash flows falls to $35.222 million, reflecting the fact that German sales now equate to fewer US$ revenues, although the cost of imported inputs has also declined somewhat.

---

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

Now, consider a new scenario (B) where the firm is able to increase the DM price of its food processors by 0.5% for every 1.0% decrease in the value of DM. 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 German customer bears some of the cost of the weak DM. We see this improvement in Figure 16.3 with the locus of cash flows marked BO.
The Scenario Approach to Estimating Exchange Rate Exposure

• How will the firm respond if the US$ weakens from the initial $0.625 rate? The firm will like to keep its unit prices in Germany at the original DM240 level. If it succeeds, the line BOA* traces the present value of cash flows. But as the US$ devalues, the firm may come under pressure to reduce its DM prices (Law of One Price).

• If the firm cannot maintain its DM240/unit price, it must pass through to consumers some of the benefits of a stronger DM, 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*.

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 German 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*.

• 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.

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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** - ownership of corporate stocks, bonds, government bonds, and other bonds.
- **Intermediated Investment** - 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?**

Empirical Facts (cont’d)

1. FDI has grown rapidly since W.W.II and especially in the last 15 years. FDI stock, by host country, $bn:

<table>
<thead>
<tr>
<th>Year</th>
<th>Developed</th>
<th>Developing</th>
</tr>
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<tbody>
<tr>
<td>1970</td>
<td>400</td>
<td>50</td>
</tr>
<tr>
<td>1995</td>
<td>1900</td>
<td>700</td>
</tr>
</tbody>
</table>

   - 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.

2. Developing countries account for an increasing share of inflows:

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.

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.

8. Most 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>1980</th>
<th>1995</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
<td>China</td>
</tr>
<tr>
<td>South Africa</td>
<td>Mexico</td>
</tr>
<tr>
<td>Indonesia</td>
<td>Singapore</td>
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<tr>
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<td>Indonesia</td>
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<td>Singapore</td>
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<td>Malaysia</td>
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<tr>
<td>Greece</td>
<td>Hong Kong</td>
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<tr>
<td>Taiwan</td>
<td>Greece</td>
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<tr>
<td>Venezuela</td>
<td>Thailand</td>
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</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 or intermediated investment? 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 that on PI or Il?

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.

### Example: Samsung of Korea

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 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?

Example: Samsung of Korea

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

Major Theories of FDI:

1. Technological Advantages

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

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 multinationaly:
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.

Key Points

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 transnationally.
3. A number of theories of FDI identify sources of these 'overcompensating advantages.'

4.15 Report

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.

Policy Issues

International Financial Managers

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 (σ) 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.

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.
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)

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 (-1.65 $\sigma_{DM}$, 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 ($5,856,500; 7,143,500$).

Thus, there is a 5 percent chance that we will lose at least $1.65 \times 6\% \times DM10,000,000 \times $0.65/DM or $643,500 over the next month.

<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></td>
<td><strong>Gross Var-&gt; 5461.5</strong></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:

$$\sigma_p = \sqrt{\sum_{i=1}^{n} w_i \sigma_i^2 + \sum_{i=1}^{n} \sum_{j=1}^{n} 2w_i w_j \sigma_i \sigma_j \rho_{ij}}$$  \hspace{1cm} (16.13)

where $w_i$ is the % weight of each asset in the portfolio, $\sigma_i$ 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 that $\rho_{ij}$ 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 |
|---------------------------------|-----------------|-----------------|-----------------|-----------------|
| C$    | FFr  | DM  | JY  | SFr  |
| C$    | 1    | -0.05 | -0.03 | -0.13 | -0.04 |
| FFr   | 1    | 0.98 | 0.48 | 0.93 |
| DM    | 1    | 0.52 | 0.94 |
| JY    | 1    | 0.54 |
| SFr   | 1    |

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 \( \sigma_p \approx 0.0132476 \), 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

Please refer to Handout #3 for detailed information on “Value at Risk” (covered in Chapters 16 and 17 of Levich).

ASSIGNMENTS from Chapter 16:
Questions 4, 5; Exercise 3
Due: Friday, July 5th

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 \( (S) \).

Solved Questions

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.