

Princeton University Press

—

**International Finance:
Theory Into Practice**

by

Piet Sercu

SOLUTIONS TO EXERCISES

magnanimously prepared by

Thi Ngoc Tuan Bui, Leuven SB&E

Marian Kane, KBC Bank

Fang Liu, Cheung Kong Business School

Thi Tuon Van Nguyen, Leuven SB&E

15:01 on 8 March 2009

P. Sercu, K.U.Leuven SB&E

Foreword

Writing the textook itself was an enormous task, over and above my regular work as a teacher, researcher, supervisor and administrator. Fortunately, as far as exercises were concerned I could fall back to a large extent on the predecessor book, Sercu-Uppal's *International Financial Markets and the Firm*. For many of these, there were even typed-up solutions extant, even though I must admit that much of the teacher's manual of that book was mysteriously lost. The bulk of the original work, fifteen years ago, had been done by Marian Kane, who was accordingly listed as the 1995 Manual's author. For the revision, I could enlist the help of Thi Ngoc Tuan Bui, Fang Liu, and Thi Tuong Van Nguyen; even R. V. Badrinath provided some questions. I thank them all very warmly.

It seems likely that this set of solutions will turn out to be less than perfect. If you disagree with an answer shown here, please feel free to mail me at piet.secru@econ.kuleuven.be, thus earning yourself many karma points and, who knows, perhaps even a reincarnation as a professor in Leuven.

Blanden, March 8, 2009

Contents in Brief

1	Why does the Existence of Borders Matter for Finance?	1
2	International Finance: Institutional Background	3
3	Spot Markets for Foreign Currency	11
4	Understanding Forward Exchange Rates for Currency	19
5	Using Forwards for International Financial Management	27
6	The Market for Currency Futures	35
7	Markets for Currency Swaps	43
8	Currency Options (1): Concepts and Uses	49
9	Currency Options (2): Hedging and Valuation	63
10	Do We Know What Makes Forex Markets Tick?	71
11	Do Forex Markets Themselves See What's Coming?	73
12	(When) Should a Firm Hedge its Exchange Risk?	75
13	Measuring Exposure to Exchange Rates	81
14	Value-at-Risk: Quantifying Overall net Market Risks	93
15	Managing Credit Risk in International Trade	99
16	International Fixed-Income Markets	105
17	Segmentation/Integration of Stock Markets	111
18	Why—or when—Should we Cross-list our Shares?	113
19	Setting the Cost of International Capital	115
20	International Taxation of Foreign Investments	123
21	Putting it all Together: International Capital Budgeting	137
22	Negotiating a Joint-Venture Contract: the NPV Perspective	145

Chapter 1

Why does the Existence of Borders Matter for Finance?

[No exercises]

Chapter 2

International Finance: Institutional Background

Quiz Questions

True-False Questions

1. If a country has a BOP deficit, the total of all BOP subaccounts is negative.
2. The current account is a record of all trade in goods and services, while the capital account is a record of direct and portfolio investment and unilateral transfers.
3. When the us private sector purchases more goods or makes more investments abroad than foreigners purchase or invest in the us during a year, the Federal Reserve (the us central bank) must make up for the shortfall.
4. All errors and omissions in the BOP are a result of black market transactions.
5. When a corporation purchases a company abroad, and the value of the firm appreciates over time, the NII and the capital account of the BOP is updated to reflect this change.
6. The BOP theory of exchange rate determination says that most changes in the exchange rate are due to the arrival of new information about the future.
7. Under a fixed exchange rate regime, if a country's private sector sells abroad more than it purchases, the central bank must sell foreign exchange.
8. BOP theory is flawed is because it assumes that investors only invest in risk-free domestic and foreign assets.

A. 1. false; 2. false; 3. true (if “investment” includes extending short-term credit); 4. false; 5. false; 6. false (except for information on r and r^*); 7. false (the central bank must buy if the $KA \geq 0$ and $CA > 0$); 8. true

Multiple-Choice Questions

For the following three questions, assume that Antarctica is the home country, and its currency is the Antarctica dollar (AAD), and Greenland is the foreign country and its currency is the crown (GRK). Choose the correct answer.

1. All else being equal, an increase in income in Greenland leads to:
 - (a) an increase in consumption in Antarctica, and therefore an increase in imports, resulting in an appreciation of the AAD.
 - (b) a decrease in consumption in Antarctica, and therefore an increase in exports, resulting in a depreciation of the AAD.
 - (c) an increase in consumption in Greenland, and therefore an increase in imports, resulting in an appreciation of the AAD.
 - (d) an increase in consumption in Greenland, and therefore an increase in imports, resulting in a depreciation of the AAD.

A1. (c).

2. All else being equal, a decrease in the interest rate r^* in Greenland leads to:
 - (a) decreased demand for assets in Greenland, and therefore a depreciation of the GRK.
 - (b) decreased demand for assets in Greenland, and therefore a depreciation of the AAD.
 - (c) an increase in consumption in Greenland, and therefore an increase in imports, resulting in an appreciation of the GRK.
 - (d) an increase in consumption in Antarctica, and therefore an increase in exports, resulting in a depreciation of the AAD.

A2. (a).

3. All else being equal, a decrease in prices in Greenland leads to:
 - (a) an increase in exports to Antarctica, and therefore an appreciation of the AAD.
 - (b) an increase in exports to Antarctica, and therefore a depreciation of the AAD.
 - (c) an increase in consumption in Greenland, and therefore an increase in imports, resulting in an appreciation of the AAD.
 - (d) a decrease in consumption in Greenland, and therefore a decrease in imports, resulting in a depreciation of the AAD.

A3. (b).

Additional Quiz Questions

1. The German subsidiary of a Canadian firm (that is, the subsidiary is owned by the Canadian firm) is sold to a German firm. The Canadian firm invests the funds obtained from the sale in Frankfurt. How is the transaction recorded in the Canadian BOP?

A1. Source: outward direct investment (decrease of foreign direct investment); use: outward portfolio investment.

2. The BOP of Timbuktu showed the following entries for 1988: a capital account surplus of 50, a deficit in the services account of 15, and a trade deficit of 45. The change in the official reserves was zero. What was the balance of unilateral transfers for Timbuktu?

A2.

$$\begin{aligned}\Delta RFX &= 0 = \text{USD}50 + CA \\ CA &= -\text{USD}50 = -\text{USD}45 - \text{USD}15 + \text{Transfers} \\ T &= \text{USD}10.\end{aligned}$$

3. If the central bank sets an exchange rate that undervalues the foreign currency—and the flows of goods and capital adjust simultaneously—what will be the impact on the following:

- (a) RFX (increase/decrease)
- (b) BOP (surplus/deficit).

A3.

- (a) The undervalued foreign currency encourages imports and discourages exports to the home country, thus the CA is less than zero. Investment (including foreign direct investment in the export sector) is not attractive, therefore, the KA is likely to be less than 0. The BOP always balances, but CA and KA are likely to be negative, as we saw.
 - (b) Whatever definition of the BOP you use, there is likely to be a deficit (net outflow).
4. If the current account balance has a surplus of USD 2 billion and the official settlements balance (RFX) has a deficit of USD 5 billion, what is the balance of the capital account?

A4. Current account + capital account = ΔRFX . Thus, the capital account balance equals -7 billion.

5. A British importer purchases goods from a French company and obtains a trade credit for the full value of the shipment (equal to GBP 100). How should this transaction be recorded in the BOP of the UK?

A5. Use: Imports -100; Source: Trade Credit + 100 (short-term inward investment).

6. Tumbikti, a country on the Atlantis continent, has a government deficit of 40 billion while private investment exceeds private savings by 10 billion. What is Tumbikti's current account balance if its exchange rate is fixed?

A6.

$$\begin{aligned} Taxes - G_{exp} = Sav^G &= -USD40billion. \\ Sav^P - I = Sav^P &= -USD10billion. \\ CA = Sav^P + Sav^G &= -USD10billion - USD40billion \\ &= -USD50billion. \end{aligned}$$

Applications

1. Antarctica uses a system of fixed exchange rates, its current account deficit is USD 6 billion, and its capital account balance is USD 4 billion.

Based on this information, answer the following questions.

- What is the change in the official foreign exchange reserves of Antarctica?
- What is the gap between the income of Antarctica and its expenditure on domestic output?
- If there is only one other country in the world, Greenland, can you estimate the current account balance of Greenland?

A1.

$$\begin{aligned} CA &= -USD6billion \\ KA &= USD4billion \end{aligned}$$

- $\Delta RFX = CA + KA = -USD 6 \text{ billion} + USD 4 \text{ billion} = -USD 2 \text{ billion}$
- The gap between the Antarctica's income and its expenditures on domestic output (A) is its net exports, that is, its current account. Thus, -USD 6 billion.
- USD 6 billion.

2. The data below is taken from the BOP of Switzerland. Based on this data, decide whether the following statement is true or false and explain your answer.

“From 1979 to 1982, foreigners have been net issuers of SF-denominated bonds in the Swiss capital markets.”

	1979	1980	1981	1982
Portfolio investment (in billions of dollars)	-11.8	-11.8	-11.9	-32.2

A2. We can conclude that, on balance, capital flowed out of Switzerland, but:

- This need not be because of Swiss purchases of securities. Possibly, Swiss banks granted loans to foreigners, or Swiss residents paid back bank loans that they had made abroad in the past.
 - If the transactions do reflect Swiss purchases of securities, the securities need not be bonds. For example, Swiss residents may have bought stocks originally held by foreigners including stocks that were issued, in the past, by Swiss companies.
 - If the transactions relate to bonds, these need not be bonds newly issued by foreigners. The bonds bought by Swiss residents could also be old bonds including bonds originally issued abroad by Swiss companies.
3. A company in Philadelphia purchases machinery from a Canadian company for USD 150 and receives one-year trade credit. The machinery is transported to Philadelphia by a Canadian trucking company that charges the US company USD 10. The US company insures the shipment with a US insurance company and pays a premium of USD 3. After delivering the machinery to Philadelphia, the Canadian truck continues its trip to Houston, where it picks up micro-computers sold by a Texan company to a Mexican company. This shipment, which is worth USD 170, is insured by a US insurance company for a premium of USD 4. No trade credit is given to the Mexican company. Compute the BOP for the US and assume that Canadian and Mexican companies maintain dollar deposits in New York.

A3.

By transaction:			
Sources		Uses	
Trade credit (short-term inflow)	150	Imports (goods from Canada)	150
Increase USD owned by Canadian*	10	Imports (services from Canada)	10
Exports (goods to Mexico)	170		
exports (services to Canadian trucker)	4	decrease USD owned by Mexicans*	174
	324		324

*: transactions on the short-term capital account. The Canadian trucker invests her revenue in a USD deposit (a “source”, from the US point of view), while the Mexican firm reduces its USD deposits (that is, the US reduces its debt to Mexicans a “use”, from the US point of view).

By BOP account:	Sources	Uses	Net inflow
Balance of trade	170	150	20
Invisibles balance	4	10	-6
Current account	174	160	14
Short-term capital transactions	160	174	-14
Capital account	160	174	-14
Balance of payments	324	324	0

4. Suppose that you are an analyst for the Central Bank of Zanzibar. Decide how the BOP accounts are affected by the following.

- (a) A budget deficit financed by foreign borrowing
- (b) An import quota for foreign cars
- (c) A purchase of a new embassy in Luxembourg
- (d) A grain embargo

A4.

- (a) Sale of securities to foreigners: inward PI (source). The interest paid will be an outflow (use) on the service balance, and the amortization an outflow (use) on PI.
- (b) Trade balance: decrease in imports.
- (c) Transfers: outward unilateral transfer.
- (d) Trade balance: decrease in imports.

5. The following data are taken from the balance of payments of Freedonia (currency FDK):

Capital account	1995	1996	1997	1998
Portfolio investment (in billions of dollars)	+2.9	-6.9	-5.4	-8.7

Is the following statement consistent with the data shown above? *"After 1995, foreigners have issued FDK -denominated bonds in the Freedonian capital market in order to take advantage of the favorable interest rate differential with respect to the US capital market."*

A5. Yes. If the German residents increase the amount of foreign assets they own, the transaction is recorded as a use (outflow) in the German BOP: there is an outflow of DEM.

6. The following passage is from an article that appeared in a newspaper: *“Last year, the US demand for capital to fund the federal deficit and to finance private investment in buildings and equipment exceeded net domestic savings by about USD 100 billion.”* What can we infer about the magnitude of the US current account deficit?

A6. It is at least USD-100 billion.

7. The following passage is from an article that appeared in an old newspaper. Which account of the German BOP is the article talking about?

“FRANKFURT, West Germany—West Germany’s balance of payments, which measures all flows of funds into and out of the country, was in surplus by the current equivalent of USD 210.3 million in February, up from the year-earlier surplus of USD 206.4 million, but sharply lower than January’s surplus of USD 10.04 billion, the central bank said January’s large surplus was caused in part by heavy central-bank intervention in support of the French franc prior to the realignment of the European Monetary System at mid-month.”

A7. The article refers to the change in official reserves because this is the only account that will be affected by “heavy central-bank intervention.”

8. You have been hired by the IMF to design a program to improve the current account balance. How should your program influence the following variables (increase/decrease):

- (a) Taxes
- (b) Government spending
- (c) Private savings

A8.

- (a) Increase taxes to reduce the budget deficit (or private consumption).
- (b) Decrease government spending to reduce the budget deficit.
- (c) Increase private savings to reduce private consumption.

9. The BOP of the US in 1982 and 1984 is given below. Is it correct to state, as it has often been done, that the deterioration of the current account was primarily financed by sales of US Treasury securities to foreigners?

US BALANCE OF PAYMENTS (billions of dollars)		
	1982	1984
Trade account	-36	-108
Service Account	35	17
Unilateral transfer	-8	-11
CURRENT ACCOUNT	-9	-102
Changes in US assets abroad (private) of which:	-108	-16
Portfolio	-8	-5
Bank-reported	-111	-7
Direct investment	6	-6
Other	5	2
Changes in foreign assets in US (private) of which:	92	91
US Treasury Security	7	22
Other	85	69
PRIVATE CAPITAL	-16	75
OFFICIAL SETTLEMENTS	-8	-3
STATISTICAL DISCREPANCY	33	30

A9. The statement is wrong. The current account deficit deteriorated by USD 93 billion, while foreign purchases of Treasury securities increased by only USD 15 billion. Most of the financing came from US banks that lent money inside the US instead of lending abroad as they had done in 1982 (bank capital outflows of USD 111 billion).

10. Venizio had a government surplus of 15 billion in the year 1988. In addition, private after-tax savings exceeded private investment spending by 10 billion. What was the current account balance of Venizio in 1988?

A9. $CA = Sav^P + Sav^G = \text{USD}10\text{billion} + \text{USD}15\text{billion} = \text{USD}25\text{billion}.$

Chapter 3

Spot Markets for Foreign Currency

Quiz Questions

1. Using the following vocabulary, complete the following text: forward; market maker or broker; shopping around; spot; arbitrage; retail; wholesale.

"When trading on the foreign exchange markets, the Bank of Brownsville deals with a (a) on the (b) tier while an individual uses the (c) tier. If the bank must immediately deliver ITL 2 million to a customer, it purchases them on the (d) market. However, if the customer needs the ITL in three months, the bank buys them on the (e) market. In order to purchase the ITL as cheaply as possible, the bank will look at all quotes it is offered to see if there is an opportunity for (f). If the bank finds that the quotes of two market makers are completely incompatible, it can also make a risk-free profit using (g)."

A. (a) market maker or currency broker; (b) wholesale; (c) retail; (d) spot; (e) forward; (f) shopping around; (g) arbitrage.

2. From a Canadian's point of view, which of each pair of quotes is the direct quote? Which is the indirect quote?

- (a) CAD/GBP 2.31; GBP/CAD 0.43
- (b) USD/CAD 0.84; CAD/USD 1.18
- (c) CAD/EUR 1.54; EUR/CAD 0.65

A.

- (a) direct; indirect.
- (b) indirect; direct.
- (c) direct; indirect.

3. You are given the following spot quote: EUR/GBP 1.5015-1.5040

- (a) The above quote is for which currency?
- (b) What is the bid price for EUR in terms of GBP?

A.

- (a) EUR/GBP equals the number of EUR per 1 GBP; therefore, the above quote is for GBP in terms of EUR.
- (b) The bid price for EUR in terms of GBP is $\text{GBP/EUR } 1/1.5040 = 0.665$.

4. You read in your newspaper that yesterday's spot quote was CAD/GBP 2.3134-2.3180.

- (a) This is a quote for which currency?
- (b) What is the ask rate for CAD?
- (c) What is the bid rate for GBP?

A.

- (a) This is a quote for GBP in terms of CAD.
- (b) The ask rate for CAD is $1/2.3134 = 0.432$.
- (c) The bid rate for GBP is 2.3134.

5. A bank quotes the following rates. Compute the EUR/JPY bid cross-rate (that is, the bank's rate for buying JPY).

	Bid	Ask
EUR/CAD	0.64	0.645
CAD/JPY	0.01	0.012

A. Synthetic $[\text{EUR/JPY}]_{\text{bid}} = [\text{EUR/CAD}]_{\text{bid}} \times [\text{CAD/JPY}]_{\text{bid}} = 0.64 \times 0.01 = 0.0064$.

6. A bank quotes the following rates: CHF/USD 2.5110-2.5140 and JPY/USD 245-246. What is the minimum JPY/CHF bid and the maximum ask cross rate that the bank would quote?

A. First calculate the JPY/CHF bid rate, the rate at which the bank buys CHF for JPY. Doing the calculations in two parts, we have:

- (a) The bank sells JPY, and it buys USD at JPY/USD 245.
 - (b) The bank sells USD, and it buys CHF at CHF/USD 2.5140.
- Thus the rate is: $\frac{\text{JPY/USD}245}{\text{CHF/USD}2.5140} = [\text{JPY/CHF}]_{\text{bid}} 97.4543$.

The JPY/CHF ask rate is the rate at which the bank sells CHF for JPY.

- (a) The bank sells CHF, buys USD at CHF/USD 2.5110.
 - (b) The bank sells USD, buys JPY at JPY/USD 246.
- Thus the rate is $\frac{\text{JPY/USD}246}{\text{CHF/USD}2.5110} = [\text{JPY/CHF}]_{\text{ask}} 97.9689$.

Note: the bid rate is less than the ask rate, as it should be.

7. A bank is currently quoting the spot rates of EUR/USD 1.3043-1.3053 and NOK/USD 6.15-6.30. What is the lower bound on the bank's bid rate for the NOK in terms of EUR?

A.

EUR/NOK bid rate is the rate at which the bank buys NOK (and pays for them in EUR).

(a) The bank sells EUR, and it buys USD at EUR/USD 1.3043.

(b) The bank sells USD, and it buys NOK at NOK/USD 6.300.

Thus, the rate is: $\frac{\text{EUR/USD } 1.3043}{\text{NOK/USD } 6.300} = [\text{EUR/NOK}]_{\text{bid}} 0.2070$.

8. Suppose that an umbrella costs USD 20 in Atlanta, and the USD/CAD exchange is 0.84. How many CAD do you need to buy the umbrella in Atlanta?

A.

$$\text{CAD/USD} \times \text{USD/umbrella} = \frac{\text{USD/umbrella}}{\text{USD/CAD}} = \frac{20}{0.84} = \text{CAD } 23.81.$$

9. Given the bid-ask quotes for JPY/GBP 220-240, at what rate will:

(a) Mr. Smith purchase GBP?

(b) Mr. Brown sell GBP?

(c) Mrs. Green purchase JPY?

(d) Mrs. Jones sell JPY?

A.

(a) JPY/GBP 240;

(b) JPY/GBP 220;

(c) JPY/GBP 220 or GBP/JPY 0.00454;

(d) JPY/GBP 240 or GBP/JPY 0.004167.

True or false? Indicate the correct statement(s).

1. CPP says that you can make a risk-free profit by buying and selling goods across countries.
2. CPP implies causality. It states that foreign prices are determined by domestic prices and other factors such as production costs, competitive conditions, money supplies, and inflation rates.
3. In order for a firm not to be affected by real exchange risk, CPP must hold not only for the goods a firm produces but also for all production inputs, and for the prices of complementary and substitute goods.

4. The equilibrium exchange rate suggested by the Absolute Purchasing Power Parity hypothesis depends on the relative relationship between the prices of a representative consumption bundle in the currencies of two countries.
5. Your purchasing power is the number of representative consumption bundles that you can buy.
6. The real effective exchange rate is the price of an average foreign consumption bundle in units of domestic currency.
7. Relative PPP shows how a consumer's purchasing power changes over time.
8. Absolute PPP may hold even when Relative PPP does not because absolute PPP looks at levels at a specific point in time, and levels are always comparable regardless of the composition of the consumption bundle.
9. Given the empirical evidence on the correlation between the nominal and real exchange rate, it is possible to use the nominal financial instruments to hedge real exchange risk.
10. Purchasing Power Parity is based on the idea that the demand for a country's currency is derived from the demand for that country's goods as well as the currency itself.

A. 1. false; 2. false; 3. true; 4. true; 5. true; 6. true: in units of the domestic bundle; 7. false: this describes $1/(1+\text{inflation})$; 8. false; 9. true; 10. true.

Multiple-Choice Questions Choose the correct answer(s).

1. CPP may not hold because:
 - (a) the prices for individual goods are sticky.
 - (b) transaction costs increase the bounds on deviations from CPP, making it more difficult to arbitrage away price differences.
 - (c) quotas and voluntary export restraints limit the ability to arbitrage across goods markets.
 - (d) parallel imports lead to two different prices for the same good.
 - (e) the prices of tradable goods fluctuate too much, which makes it difficult to take advantage of arbitrage opportunities.

A. (a), (b), (c).
2. Absolute Purchasing Power Parity may not hold when:
 - (a) the prices of individual goods in the consumption bundle consistently deviate from CPP across two countries.
 - (b) it can be computed even if the consumption bundles of different countries are not the same (*ie* if the APPP rate cannot even be defined, theoretically).

- (c) the prices for individual goods are sticky.
- (d) there are tariffs, quotas, and voluntary export restraints.
- (e) competition is perfect.

A. (a), (b), (c), (d), (e).

3. Relative Purchasing Power Parity is relevant because:

- (a) empirical tests have shown that Absolute PPP is always violated, while Relative PPP is a good predictor of short-term exchange rate exposure.
- (b) consumption bundles are not always comparable across countries.
- (c) price levels are not stationary over time.
- (d) investors care about the real return on their international portfolio investments.
- (e) investors care about the nominal return on their international portfolio investments.

A. (b), (c), (d).

Applications

1. You have just graduated from the University of Florida and are leaving on a whirlwind tour to see some friends. You wish to spend USD 1,000 each in Germany, New Zealand, and Great Britain (USD 3,000 in total). Your bank offers you the following bid-ask quotes: USD/EUR 1.304-1.305, USD/NZD 0.67-0.69, and USD/GBP 1.90-1.95.

- (a) If you accept these quotes, how many EUR, NZD, and GBP do you have at departure?
- (b) If you return with EUR 300, NZD 1,000, and GBP 75, and the exchange rates are unchanged, how many USD do you have?
- (c) Suppose that instead of selling your remaining EUR 300 once you return home, you want to sell them in Great Britain. At the train station, you are offered GBP/EUR 0.66-0.68, while a bank three blocks from the station offers GBP/EUR 0.665-0.675. At what rate are you willing to sell your EUR 300? How many GBP will you receive?

A.

- (a) EUR 884.56; NZD 1,449.27; GBP 512.82.
- (b) $301.3 + 670 + 142.5 = \text{USD } 1113.8$.
- (c) You will sell at GBP/EUR 0.665; you will receive GBP 199.5.

2. Abitibi Bank quotes JPY/EUR 155-165, and Bathurst Bank quotes EUR/JPY 0.0059-0.0063.

- (a) Are these quotes identical?
- (b) If not, is there a possibility for shopping around or arbitrage?
- (c) If there is an arbitrage opportunity, how would you profit from it?

A2.

- (a) No, Abitibi Bank's quotes imply EUR/JPY 0.0061 - 0.0065.
- (b) Since both rates quoted by Abitibi exceed those offered by Bathurst, there is an arbitrage opportunity.
- (c) Buy JPY from Bathurst Bank at EUR/JPY 0.0063 and sell them to Abitibi Bank at EUR/JPY 0.0061. Equivalently, buy EUR from Abitibi at 165 and sell them to Bathurst at 158.7302.

The following spot rates against the GBP are taken from the Financial Times of Friday, February 2, 2007. Use the quotes to answer the questions in Exercises 3 through 5.

Country	Code	midpoint	change	spread
Czech Rep	CZJ	42.7945	+0.1868	616-273
Denmark	DKK	11.30929	+0.0289	065-119
Euro	EUR	1.5172	+0.0039	168-175
Norway	NOK	12.3321	+0.0394	263-379
Russia	RUB	52.1528	- 0.0368	376-679
Switzerland	CHF	2.4531	+0.0040	522-540
Turkey	YTL	2.7656	-0.0050	614-698

Note: Bid-ask spreads show only the last three decimal places. When the ask seems to be smaller than the bid, add 1000.

3. What are the bid-ask quotes for:

- (a) CZJ/GBP?
- (b) DKK/GBP?
- (c) EUR/GBP?
- (d) NOK/GBP?

A.

- (a) CZJ/GBP 42.7616 - 42.8273.
- (b) DKK/GBP 11.30065 - 11.30119.
- (c) EUR/GBP 1.5168 - 1.5175.
- (d) NOK/GBP 12.3263 - 12.3379.

4. What are the bid-ask quotes for:

- (a) GBP/CZJ?
- (b) GBP/DKK?
- (c) GBP/EUR?
- (d) GBP/NOK?

A.

- (a) GBP/CZJ 0.023350 - 0.023385
- (b) GBP/DKK 0.088486 - 0.088490
- (c) GBP/EUR 0.658979 - 0.659283
- (d) GBP/NOK 0.081051 - 0.081127

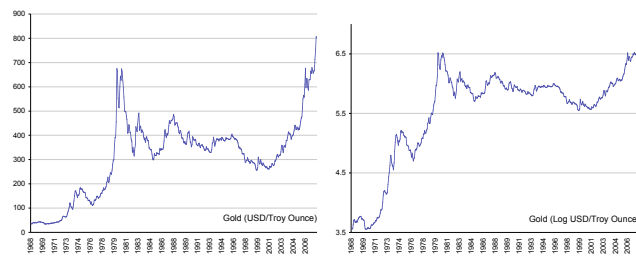
5. What are the cross bid-ask rates for:

- (a) RUB/CHF?
- (b) NOK/YTL?
- (c) DKK/EUR?
- (d) CZJ/CHF?

A. The cross market can have customers only if

- (a) $21.24597 \leq [\text{RUB/CHF}]_{\text{bid}} < [\text{RUB/CHF}]_{\text{ask}} \leq 21.27392$.
- (b) $4.45025 \leq [\text{NOK/YTL}]_{\text{bid}} < [\text{NOK/YTL}]_{\text{ask}} \leq 4.46799$.
- (c) $7.44689 \leq [\text{DKK/EUR}]_{\text{bid}} < [\text{DKK/EUR}]_{\text{ask}} \leq 7.45068$.
- (d) $17.42526 \leq [\text{CZJ/CHF}]_{\text{bid}} < [\text{CZJ/CHF}]_{\text{ask}} \leq 17.46485$.

6. In a figure discussed in the text, and reproduced below, I showed plots of the gold price and mentioned that, if we had corrected for inflation, then the 1980 price would be seen to be much above the current peak: obviously, the small percentage price rise of gold, between 1980 and 2007, must have been way below the percentage rise of the US CPI.



- (a) In the above we presumably use US CPI rate to deflate the USD prices. But is this result generalizable to all countries—is this conclusion necessarily also valid for Japanese or German investors? Why (not)?
- (b) If you think the result does not necessarily hold true elsewhere, what would you bet w.r.t. a hyper-inflator like Zimbabwe?: if inflation is much higher, then the real price of gold must have fallen even more—no?
- (c) What would guarantee identical real price paths in all countries: APPP, RPPP, or what?

A.

- (a) Valid only if PPP holds, which is not true.
- (b) Not if the exchange rate for the USD rose even faster. Whether it rose/fell more than in US depends on $\frac{p_G^{USD} S_{USD}^{ZBD}}{CPI_Z^{ZBD}}$ versus $\frac{p_G^{USD}}{CPI_{US}^{USD}}$, i.e. whether $S_{USD}^{ZBD} \frac{CPI_{US}^{USD}}{CPI_Z^{ZBD}}$ rose or fell.
- (c) RPPP versus a constant base period, or also period-by-period RPPP.

Chapter 4

Understanding Forward Exchange Rates for Currency

Quiz Questions

1. Which of the following statements are correct?

- (a) A forward purchase contract can be replicated by: borrowing foreign currency, converting it to domestic currency, and investing the domestic currency.
- (b) A forward purchase contract can be replicated by: borrowing domestic currency, converting it to foreign currency, and investing the foreign currency.
- (c) A forward sale contract can be replicated by: borrowing foreign currency, converting it to domestic currency, and investing the domestic currency.
- (d) A forward sale contract can be replicated by: borrowing domestic currency, converting it to foreign currency, and investing the foreign currency.
- (e) In a perfect market you could forbid forward markets (on the basis of anti-gambling laws, for instance), and nobody would give a fig.
- (f) The spot rate and the interest rate determine the forward price.
- (g) No, the forward determines the spot.
- (h) No, the forward and the spot and the foreign interest rate determine the domestic interest rate.
- (i) No, there are just four products that are so closely related that their prices cannot be set independently.

A. (a) No (Sale); (b) Yes; (c) Yes; (d) No (purchase); (e) Yes; (f) No (Set jointly); (g) No (Set jointly); (h) No (Set jointly); (i) Yes.

2. What's wrong with the following statements?

- (a) The forward is the expected future spot rate.
- (b) The sign of the forward premium tells you nothing about the strength of a currency; it just reflects the difference of the interest rates.
- (c) The difference of the interest rates tells you nothing about the strength of a currency; it just reflects the forward premium or discount.
- (d) The forward rate is a risk-adjusted expectation but the spot rate is independent of expectations
- (e) A certainty equivalent tends to be above the risk-adjusted expectation because of the risk correction.
- (f) A risk-adjusted expectation is always below the true expectation because we don't like risk.
- (g) A risk-adjusted expectation can be close to, or above the true expectation. In that case the whole world would hold very little of that currency, or would even short it.
- (h) Adding a zero-value contract cannot change the value of the firm; therefore a forward hedge cannot make the shareholders better off.

A.

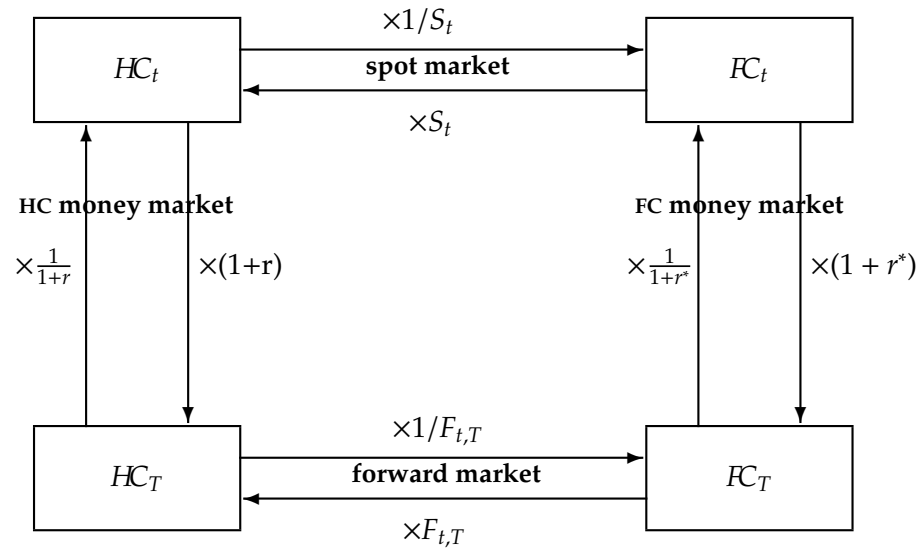
- (a) Risk premium.
- (b) Expectation (and risk premium) are jointly reflected in interest differential of forward premium.
- (c) idem.
- (d) The second part is wrong: $S_t = \text{CEQ}_t(\tilde{S}_T) \frac{1+r_{t,T}^*}{1+r_{t,T}}$ or even $= E_t(\tilde{S}_T) \frac{1+r_{t,T}^*}{1+E_t(\tilde{r}_{s,t,t})}$ where $E_t(\tilde{r}_{s,t,t})$ is the required return for an investment of that risk.
- (e) The risk premium can be negative or positive.
- (f) idem.
- (g) It depends on risk adverse and transaction demand for money.
- (h) Interaction with operations.

Applications

1. Check analytically the equivalence of the two alternative ways to do the following trips:
 - (a) Financing of international trade: you currently hold a FC claim on a customer payable at T , but you want cash HC instead.

- (b) Domestic deposits: you currently hold spot HC and you want to park that money in HC, risk-free.
- (c) You want to borrow HC for 3 months.
- (d) Immunizing a HC debt: you want to set aside some of your cash HC so as to take care of a future FC debt.
- (e) Borrowing FC. You want to borrow FC but a friend tells you that swapping a HC loan is much cheaper

A.



(a) Go from START, 1 unit of FC_T , to END, HC_t :

- Route 1: $FC_T \rightarrow FC_t \rightarrow HC_t$. The end outcome is:

$$HC_t = \frac{1}{1+r^*} \times S_t.$$

- Route 2: $FC_T \rightarrow HC_T \rightarrow HC_t$. The end outcome is:

$$HC_t = F_{t,T} \times \frac{1}{1+r}.$$

Under CIP:

$$\frac{1}{1+r^*} \times S_t = F_{t,T} \times \frac{1}{1+r}.$$

(b) Go from START, 1 unit of HC_t , to END, HC_T :

- Route 1: $HC_t \rightarrow HC_T$. The end outcome is:

$$HC_T = (1+r).$$

- Route 2: $HC_t \rightarrow FC_t \rightarrow FC_T \rightarrow HC_T$. The end outcome is:

$$HC_T = \frac{1}{S_t} \times (1+r^*) \frac{1}{F_{t,T}}.$$

Under CIP, the end outcomes of the two routes are equal.

(c) Go from START, 1 unit of HC_T , to END, HC_t

- Route 1: $HC_T \rightarrow HC_t$. The end outcome is:

$$HC_t = \frac{1}{1+r}.$$

- Route 2: $HC_T \rightarrow FC_T \rightarrow FC_t \rightarrow HC_t$. The end outcome is:

$$HC_t = F_{t,T} \times \frac{1}{1+r^*} S_t.$$

Under CIP, the end outcomes of the two routes are equal.

(d) Go from START, 1 unit of FC_T , to END, HC_t . Similar to (a).

(e) We show that borrowing FC 1 costs as much as borrowing HC S_t .

- Route 1: $FC_t \rightarrow FC_T \rightarrow HC_T$. The final debt at time T in units of HC is:

$$HC_T = F_{t,T} \times (1 + r^*).$$

- Route 2: $HC_t \rightarrow HC_T$. The final debt at time T in units of HC is:

$$HC_T = S_t \times (1 + r).$$

Under CIP, the final debt of the two routes are the same.

2. You hold a set of forward contracts on EUR , against USD ($=HC$). Below I show you the forward prices in the contract; the current forward prices (if available) or at least the current spot rate and interest rates (if no forward is available for this time to maturity). Compute the fair value of the contracts.

(a) Purchased: EUR 1m 60 days (remaining). Historic rate: 1.350; current rate for same date: 1.500; risk-free rates (simple per annum): 3% in USD , 4% in EUR .

(b) Purchased: EUR 2.5m 75 days (remaining). Historic rate: 1.300; current spot rate: 1.5025; risk-free rates (simple per annum): 3% in USD , 4% in EUR .

(c) Sold: EUR 0.75m 180 days (remaining). Historic rate: 1.400; current rate for same date: 1.495; risk-free rates (simple per annum): 3% in USD , 4% in EUR .

A.

(a) $F_{t_0,T} = 1.350$; $F_{t,T} = 1.500$; $r_{t,T} = 3\%/6$. The fair value of the contract is:

$$USD1m \times \frac{F_{t,T} - F_{t_0,T}}{1 + r_{t,T}} = USD1m \times \frac{1.500 - 1.350}{1 + 0.03/6} = USD149,253.7313$$

(b) $F_{t_0,T} = 1.300$; $F_{t,T} = 1.5025$; $r_{t,T} = 3\% \times 75/360$. The fair value of the contract is:

$$USD2.5m \times \frac{F_{t,T} - F_{t_0,T}}{1 + r_{t,T}} = USD2.5m \times \frac{1.5025 - 1.300}{1 + 0.03 \times 75/360} = USD50,3105.5901$$

(c) $F_{t_0,T} = 1.400$; $F_{t,T} = 1.495$; $r_{t,T} = 3\%/2$. The fair value of the contract is:

$$USD0.75m \times \left(-\frac{F_{t,T} - F_{t_0,T}}{1 + r_{t,T}} \right) = 0.75m \times \left(-\frac{1.495 - 1.400}{1 + 0.03/2} \right) = USD - 7,0197.04433.$$

3. 60-day interest rate (simple, p.a.) are 3% at home (USD) and 4% abroad (EUR). The spot rate moves from 1.000 to 1.001.

- What is the return differential, and what is the corresponding prediction of the change in the forward rate?
- What is the actual change in the forward rate?
- What is the predicted change in the swap rate computed from the return differential?
- What is the actual change in the swap rate?

A.

- The return differential is $r_{t,T} - r_{t,T}^* = 0.03/6 - 0.04/6 = -0.0017$.
 - The prediction of the percentage change in the forward rate is: - 0.17%; the prediction of level change is $\Delta F_{t,T} = \Delta S_t \times (1 + (r_{t,T} - r_{t,T}^*)) = 0.001 \times (1 - 0.0017) = 0.0009983$
- the actual change in the forward rate is: $\Delta F_{t,T} = \Delta S_t \frac{1+r_{t,T}}{1+r_{t,T}^*} = 0.001 \times \frac{1+0.03/6}{1+0.04/6} = 0.000998344$.
- The predicted change in the swap rate is $\Delta S_t (r_{t,T} - r_{t,T}^*) = 0.001 \times (-0.0017) = -0.0000017$
- The actual change in the swap rate is:

$$\begin{aligned} \Delta[\text{swaprate}]_{t,T} &= \Delta S_{t,t} \left[\frac{r_{t,T} - r_{t,T}^*}{1 + r_{t,T}^*} \right], \\ &= 0.001 \times \frac{0.03/6 - 0.04/6}{1 + 0.04/6}, \\ &= -0.000002. \end{aligned} \quad (4.1)$$

4. 60-day interest rate (simple, p.a.) are 3% at home (USD) and 4% abroad (EUR). The spot rate is 1.250. There are no spreads, as you probably noticed.

- Check that investing EUR 1m, hedged, returns as much as USD 1.25m
- Check that if taxes are neutral, and the tax rate is 30%, also the after-tax returns are equal. (Yes, this is trivial.)
- How much of the income from swapped EUR is legally interest income and how much is capital gain or loss?
- If you do not have to pay taxes on capital gains and cannot deduct capital losses, would you still be indifferent between USD deposits and swapped EUR?

A. The 6-month forward rate is $F_{t,T} = 1.25 \frac{1+0.03/6}{1+0.04/6}$

- Each investment returns USD 6,250.

	Invest USD 1.25m	Invest EUR 1m and hedge
initial investment	1.25m	1m×1.25 1.25m
final value	$1.25m \times (1+0.03/6) =$ 1,256,250	$[1m \times (1+0.04/6)] \times F_{t,T} =$ 1,256,250
income	6,250	6,250
interest	6,250	$[1m \times 0.04/6] \times F_{t,T} =$ 8,319
capgain	0	$(F_{t,T} - 1.25) \times 1m =$ -2,069
taxable	6,250	6,250
tax (30%)	1,875	1,875
after-tax income	4,375	4,375

- (b) The after-tax return of each investment is USD 4,375.
- (c) The interest income is USD 8,319; The capital loss is USD-2,069.
- (d) No. The after-tax income of the USD 1.25m investment is still 4,375. The taxable income of the swapped EUR is USD 8,319, thus the corresponding tax is USD 2,495. The after-tax income becomes USD 6,250- USD 2,495 = USD 3,755, which is lower than the return of investing in USD 1.25m.
5. 60-day interest rate (simple, p.a.) are 3% at home (USD) and 4% abroad (EUR). The spot rate is 1.250.
- (a) Check that borrowing EUR 1m (=current proceeds, not future debt), hedged, costs as much as borrowing USD 1.25m
- (b) Check that if taxes are neutral, and the tax rate is 30%, also the after-tax costs are equal. (Yes, this is trivial.)
- (c) How much of the costs of bowwowing swapped EUR is legally interest paid and how much is capital gain or loss?
- (d) If you do not have to pay taxes on capital gains and cannot deduct capital losses, would you still be indifferent between USD loans and swapped EUR?

A.

A. The 6-month forward rate is $F_{t,T} = 1.25 \frac{1+0.03/6}{1+0.04/6}$

- (a) Each loan pre-tax interest cost is USD 6,250.
- (b) The after-tax cost of each loan is USD 4,375.
- (c) The interest cost is USD 8,319; The capital gain is USD 2,069,
- (d) No. The tax-deductible cost of the swapped EUR loan is USD 8,319, thus the corresponding tax reduction is USD 2,495. Its after-tax cost becomes USD 6,250 – USD 2,495 = USD 3,755, which is lower than the cost of directly borrowing USD 1.25m.

	Borrow USD 1.25m	Borrow EUR 1m and hedge
initial borrow	1.25m	1m×1.25 1.25m
final debt	$-1.25m \times (1+0.03/6) = -1,256,250$	$[1m \times (1+0.04/6)] \times (-F_{t,T}) = -1,256,250$
cost	-6,250	-6,250
interest	-6,250	$[1m \times 0.04/6] \times (-F_{t,T}) = -8,319$
capgain	0	$(-F_{t,T} + 1.25) \times 1m = 2,069$
taxable	-6,250	-6,250
tax (30%)	1,875	1,875
after-tax income	-4,375	-4,375

6. Groucho Marx, as Governor of Freedonia's central bank, has problems. He sees the value of his currency, the FDK, under constant attack from Rosor, a wealthy mutual-fund manager. Apparently, Rosor believes that the FDK will soon devalue from GBP 1.000 to 0.950.

- Currently, both GBP and FDK interest rates are 6% *p.a.* By how much should Groucho change the one-year interest rate so as to stabilize the spot rate even if Rosor expects a spot rate of 0.950 in one year? Ignore the risk premium—that is, take 0.950 to be the certainty equivalent.
- If the interest-rate hike also affects Rosor's expectations about the future spot rate, in which direction would this be? Taking into account also this second-round effect, would Groucho have to increase the rate by more than your first calculation, or by less?

A.

- From Mr. Marx's point of view, FDK is HC and GBP is FC. The risk-adjusted expectation of future spot rate is $F_{t,T} = CEQ_t(\tilde{S}_T) = 1/0.950$. The new interest rate should be changed such that:

$$F_{t,T} = S_t \frac{1 + r_{new}}{1 + r^*},$$

$$1/0.95 = 1 \times \frac{1 + r_{new}}{1 + 0.06}.$$

The new interest is $r_{new} = 1/0.95 \times 1.06 - 1 = 11.6\%$.

- The increase in the interest rate now also means the risk-adjusted expectation about the HC, *i.e.* FDK would strengthen. From Groucho's perspective, the pound is expected to rise from its level of 1.00 not to $1/0.95 (\approx 1.05)$ —the level of the central bank had not reacted—but to, say, $1/1.97 (\approx 1.03)$. Therefore, the increase in the FDK interest rate would be smaller, for example $1/0.97 \times 1.06 - 1 = 9.3\%$.

Chapter 5

Using Forwards for International Financial Management

Quiz Questions

1. Which of the following are risks that arise when you hedge by buying a forward contract in imperfect financial markets?

- (a) Credit risk: the risk that the counterpart to a forward contract defaults.
- (b) Hedging risk: the risk that you are not able to find a counterpart for your forward contract if you want to close out early.
- (c) Reverse risk: the risk that results from a sudden unhedged position because the counterpart to your forward contract defaults. So if you then close out (to reverse the position) you might already have lost money, *i.e.* reversing may mean you lock in a loss.
- (d) Spot rate risk: the risk that the spot rate has changed once you have signed a forward contract.

A.

Surely (a) & (c) if the counterpart is not top notch or has not put up substantial margin.

- (b) is not a major risk because you can otherwise close out in the forward market or hedge via the money markets.
- (d) is a risk in the sense that, at time T , you may regret your forward purchase.
(d) is not a risk on the sense that your cash flow is not affected by S_T , barring reverse risk.

2. Which of the following statements are true?

- (a) Margin is a price paid to the bank to compensate it for taking on credit risk.
- (b) If you hold a forward purchase contract for JPY that you wish to reverse, and the JPY has increased in value, you owe the bank the discounted difference between the current forward rate and the historic forward rate, that is, the market value.
- (c) If the balance in your margin account is not sufficient to cover the losses on your forward contract and you fail to post additional margin, the bank must speculate in order to recover the losses.

A.

- (a) Margin is not a price paid; it is a security deposit.
- (b) No. The contract has increased in value. That is, you made a gain rather than a loss.
- (c) No. The bank will seize the margin and reverse the forward contract.

3. Which of the following statements are correct?

- (a) A forward purchase contract can be replicated by: borrowing foreign currency, converting it to domestic currency, and investing the domestic currency.
- (b) A forward purchase contract can be replicated by: borrowing domestic currency, converting it to foreign currency, and investing the foreign currency.
- (c) A forward sale contract can be replicated by: borrowing foreign currency, converting it to domestic currency, and investing the domestic currency.
- (d) A forward sale contract can be replicated by: borrowing domestic currency, converting it to foreign currency, and investing the foreign currency.

A. (b), (c).

4. The following spot and forward rates are in units of THB/FC. The forward spread is quoted in centimes.

	Spot	1 month		3 month		6 month		12 month	
1 BRL	18.20–18.30	+0.6	+0.8	+2.1	+2.7	+3.8	+4.9	+6.9	+9.1
1 DKK	5.95–6.01	–0.1	–0.2	–0.3	–0.1	–0.7	–0.3	–0.9	+0.1
1 CHF	24.08–24.24	+3.3	+3.7	+9.9	+10.8	+19.3	+21.1	+36.2	+39.7
100 JPY	33.38–33.52	+9.5	+9.9	+28.9	+30.0	+55.2	+57.5	+99.0	+105.0
1 EUR	39.56–39.79	–1.7	–1.0	–3.4	–1.8	–5.8	–2.9	–10.5	–5.2

Choose the correct answer.

- i. The one-month forward bid/ask quotes for CHF are:

- a. 27.387–27.942 b. 25.078–24.357 c. 24.113–24.277 d. 24.410–24.610
- ii. The three-month forward bid/ask quotes for EUR are:
- a. 39.526–39.772 b. 36.167–37.992 c. 39.641–40.158 d. 39.397–39.699
- iii. The six-month forward bid/ask quotes for JPY are:
- a. 38.902–39.273 b. 88.584–91.025 c. 33.686–33.827 d. 33.932–34.095
- iv. The twelve-month forward bid/ask quotes for BRL are:
- a. 18.731–19.352 b. 25.113–27.404 c. 17.305–17.716 d. 18.269–18.391
- A. i. c.; ii. a.; iii. d.; iv. d.

5. Suppose that you are quoted the following NZD/FC spot and forward rates:

	Spot bid-ask	3-mo. forward bid-ask	<i>p.a.</i> 3 month Euro-interest	6-mo. forward bid-ask	<i>p.a.</i> 6 month Euro-interest
NZD			5.65–5.90		5.47–5.82
USD	0.5791–0.5835	0.5821–0.5867	3.63–3.88	0.5839–0.5895	3.94–4.19
EUR	0.5120–0.5159	0.5103–0.5142	6.08–6.33	0.5101–0.5146	5.60–6.25
DKK	3.3890–3.4150	3.3350–3.4410	6.05–6.30	3.3720–3.4110	5.93–6.18
CAD	0.5973–0.6033	0.5987–0.6025	1.71–1.96	0.5023–0.5099	2.47–2.75
GBP	0.3924–0.3954	0.3933–0.3989	5.09–5.34	0.3929–0.3001	5.10–5.35

- (a) What are the three-month synthetic-forward NZD/USD bid-ask rates?
- (b) What are the six-month synthetic-forward NZD/EUR bid-ask rates?
- (c) What are the six-month synthetic-forward NZD/DKK bid-ask rates?
- (d) What are the three-month synthetic-forward NZD/CAD bid-ask rates?
- (e) In a–d, are there any arbitrage opportunities? What about least cost dealing at the synthetic rate?

A.

- (a) 0.5816–0.5868;
- (b) 0.5117–0.5148;
- (c) 3.381–3.409;
- (d) 0.6028–0.6096.
- (e) NZD/USD: no arbitrage opportunity; NZD/EUR: least cost dealing opportunity for sellers of EUR; NZD/DKK: least-cost dealing opportunity for both buyers and sellers of DKK; NZD/CAD: arbitrage opportunity.
6. True or False: Occasionally arbitrage bounds are violated using domestic (“on-shore”) interest rates because:
- (a) Offshore or euromarkets are perfect markets while “on-shore” markets are imperfect.

- (b) Offshore or euromarkets are efficient markets while “on-shore” markets are inefficient.

A.

Neither (a) nor (b). Neither market is perfect—although off-shore markets tend to be less imperfect, an better integrated.

Applications

1. Michael Milkem, an ambitious MBA student from Anchorage, Alaska, is looking for free lunches on the foreign exchange markets. Keeping his eyes glued to his Reuters screen until the wee hours, he spots the following quotes in Tokyo:

Exchange rate: Spot	NZD/USD	1.59–1.60	JPY/USD	100–101
	NZD/GBP	2.25–2.26	JPY/GBP	150–152
180 - day Forward	NZD/USD	1.615–1.626	JPY/USD	97.96–98.42
	NZD/GBP	2.265–2.274	JPY/GBP	146.93–149.19
Interest rates (simple, <i>p.a.</i>)				
180 days	USD	5%–5.25%	JPY	3%–3.25%
	NZD	8%–8.25%	GBP	7%–7.25%

Given the above quotes, can Michael find any arbitrage opportunities?

A.

The synthetic 180-day forward quotes are NZD/USD 1.6113–1.6254, JPY/USD 98.9038–100.1378, NZD/GBP 2.258–2.2736, JPY/GBP 146.924–149.2464. There is an opportunity for least-cost dealing when selling USD against JPY, and when buying GBP against NZD, but Michael is only interested in a free lunch (and not in the cheapest way to take a position in a currency). So, because the arbitrage bounds for the JPY/USD rate are violated, he will buy USD with JPY in the direct market and sell the USD synthetically in order to make a risk-free profit.

2. us-based Polyglot Industries will send its employee Jack Pundit to study Danish in an intensive training course in Copenhagen. Jack will need DKK 10,000 at $t = 3$ months when classes begin, and DKK 6,000 at $t = 6$ months, $t = 9$ months, and $t = 12$ months to cover his tuition and living expenses. The exchange rates and *p.a.* interest rates are as follows:

DKK/USD	Exchange rate	p.a. interest rate USD	p.a. interest rate DKK
Spot	5.820–5.830		
90 days	5.765–5.770	3.82–4.07	8.09–8.35
180 days	5.713–5.720	3.94–4.19	8.00–8.26
270 days	5.660–5.680	4.13–4.38	7.99–8.24
360 days	5.640–5.670	4.50–4.75	7.83–8.09

Polyglot wants to lock in the DKK value of Jack's expenses. Is the company indifferent between buying DKK forward and investing in DKK for each time period that he should receive his allowance?

A.

The synthetic USD/FRF forward rates are:

USD/FRF	Exchange Rate
90 days	5.76-5.77
180 days	5.70-5.72
270 days	5.65-5.68
360 days	5.63-5.67

Because the rates on the synthetic market equal or exceed those on the direct forward market, Polyglot will always prefer to buy DKK forward directly.

3. Check analytically that a money-market hedge replicates an outright forward transaction. Analyze, for instance, a forward sale of DKK 1 against NZD.

A.

Six months: borrow NZD $\frac{1}{1.025}$, convert spot, and invest at an effective return of 5.0625 percent; your NZD debt is 1, your DKK inflow will be $\frac{1}{1.025} \times 1.050625 = 1.025$, QED. Selling DKK 1 at a forward rate of 1.025 gives the same result. Twelve months: borrow NZD $\frac{1}{1.05}$, convert spot, and invest at an effective return of 10.25 percent; your NZD debt is 1, your DKK inflow will be $\frac{1}{1.05} \times 1.1025 = 1.05$, QED. This is equivalent to selling forward at 1.05.

Exercises 4 through 6 use the following time-0 data for the fictitious currency, the Walloon Franc (WAF) and the Flemish Yen (FLY), on Jan. 1, 2000. The spot exchange rate is 1 WAF/FLY.

	Interest rates		Swap rate
	FLY	WAF	WAF/FLY
180 days	5%	10.125%	0.025
360 days	5%	10.250%	0.050

4. On June 1, 2000, the FLY has depreciated to WAF 0.90, but the six-month interest rates have not changed. In early 2001, the FLY is back at par. Compute the gain or loss (and the cumulative gain or loss) on two consecutive 180-day forward sales (the first one is signed on Jan. 1, 2000), when you start with a FLY 500,000 forward sale. First do the computations without increasing the size of the forward contract. Then verify how the results are affected if you do increase the contract size, at the roll-over date, by a factor $1 + r_{T_1, T_2}^*$ —that is, from FLY 500,000 to FLY 512,500.

A.

The first 180d: $(1.025 - 0.90) \times 500,000 = \text{WAF } 62,500$ profit.

The new forward rate: $\frac{0.9}{1.025} \times 1.050625 = 0.9225$. So if you do not adjust the contract size, your second profit will be $(0.9225 - 1) \times 500,000 = -38,750$. The total, not corrected for time value, is $62,500 - 38,750 = 23,750$.

The cumulative profit makes sense only if you bring in interest rates. First, you reinvest the first gain: $62,500 \times 1.050625 = 65,664$. The second time you increase the contract size to $500,000 \times 1.025 = 512,500$ so that your ex post result from the second contract is $512,500 \times (0.9225 - 1) = -39,718.7$. Thus, your total profit is $65,664 - 39,718.7 = 25,945.3$.

5. Repeat the previous exercise, except that after six months the exchange rate is at WAF/FLY 1, not 0.9.

A.

The first 180d: $(1.025 - 1) \times 500,000 = \text{WAF } 12,500$ profit.

The new forward rate: $\frac{1}{1.025} \times 1.050625 = 1.025$. So if you do not adjust the contract size, your second profit will be $(1.025 - 1) \times 500,000 = 12,500$. Notice how the total, without correction for time value, now is 25,000.

The cumulative profit makes sense only if you bring in interest rates. First, you reinvest the first gain: $12,500 \times 1.050625 = 13,132.8$. The second time you increase the contract size to $500,000 \times 1.025 = 512,500$ so that your ex post gain from the second contract is $512,500 \times (1.025 - 1) = 12,812.5$. Thus, your total profit is $13,132.8 + 12,812.5 = 25,945.3$, as before.

Conclusion:

- When rolling over short-term contracts, the result is "essentially" independent of the intermediate spot rate: the profit is around 25,000.
- We can entirely eliminate the uncertainty about the intermediate spot rate by slightly increasing the forward contract's size at each roll-over date. Then, the profit is 25,945.30 independent of the intermediate spot rate.
- The final result always depends on the interest rates at the roll-over date.

6. Compare the analyses in Exercises 4 and 5 with a rolled-over money-market hedge. That is, what would have been the result if you had borrowed WAF for six months (with conversion and investment of FLY—the money-market replication of a six-month forward sale), and then rolled-over (that is, renewed) the WAF loan and the FLY deposit, principal plus interest?

A.

Borrow FLY $\frac{500,000}{1.025} = 487,804.88$, convert into WAF, and invest. The values are:

	WAF deposit	FLY debt	net value
time-0	487,804.88	487,804.88	0
time-1	512,500.00	500,000.00	12,500.00
time-2	538,445.30	512,500.00	25,945.30

Rolling over money market hedges is the same as rolling over forward contracts. Clearly, the intermediate spot exchange rates here are irrelevant, and the only risk is interest rate risk.

Chapter 6

The Market for Currency Futures

Quiz Questions

1. For each pair shown below, which of the two describes a forward contract?
Which describes a futures contract?

- (a) standardized/made to order
- (b) interest rate risk/no interest rate risk
- (c) ruin risk/no ruin risk even when there is a matching cash flow at T
- (d) short maturities/even shorter maturities
- (e) no secondary market/liquid secondary market
- (f) for hedgers/speculators
- (g) more expensive/less expensive
- (h) no credit risk/credit risk
- (i) organized market/no organized market

A.

	Forward contract	Futures contract
(a)	made to order	standardized
(b)	no interest rate risk	interest rate risk
(c)	no ruin risk	ruin risk
(d)	short maturities	even shorter maturities
(e)	no secondary market	liquid secondary market
(f)	for hedgers	for speculators
(g)	more expensive	less expensive
(h)	credit risk	no credit risk
(i)	no organized market	organized market

2. Match the vocabulary below with the following statements.

- | | |
|------------------------------|-------------------------|
| (1) organized market | (11) maintenance margin |
| (2) standardized contract | (12) margin call |
| (3) standardized expiration | (13) variation margin |
| (4) clearing corporation | (14) open interest |
| (5) daily recontracting | (15) interest rate risk |
| (6) marking to market | (16) cross-hedge |
| (7) convergence | (17) delta-hedge |
| (8) settlement price | (18) delta-cross-hedge |
| (9) default risk of a future | (19) ruin risk |
| (10) initial margin | |

- (a) Daily payment of the change in a forward or futures price.
- (b) The collateral deposited as a guarantee when a futures position is opened.
- (c) Daily payment of the discounted change in a forward price.
- (d) The minimum level of collateral on deposit as a guarantee for a futures position.
- (e) A hedge on a currency for which no futures contracts exist and for an expiration other than what the buyer or seller of the contract desires.
- (f) An additional deposit of collateral for a margin account that has fallen below its maintenance level.
- (g) A contract for a standardized number of units of a good to be delivered at a standardized date.
- (h) A hedge on foreign currency accounts receivable or accounts payable that is due on a day other than the third Wednesday of March, June, September, or December.
- (i) The number of outstanding contracts for a given type of futures.
- (j) The one-day futures price change.
- (k) A proxy for the closing price that is used to ensure that a futures price is not manipulated.
- (l) Generally, the last Wednesday of March, June, September, or December.
- (m) Organization that acts as a “go-between” for buyers and sellers of futures contracts.
- (n) The risk that the interim cash flows must be invested or borrowed at an unfavorable interest rate.
- (o) A hedge on a currency for which no futures contract exists.
- (p) The risk that the price of a futures contract drops (rises) so far that the purchaser (seller) has severe short-term cash flow problems due to marking to market.
- (q) The property whereby the futures equals the spot price at expiration.

- (r) Centralized market (either an exchange or a computer system) where supply and demand are matched.

A.

- (a) 6; (b) 10.; (d) 11.; (e) 16.; (f) 12.; (g) 2. and 3.; (h) 17.; (i) 14.; (k) 8.; (l) 3.; (m) 4.; (n) 15.; (o) 16.; (p) 19.; (q) 7.; (r) 1.

The table below is an excerpt of futures prices from an old *The Wall Street Journal* copy. Use this table to answer Questions 3 through 6.

	Open	High	Low	Settle	Change	Lifetime		Open Interest
						High	Low	
JAPAN YEN (CME) — 12.5 million yen; \$ per yen (.00)								
June	.9432	.9460	.9427	.9459	+.0007	.9945	.8540	48,189
Sept	.9482	.9513	.9482	.9510	+.0007	.9900	.8942	1,782
Dec	.9550	.9610	.9547	.9566	+.0008	.9810	.9525	384
Est vol 13,640; vol Fri 15,017; open int 50,355, +414								
New Zealand Dollar (CME) — 125,000 dollars; \$ per dollar								
June	.5855	.5893	.5847	.5888	+.0018	.6162	.5607	87,662
Sept	.5840	.5874	.5830	.5871	+.0018	.6130	.5600	2,645
Dec	.5830	.5860	.5830	.5864	+.0018	.5910	.5590	114
Est vol 40,488; vol Fri 43,717; open int 90,412, -1,231								
Swiss Franc (CME) — 100,000 francs; \$ per franc								
June	.7296	.7329	.7296	.7313	+.0021	.7805	.7290	43,132
Sept	.7293	.7310	.7290	.7297	+.0018	.7740	.7276	962
Dec	.7294	.7295	.7285	.7282	+.0016	.7670	.7270	640
Est vol 5,389; vol Fri 4,248; open int 44,905, -1,331								

3. What is the CME contract size for:

- (a) Japanese yen?
 (b) New Zealand Dollar?
 (c) Swiss Franc?

A.

- (a) 12.5 million yen; (b) 125,000 dollars; (c) 100,000 francs.

4. What is the open interest for the September contract for:

- (a) Japanese yen?
 (b) New Zealand Dollar?
 (c) Swiss Franc?

A.

- (a) 1,782; (b) 2,645; (c) 962 contracts.

5. What are the daily high, low, and settlement prices for the December contract for:

- (a) Japanese yen?
- (b) New Zealand Dollar?
- (c) Swiss Franc?

A.

(a) high: 0.9610, low: 0.9547, settle: 0.9566; (b) high: 0.5860, low: 0.5830, settle: 0.5864; (c) high: 0.7295, low: 0.7285, settle: 0.7282.

6. What is the day's cash flow from marking to market for the holder of a:

- (a) JPY June contract?
- (b) NZD June contract?
- (c) CHF June contract?

A.

- (a) $\frac{0.0007}{100} \times 12.5\text{million} = \text{USD } 87.50$ (inflow).
- (b) $0.0018 \times 125,000 = \text{USD } 2.25$ (inflow).
- (c) $0.0021 \times 100,000 = \text{USD } 210$ (inflow).

7. What statements are correct? If you disagree with one or more of them, please put them right.

- (a) Margin is a payment to the bank to compensate it for taking on credit risk.
- (b) If you hold a forward purchase contract for JPY that you wish to reverse, and the JPY has increased in value, you owe the bank the discounted difference between the current forward rate and the historic forward rate, that is, the market value.
- (c) If the balance in your margin account is not sufficient to cover the losses on your forward contract and you fail to post additional margin, the bank must speculate in order to recover the losses.
- (d) Under the system of daily recontracting, the value of an outstanding forward contract is recomputed every day. If the forward rate for GBP/NZD drops each day for ten days until the forward contract expires, the purchaser of NZD forward must pay the forward seller of NZD the market value of the contract for each of those ten days. If the purchaser cannot pay, the bank seizes his or her margin.

A.

- (a) Margin is not a payment; it is a security deposit.

- (b) No. The contract has increased in value. That is, you made a gain rather than a loss.
- (c) No. The bank will seize the margin and reverse the forward contract.
- (d) True.

Applications

1. Innovative Bicycle Makers of Exeter, UK, must hedge an accounts payable of MYR 100,000 due in 90 days for bike tires purchased in Malaysia. Suppose that the GBP/MYR forward rates and the GBP effective returns are as follows:

Time	$t=0$	$t=1$	$t=2$	$t=3$
Forward rate	4	4.2	3.9	4
Effective return	12%	8.5%	4%	0%

- (a) What are IBM's cash flows given a variable-collateral margin account?
- (b) What are IBM's cash flows given periodic contracting?

A.

Forward , price, $F_{t,3}$ in GBP/MYR	GBP return, $r_{t,3}$	Variable Collateral	Periodic Recontracting
At time 0: $F_{0,3} = 4$	12%	IBM buys forward at $F_{0,3} = 4$	IBM buys forward at $F_{0,3} = 4$
At time 1: $F_{1,3} = 4.5$	8.50%	Market value of the contract is $\frac{4.5-4}{1.085} = 0.461$. IBM's margin account is worth 0.461.	Market value of the contract is $\frac{4.5-4}{1.085} = 0.461$. IBM receives 0.461 for the old contract, and signs a new contract at $F_{1,3} = 4.5$.
At time 2: $F_{2,3} = 3.7$	4%	Market value of the contract is $\frac{3.7-4}{1.04} = -0.288$. IBM deposits at least -0.288 in its margin account as collateral.	Market value of the contract is $\frac{3.7-4.5}{1.04} = -0.769$. IBM buys back the old contract for -.769, and signs a new contract at $F_{2,3} = 3.7$.
At time 3: $S_3 = 4$	0%	IBM pays per MYR: 0.4 The collateral in IBM's margin account is returned to IBM, including the interest earned on it.	As payments adjusted for time value: time 3: (purchase of MYR) = 3.7 time 2: 0.769×1.04 = 0.8 time 1: -0.461×1.085 = -0.5 4.0

2. On the morning of Monday, August 21, you purchased a futures contract for 1 unit of CHF at a rate of USD/CHF 0.7. The subsequent settlement prices are shown in the table below.
- (a) What are the daily cash flows from marking to market?
- (b) What is the cumulative total cash flow from marking to market (ignoring discounting)?

August	21	22	23	24	25	28	29	30
Futures rate	0.71	0.70	0.72	0.71	0.69	0.68	0.66	0.63

- (c) Is the total cash flow greater than, less than, or equal to the difference between the price of your original futures contract and the price of the same futures contract on August 30?

A.

August	21	22	23	24	25	28	29	30
Cash flow	0.01	-0.01	0.02	-0.01	-0.02	-0.01	-0.02	-0.03

(b) -0.07.

(c) Equal to.

3. On November 15, you sold ten futures contracts for 100,000 CAD each at a rate of USD/CAD 0.75. The subsequent settlement prices are shown in the table below.

- (a) What are the daily cash flows from marking to market?
- (b) What is the total cash flow from marking to market (ignoring discounting)?
- (c) If you deposit USD 75,000 into your margin account, and your broker requires USD 50,000 as maintenance margin, when will you receive a margin call and how much will you have to deposit?

November	16	17	18	19	20	23	24	25
Futures rate	0.74	0.73	0.74	0.76	0.77	0.78	0.79	0.81

A.

November	16	17	18	19	20	23	24	25
cash flow	0.01	0.01	-0.01	-0.02	-0.01	-0.01	-0.01	-0.01

(b) $1m \times (-0.05) = \text{USD}-50,000$

November	16	17	18	19	20	23	24	25
Margin account	85,000	95,000	85,000	65,000	55,000	75,000	65,000	55,000

4. On the morning of December 6, you purchased a futures contract for one EUR at a rate of INR/EUR 55. The following table gives the subsequent settlement prices and the p.a. bid-ask interest rates on a INR investment made until December 10.

- (a) What are the daily cash flows from marking to market?

- (b) What is the total cash flow from marking to market (ignoring discounting)?
- (c) If you must finance your losses and invest your gains from marking to market, what is the value of the total cash flows on December 10?

December	6	7	8	9	10
Futures price	56	57	54	52	55
Bid-ask interest rates, INR, % p.a.	12.00-12.25	11.50-11.75	13.00-13.25	13.50-13.75	NA

A.

(a)	December	6	7	8	9	10
	Cash flow	1	1	-3	-2	3

(b) EUR 0.

(c) Using the convention of 360-days per year:

December	6	7	8	9	10
Cash flow	1	1	-3	-2	3
Future value of cash flow invested until Dec. 11th	1.0013333	1.0009583	-3.0022083	-2.00076	3

5. You want to hedge the EUR value of a CAD 1m inflow using futures contracts. On Germany's exchange, there is a futures contract for USD 100,000 at EUR/USD 1.5.

(a) Your assistant runs a bunch of regressions:

- i. $\Delta S[\text{EUR/CAD}] = \alpha_1 + \beta_1 \Delta f[\text{USD/EUR}]$
- ii. $\Delta S[\text{EUR/CAD}] = \alpha_2 + \beta_2 \Delta f[\text{EUR/USD}]$
- iii. $\Delta S[\text{CAD/EUR}] = \alpha_3 + \beta_3 \Delta f[\text{EUR/USD}]$
- iv. $\Delta S[\text{CAD/EUR}] = \alpha_4 + \beta_4 \Delta f[\text{USD/EUR}]$

Which regression is relevant to you?

(b) If the relevant β were 0.83, how many contracts do you buy? sell?

A.

(a) regression (2). Both sides of the regression take the EUR as the home currency. The left-hand side is the spot rate that you are exposed to, and the right-hand side is the futures rate you use as a hedge.

(b) You sell USD $\frac{1,000,000}{100,000} \times 0.83 = 8.3$ contracts, or after rounding, 8 USD contracts.

6. In the preceding question, we assumed that there was a USD futures contract in Germany, with a fixed number of USD (100,000 units) and a variable EUR/USD price. What if there is no German futures exchange? Then you would have to go to a US exchange, where the number of EUR per contract is fixed (at, say, 125,000), rather than the number of USD. How many USD/EUR contracts will you buy?

A.

If hedging is done on a U.S. futures exchange, you buy forward eight contracts worth USD 100,000 each for a total of USD 800,000. At the futures rate of EUR/USD 1.5, this corresponds to $800,000 \times 1.5 = \text{EUR } 1,200,000$, or about ten contracts of EUR 125,000 each.

7. A German exporter wants to hedge an outflow of NZD 1m. She decides to hedge the risk with a EUR/USD contract and a EUR/AUD contract. The regression output is, with t-statistics in parentheses, and $R^2 = 0.59$:

$$\Delta S_{[\text{EUR}/\text{NZD}]} = a + \underset{(1.57)}{0.15 \Delta f_{[\text{EUR}/\text{USD}]}} + \underset{(17.2)}{0.7 \Delta f_{[\text{EUR}/\text{AUD}]}}$$

- (a) How will you hedge if you use both contracts, and if a USD contract is for USD 50,000 and the AUD contract for AUD 75,000?
- (b) Should you use the USD contract, in view of the low t-statistic? Or should you only use the AUD contract?

A.

- (a) USD: $0.15 \times \frac{1,000,000}{50,000} = 3$ contracts. AUD: $0.70 \times \frac{1,000,000}{75,000} = 9(.33)$ contracts.
- (b) The t-statistic is rather low, so on the basis of this sample there is no way to say, with reasonable confidence, whether or not the USD contract actually reduces the risk.

Chapter 7

Markets for Currency Swaps

Quiz Questions

1. How does a fixed-for-fixed currency swap differ from a spot contract combined with a forward contract in the opposite direction?
2. Describe some predecessors to the currency swap, and discuss the differences with the modern swap contract.
3. What are the reasons why swaps may be useful for companies who want to borrow?
4. How are swaps valued in general? How does one value the floating-rate leg (if any), and why?

A.

1. A forward contract can be viewed as an exchange of two *zero-coupon* bonds with identical times to maturity—one bond having a face value equal to X units of home currency, and the other bond having a face value equal to one unit of foreign currency. Default risk is low, and there is a right of offset. If, at time t , X is set equal to $X = F_{t,T}$, the initial values of the two zero-coupon bonds are equal:

$$PV \text{ of HC leg} = \frac{F_{t,T}}{1 + r_{t,T}} = S_t \times \frac{1}{1 + r_{t,T}^*} = S_t \times [PV, \text{ in FC, of FC leg }]$$

which implies that the forward contract has zero initial net value.

A fixed-for-fixed currency swap can be viewed as an exchange of two *coupon* bonds with identical times to maturity—one bond having a face value equal to X units of home currency, and the other bond having a face value equal to

one unit of foreign currency. Default risk is low, and there is a right of offset. Both bonds pay out the "yield at par" that is normal for their time to maturity and currency, and each bond's initial market value is, therefore, equal to its par value. If, at time t , X is set equal to $X = S_t$, the initial values of the two zero-coupon bonds are equal:

$$PV \text{ of HC leg} = \sum_{i=1}^n \frac{S_t y}{(1+y)^{T_{i-t}}} + \frac{S_t}{(1+y)^{T_{n-t}}} = S_t, \text{ by definition of } y,$$

$$PV, \text{ in FC, of FC leg} = \sum_{i=1}^n \frac{y^*}{(1+y^*)^{T_{i-t}}} + \frac{1}{(1+y^*)^{T_{n-t}}} = 1, \text{ by definition of } y^*.$$

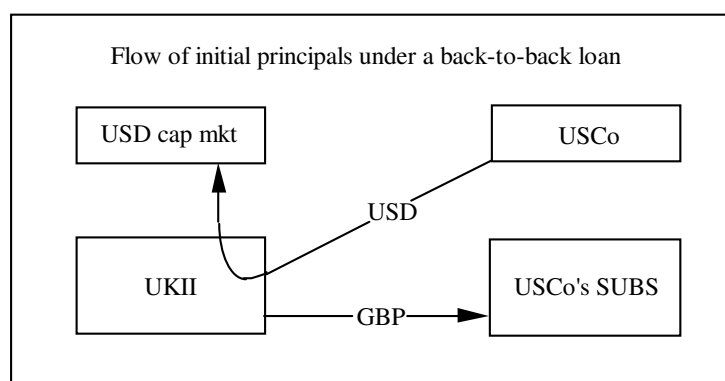
which implies that the swap has zero initial net value:

$$PV \text{ of HC leg} = S_t [PV, \text{ in FC, of FC leg }].$$

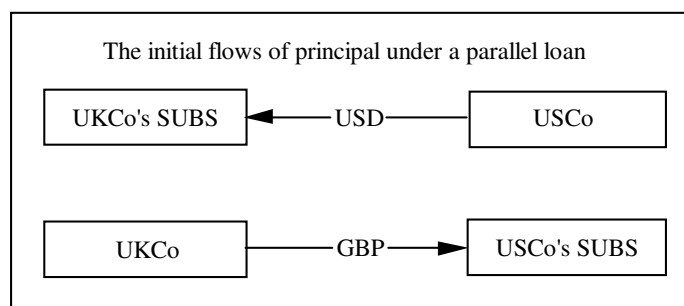
Thus, with a swap,

- Interest is paid periodically rather than all at once (at the end). This implies that: (1) There are n future exchanges of moneys, not just one, and (2) X has to be set differently because the face value of the swap does not include interest.
- The PV of all inflows taken together equals, initially, the PV of all outflows taken together. The PV of the two amounts exchanged at one particular date T_i need not be equal.

2. Short-term swap and repurchase order: see question 1. Back-to-back loan:



Parallel loan:



Both predecessors use two separate loan contracts, usually linked by a right of offset. The swap is one contract with a right of offset.

Applications

1. The modern long-term currency swap can be viewed as:
 - (a) a spot sale and a forward purchase.
 - (b) a combination of forward contracts, each of them having zero initial market value.
 - (c) a combination of forward contracts, each of them having, generally, a non-zero initial market value but with a zero initial market value for all of them taken together.
 - (d) a spot transaction and a combination of forward contracts, each of them having, generally, a non-zero initial market value but with a zero initial market value for all of them taken together.

A. (d).
2. The swap rate for a long-term swap is:
 - (a) the risk-free rate plus the spread usually paid by the borrower.
 - (b) the risk-free rate plus a spread that depends on the security offered on the loan.
 - (c) close to the risk-free rate, because the risk to the financial institution is very low.
 - (d) the average difference between the spot rate and forward rates for each of the maturities.

A. (c).
3. The general effect of a swap is:

- (a) to replace the entire service payment schedule on a given loan by a new service payment schedule on an initially equivalent loan of another type (for instance, another currency, or another type of interest).
- (b) to replace the risk-free component of the service payment schedule on a given loan by a risk-free component of the service payment schedule on an initially equivalent loan of another type (for instance, another currency, or another type of interest).
- (c) to change the currency of a loan.
- (d) to obtain a spot conversion at an attractive exchange rate.

A. (a) or (b), depending on how you agree to do it.

4. You borrow USD 1m for six months, and you lend EUR 1.5m—an initially equivalent amount—for six months, at p.a. rates of 6 percent and 8 percent, respectively, with a right of offset. What is the equivalent spot and forward transaction?

A.

The spot transaction is USD 1m for EUR 1.5m (at $S_t = \text{EUR/USD } 1.5$), and the forward transaction is an exchange of USD $1\text{m} \times 1.03$ for EUR $1.5\text{m} \times 1.04 = 1.56$, with an implied forward rate of $\text{EUR/USD } \frac{1.56\text{m}}{1.03\text{m}} = 1.5145631$. This forward rate can be computed directly from the spot and interest rates as $\text{EUR/USD } 1.5 \times (\frac{1.04}{1.03}) = F_{t,T}$.

5. Your firm has USD debt outstanding with a nominal value of USD 1m and a coupon of 9 percent, payable annually. The first interest payment is due three months from now, and there are five more interest payments afterwards.
- (a) If the yield at par on bonds with similar risk and time to maturity is 8 percent, what is the market value of this bond in USD? In Yen (at $S_t = \text{JPY/USD } 100$)?
 - (b) Suppose that you want to exchange the service payments on this USD bond for the service payments of a 5.25-year JPY loan at the going yield, for this risk class, of 4 percent. What should be the terms of the JPY loan?

A.

- (a) $\text{USD } 1\text{m} \times [1 + (0.09 - 0.08) \times a(6\text{years}, 8\%)] \times 1.08^{0.75} = 1,108,396.1$, or JPY 110,839,609.
- (b) The face value must satisfy $(\text{face value}) \times 1 \times 1.04^{0.75} = \text{JPY } 110,839,480$. Thus, the face value is $\text{JPY } \frac{110,839,482}{1.04^{0.75}} = 107,626,564$.

6. You borrow NOK 100m at 10 percent for seven years, and you swap the loan into NZD at a spot rate of NOK/NZD 4 and the seven-year swap rates of 7 percent (NZD) and 8 percent (NOK). What are the payments on the loan, on the swap,

and on the combination of them? Is there a gain if you could have borrowed NZD at 9 percent?

A.

	NOK loan	Swap		
		NZD 25m at 7%	NOK 100m at 8%	combined
Principal at t	NOK 100	NZD 25	<NOK 100>	NZD 25
Interest	<NOK 10>	<NZD 1.75>	NOK 8	<NZD 1.75 + NOK 2>
Principal at T	<NOK 100>	<NZD 25>	NOK 100	<NZD 25>

Thus, the 2 percent spread on NZD 25m in a direct fixed-rate loan is replaced by the 2 percent spread on NOK 100m. The NZD spread, when discounted at 9 percent and translated into NOK, is worth more than the NOK spread, which must be discounted at 10 percent. Thus, there still is a (small) gain in swapping.

7. Use the same data as in the previous exercise, except that you now swap the loan into floating rate (at LIBOR). What are the payments on the loan, on the swap, and on the combination of them? Is there a gain if you could have borrowed NZD at LIBOR + 1 percent?

A.

	NOK loan	Swap		
		NZD 25m at LIBOR	NOK 100m at 8%	combined
Principal at t	NOK 100	NZD 25	<NOK 100>	NZD 25
Interest	<NOK 10>	<NZD 25 × LIBOR>	NOK 8	<NZD 25 × LIBOR + NOK 2>
Principal at T	<NOK 100>	<NZD 25>	NOK 100	<NZD 25>

Thus, the 1 percent spread above LIBOR that you would have paid on a direct floating rate loan of NZD 25m in a direct loan is replaced by the 2 percent spread on NOK 100m. The former, when discounted at 9 percent and translated into NOK, is worth less than the latter, even though it must be discounted at 10 percent. Thus, the swap is not recommendable.

8. You can borrow CAD at 8 percent, which is 2 percent above the swap rate, or at CAD LIBOR + 1 percent. If you want to borrow at a fixed-rate, what is the best way: direct, or synthetic (that is, using a floating-rate loan and a swap)?

A

Synthetic: you borrow at LIBOR + 1, and the swap replaces LIBOR by the fixed swap rate, 6 percent. Thus, the borrowing cost of the synthetic fixed-rate loan is $\text{LIBOR} + 1\% - \text{LIBOR} + 6\% = 7\%$ percent fixed, which is below your (direct) fixed-rate interest cost.

9. You have an outstanding fixed-for-fixed NOK/NZD swap for NOK 100m, based on a historic spot rate of NOK/NZD 4 and initial seven-year swap rates of 7 percent (NZD) and 8 percent (NOK). The swap now has three years to go, and the current rates at NOK/NZD 4.5, 6 percent (NZD three years), and 5 percent (NOK three years). What is the market value of the swap contract?

A.

The NZD leg is worth $(\text{NZD}25\text{m} \times (1 + (0.07 - 0.06) \times a(3 \text{ years}, 6 \text{ percent})) \times 4.5 = \text{NOK}115.507\text{m}$, while the NOK leg is worth $\text{NOK} 100 \times (1 + (0.08 - 0.05) \times a(3 \text{ years}, 5 \text{ percent})) = \text{NOK}108.170\text{m}$. Thus, the net value is $\text{NOK} 7.337\text{m}$.

10. Use the same data as in the previous exercise, except that now the NZD leg is a floating rate. The rate has just been reset. What is the market value of the swap?

A.

The NZD leg is at par in NZD, so its NOK value is $25\text{m} \times 4.5 = \text{NOK} 112.5\text{m}$. The NOK leg was valued at $\text{NOK} 108.170$ in the previous exercise. Thus, the net value of the swap is $\text{NOK} 4.33\text{m}$.

Chapter 8

Currency Options (1): Concepts and Uses

Quiz Questions

True-False Questions

1. The only difference between European-style and American-style options is that European-style options are traded only in Europe while American options are traded only in the us.
2. The buyer of an option has an obligation to purchase the underlying asset in the case of a call, or sell in the case of a put, while the seller of an option has the right to deliver in the case of a call, or take delivery in the case of a put.
3. A put offers the holder of an asset protection from drops in the underlying asset's value, while a call provides protection from an increase in the underlying asset's price.
4. The intrinsic value of a call is its risk-adjusted expected value.
5. The immediate exercise value of an option is its value alive.
6. If a call's strike price exceeds the spot rate, the call is in the money.
7. If an in-the-money put has positive value, its value is based purely on time value.
8. A European-style call will always be at least as valuable as a comparable American call.
9. An option is always at least as valuable as the comparable forward contract.

10. Put Call Parity implies that puts and calls written at the forward rate will have different values because, if the foreign interest rate exceeds the domestic rate, the forward rate is at a discount; therefore the exchange rate is expected to depreciate, making the put more valuable.
11. Speculators disagree with the market's probability distribution function for an asset's value; that is, they sell assets that the market perceives as overvalued and buy assets that the market perceives as undervalued.

A.

1. false; 2. false; 3. true; 4. false; 5. false; 6. false; 7. false; 8. false; 9. true; 10. false; 11. false.

Multiple-Choice Questions

The exercises below assume that the put and the call both have a strike price equal to X , a domestic T-bill has a face value equal to X , and both a foreign T-bill and forward contract pay off one unit of foreign currency at expiration. All instruments expire on the same date.

1. A forward sale can be replicated by:
 - (a) selling a put and buying a call.
 - (b) selling a foreign T-bill and buying a domestic T-bill.
 - (c) buying a put and selling a call.
 - (d) both b and c
 - (e) all of the above

A. (d).
2. A put can be replicated by:
 - (a) buying a call and selling foreign currency forward.
 - (b) buying a foreign T-bill and selling a call.
 - (c) buying a domestic T-bill, selling a foreign T-bill, and buying a call.
 - (d) both a and c
 - (e) all of the above

A. (d).
3. A call can be replicated by:
 - (a) buying foreign currency forward and buying a put.

- (b) buying a foreign T-bill and selling a put.
- (c) buying a put, selling a domestic T-bill, and buying a foreign T-bill.
- (d) all of the above
- (e) none of the above

A. (a) & (c).

Additional Quiz Questions

Use the following table's data, excerpted from *The Wall Street Journal* of Tuesday, March 22, 1994, to answer questions 1 to 4.

Option& underlying	Strike price	Call—Last			Put—Last		
		Apr	May	Jun	Apr	May	Jun
31,250 British Pounds—cents per unit.							
148.61	147 1/2	r	r	r	0.95	1.80	r
148.61	150	0.60	r	1.85	r	r	r
148.61	155	0.07	r	0.57	r	r	r
148.61	157 1/2	0.03	r	r	r	r	r
62,500 New Zealand Dollars—cents per unit.							
59.04	58	1.08	r	r	0.35	0.65	0.90
59.04	58 1/2	0.79	r	1.35	0.46	r	1.13
59.04	59	0.51	0.80	1.02	0.80	1.10	1.40
59.04	59 1/2	0.35	r	r	r	r	r
6,250,000 Japanese Yen—100ths of a cent per unit.							
94.18	93	r	r	r	r	r	1.29
94.18	93 1/2	r	r	r	0.72	r	r
94.18	94	r	r	r	r	1.41	1.68
94.18	94 1/2	0.81	r	r	1.12	r	r
r—not traded. s—no option offered. Last is premium(purchase price).							

r—not traded. s—no option offered. Last is premium(purchase price).

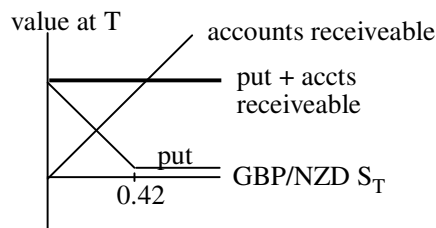
- What is the last quote for an April call option on GBP with a strike price of 155?
A. 0.07.
- What is the last quote for a May put option on NZD with a strike price of 58?
A. 0.65.
- What is the last quote for a June put option on JPY with a strike price of 93 1/2?
A. The option was not traded on Monday, March 21.
- For the options below, what is the intrinsic value? Is the intrinsic value greater than, less than, or equal to the option premium?
(a) June call on GBP with a strike price of 150.

- (b) May put on GBP with a strike price of 147 1/2.
- (c) April call on NZD with a strike price of 59.
- (d) June put on NZD with a strike price of 59.
- (e) May call on JPY with a strike price of 93.
- (f) May put on JPY with a strike price of 94.

A.

- (a) $IV = 0 < 1.85 = \text{premium}$.
 - (b) $IV = 0 < 1.80 = \text{premium}$.
 - (c) $IV = 0.04 < 0.51 = \text{premium}$.
 - (d) $IV = 0 < 1.40 = \text{premium}$.
 - (e) option not traded.
 - (f) $IV = 0 < 1.41 = \text{premium}$.
5. You hold a foreign exchange asset that you have hedged with a put. Show graphically how the put limits the potential losses created by low exchange rates, without eliminating the potential gains from high rates.
6. You have covered a foreign exchange debt using a call. Show graphically how the call limits the potential losses created by high exchange rates, without eliminating the potential gains from low rates.

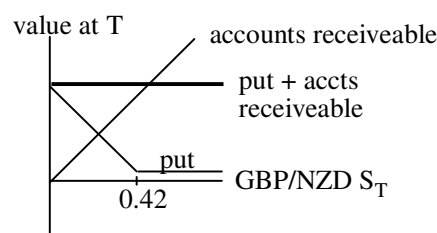
A5. & A6.



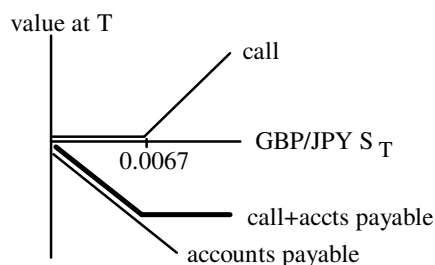
7. Assume that the contracts discussed below are described with the GBP as the home currency and that the option's expiration date matches the expiration date of the cash flow to be hedged. Illustrate how the exchange rate affects the GBP value of:
- (a) a NZD 500,000 accounts receivable and a purchase of ten puts each worth NZD 50,000 with a strike price of GBP/NZD 0.42.
 - (b) a JPY 10,000,000 accounts payable and a purchase of ten calls each worth JPY 1,000,000 with a strike price of GBP/JPY 0.0067.

A.

(a)



(b)

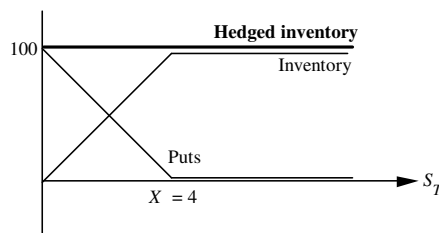


Applications

1. The Danish wool trader in Section 6.5.3 faces potential competition from Australian producers.
 - (a) Graphically analyze the value of the trader's inventory as a function of the future spot price.
 - (b) Explain why a put on AUD eliminates the dependence of the inventory's value on the exchange rate for DKK/AUD.

A.

- (a) For $S_T \geq X = 4$, his stock is worth DKK 100 irrespective of S_T (a flat line); for $S_T < X$, the stock is worth $25 \times S_T$, a ray through the origin with a slope of 25 (see the graph below). This is like a domestic currency bond with face value 100, *minus* a put (that is, with a *shorted* put) struck at $X = 4$.
- (b) By buying a put with a strike price $X = 4$, you add a downward-sloping line with an intercept at 100 and with the same (absolute) slope as the inventory line in the domain $S_T < X$. In short, you are just buying back the implicit (shorted) puts.

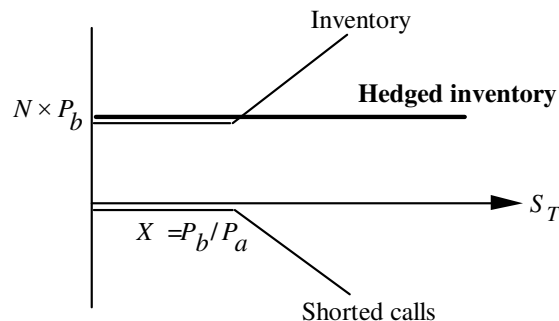


Note how the price of the puts is the present risk-adjusted expected value of the potential losses created by Australian imports.

2. The UK firm, Egress Import-Export, Ltd, sells its goods at home for P_b when the value of the EUR is low. As the value of the EUR increases, it starts exporting its goods at the foreign price (net of costs) P_a , netting it $P_a \times \tilde{S}_T$.
 - (a) Illustrate the value of Egress's goods as a function of the future spot price.
 - (b) How can Egress eliminate its exposure to the EUR (that is, sell its potential EUR profits)?

A.

The stock of commodities is worth $N \times P_b$ when $S_T < P_b/P_a$ and $N \times P_a \times S_T$, otherwise. From the graphical representation, this is like a domestic bond with face value $N \times P_b$, plus $N \times P_a$ calls on foreign exchange with strike price $X = P_b/P_a$. Selling the implicit calls will eliminate exposure. The premium received is the risk-adjusted present value of potential extra gains from exports.



3. The Thailand Plettery Steel Company has a debt of NZD 100,000, which is repayable in twelve months. Plettery's controller Jane Due is having trouble sleeping at night knowing that the debt is unhedged. The current THB/NZD exchange rate is 20, and p.a. interest rates are 21 percent on THB and 10 percent on NZD. Jane is considering a forward hedge (at $F_{t,T} = 20 \times 1.21/1.10 = 22$), but a friend tells her that he recently bought a call on NZD 100,000 with $X = 20$,

and is willing to sell it to her at the historic cost, THB 1 per NZD or THB 100,000 for the total contract. What should she do?

A.

The call premium asked by her friend violates the lower bound and therefore is an absolute must. A forward contract at $X = 20$ has a value of $(22 - 20)/1.21 = 1.653$. Since, unlike a forward contract at $X = 20$, the option cannot have a negative expiration value, and it should be worth more than that.

4. Assume that the interest rates are 21 percent and 10 percent p.a. in Thailand and Switzerland, respectively. Consider a call and a put at $X = \text{THB/CHF } 21$.
- What is the lower bound for European-style options with lives equal to $T - t =$ one year, six months, three months, one month, when $S_T = 18, 20, 22, 24$, respectively?
 - If $S_T = 20$, $r_{t,T} = 0.21$, $r_{t,T}^* = 0.10$, a one-year call with $X = \text{THB/CHF } 20$ priced at 1 is undervalued. Show that, with this call price, we can buy a synthetic put at a negative price.

A.

For the call, first compute the value of the forward contract at $X = 21$,

$$\frac{S_t}{1+(T-t) \times 0.10} - \frac{21}{1+(T-t) \times 0.21}$$

$S_t =$	18	20	22	24
Life = 12 months	-0.99	0.83	2.64	4.46
6 months	-1.86	0.04	1.85	3.85
3 months	-2.39	-0.44	1.51	3.46
1 month	-2.79	-0.8	1.18	3.16

Next, add the bound $C_t > 0$ which, of course, becomes relevant when the value of a comparable forward is negative. Also the option's intrinsic value becomes a minimum value:

$S_1 =$	18	20	22	24
<i>Lower bounds:</i>				
Life = 12 months	0	0.83	2.64	4.46
6 months	0	0.04	1.85	3.85
3 months	0	0	1.51	3.46
1 month	0	0	1.18	3.16
<i>Intrinsic value:</i>	0	0	1	3

If at $S_T = 24$ the call is almost a forward purchase contract (so that the call is priced close to its lower bound¹), its value still exceeds the intrinsic value, and exercise is never optimal. An American call will therefore be priced as if it were European. In this example, the reason is that the foreign interest rate is far below the domestic rate.

For the put, first look at the values of comparable forward sales contracts, and these are the same as the above values of the purchase contracts, except for the sign. The non-negativity bound yields the following floor for our various put prices:

$S_1 =$	18	20	22	24
<i>lower bounds:</i>				
life = 12 months	0.99	0	0	0
6 months	1.86	0	0	0
3 months	2.39	0.44	0	0
1 month	2.79	0.8	0	0
<i>intrinsic value:</i>	3	1	0	0

If, for instance, at $S_t = 18$ the (European) put is nearly degenerate and therefore trades near the value of a forward sale², its value would be below the intrinsic value. Given this, an American put would already have been exercised. Therefore, early exercise of the put does not have an *ex ante* probability equal to zero, and all “alive” American puts must trade above European put prices. If the foreign rate had far exceeded the domestic interest rate, you would not have observed this.

5. A charitable organization has issued a bond that gives the holder the option to cash in the principal as either USD 10,000 or NZD 20,000. This asset can be viewed as a USD 10,000 bond plus a call on NZD 20,000 at $X = 0.5$ USD/NZD.
 - (a) Can the bond also be viewed as a NZD bond plus an option?
 - (b) Explain how the two equivalent views are just an application of Put Call Parity.
 - (c) The strike price, $X = \text{USD}/\text{NZD}$, is the natural way of quoting a rate for a US investor. But buying NZD 20,000 at USD/NZD 0.5 is the same as selling USD 10,000 at $X' = \text{NZD}/\text{USD} 2$. This way of expressing the transaction makes more sense to a New Zealander. Restate the conditions of the bonds using

¹With the above figures, that is. In general, the answer could change.

²Note how the lower bound becomes important not when the put is cheap, but when the lower bound is very high. In other words, a put trading close to its bound is deep in the money, and therefore very valuable.

this NZD/USD strike price, and make the two possible interpretations of the option from a German investor's point of view.

A.

- (a) Yes. The bond may be viewed as a NZD 20,000 bond plus a call on USD_T 10,000 at $X = \text{NZD/USD } 2$, or as a NZD 20,000 bond plus a put on NZD_T 20,000 at $X = \text{USD/NZD } 0.5$, or as a USD 10,000 bond with a put on USD_T 10,000 at $X = \text{NZD/USD } 2$. To check all this, first consider the US point of view, and express all prices in USD. Start with the common sense interpretation of the bond, and then check all of the above combinations where the strike price is in USD/NZD:

	$S_T (\text{USD/NZD}) < 0.5$	$S_T > 0.5$
Payoff of bond	10,000	$S_T \times 20,000$
Interpretation 1: USD 10,000 bond + call on NZD at 0.5	10,000 0	10,000 $(S_T - 0.5) \times 20,000$
Total	10,000	$S_T \times 20,000$
Interpretation 2: NZD 20,000 bond + put on NZD at 0.5	$S_T \times 20,000$ $(0.5 - S_T) \times 20,000$	$S_T \times 20,000$ 0
Total	10,000	$S_T \times 20,000$

- (b) Since both views are perfectly and equally correct at time t , it must be that in equilibrium:

$$\frac{10,000}{1+r_{t,T}} + C_t \times 20,000 = S_t \times \frac{20,000}{1+r_{t,T}^*} + P_t \times 20,000$$

or, after division by 20,000 and noting that $X = 0.5$,

$$X_1 + r_{t,T} + C_t = S_t \frac{1}{1+r_{t,T}^*} + P_t$$

which is Put Call Parity.

- (c) To take the German point of view, do the same:

	$S'_T \text{ (USD/NZD)} < 2$	$S'_T > 2$
Payoff of bond	$S'_T \times 10,000$	20,000
Interpretation 1: USD 10,000 bond + call on NZD at 0.5	20,000 $(S'_T - 2) \times 10,000$	20,000 0
Total	$S'_T \times 10,000$	20,000
Interpretation 2: NZD 20,000 bond + put on NZD at 0.5	$S'_T \times 10,000$ 0	$S'_T \times 10,000$ $(2 - S'_T) \times 10,000$
Total	$S'_T \times 10,000$	20,000

6. The software giant, Kludge Systems, has issued a bond that gives the holder the choice between USD 10,000, NZD 20,000, and GBP 5,000. Can Kludge's bond be replicated using simple options?

A.

No. It is tempting to say that you have, for instance, a USD_T 10,000 bond plus a call on NZD_T 20,000 at $X = \text{USD}/\text{NZD } 0.5$, plus a call on GBP_T 5,000 at $X = \text{USD}/\text{GBP } 2$. But it is possible that, at time T , both the NZD and the GBP are above their strike prices; if you had two separate calls, you would exercise both of them. In contrast, this bond allows you to exercise only one of the above options. Therefore, you really have a USD 10,000 bond, plus a call on the maximum of (NZD 20,000, GBP 5,000).

7. You have purchased a zero-coupon EUR bond that gives you the choice between EUR 100,000 at $T_2 = 2$ or EUR 90,000 at $T_1 = 1$.

- (a) What options (put and/or call) are implicit in this bond? (Hint: there are two correct descriptions.)
- (b) Show that the two equivalent views of this instrument are an application of Put Call Parity.

A.

You could view this as a: o Two-year EUR₂ 100,000 bond with a put on a one-year EUR₁ 90,000 bond with a strike price of $X = \text{EUR } 90,000$; or, o One-year EUR₁ 90,000 bond with a call on the two-year EUR₂ 100,000 bond with a strike price of $X = \text{EUR } 90,000$. Both options are European and expire at T . Define V_T as the (EUR) price of the underlying asset, the two-year bond. Verify the claim by looking at the value of the bond at $T = 1$.

	$V_T \leq 90,000$	$V_T > 90,000$
Your bond	V_T	90,000
Interpretation 1: Two-year bond + call on EUR at 0.5	V_T 0	V_T $90,000 - V_T$
Total	V_T	90,000
Interpretation 2: One-year bond + call at 90,000	90,000 $V_T - 90,000$	90,000 0
Total	V_T	90,000

Since both views are equally correct, it must be that $V_t + P_t = PV_t(90,000) + C_t$ where V_t is the value of the underlying asset (the non-dividend paying two-year bond), and 90,000 is the value of the one-year bond. This is Put Call Parity.

8. The lower bound on a non-degenerate American-style put (that is, a put where there is still some uncertainty about whether $\tilde{S}_T > X$ or not) is:

$$P_t^{am} > P_t > \frac{X}{1+r_{t,T}} - \frac{S_t}{1+r_{t,T}^*}$$

Assume that $S_T = 0$ and $r_{t,T} = 0$. Common sense says that you should exercise the put, since the exchange rate cannot fall any further. Yet the bound $P_t > X$ says that the put should trade above its intrinsic value. Where is the fallacy?

A.

The fallacy is that an exchange rate is literally zero only if it is known never to achieve a positive value again. Then, the option is degenerate, and its value is $P_t = X$ (with equality rather than inequality).

In reality, an exchange rate never quite reaches zero, and it can always fall farther. So if S_t is not quite zero, and if there is no time value lost by postponing exercise, standard logic is still applicable: a forward sale is riskier than a put option, so the put trades above $X - \frac{S_t}{1+r_{t,T}^*}$ and *a fortiori* above $X - S_t$.

9. A *cylinder* option on the sale of foreign currency is a contract defined as follows:

- If $\tilde{S}_T > X_1$, you sell foreign exchange at X_1 , the floor
- If $\tilde{S}_T > X_2$, where $X_2 > X_1$, you sell at X_2 , the cap
- If $X_1 \leq \tilde{S}_T \leq X_2$, you sell at \tilde{S}_T .

This contract restricts the uncertainty about the futures sales price to the range $X_1 \leq \tilde{S}_T \leq X_2$.

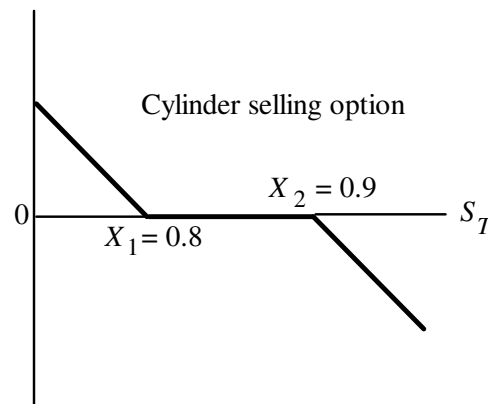
For instance, Barrel Imports has a sales contract to sell CAD against USD:

- At $X_1 = \text{USD/CAD } 0.80$ if the CAD trades below 0.80.
- At $X_2 = \text{USD/CAD } 0.90$ if the CAD trades above 0.90.
- The spot rate if that rate is between 0.80 and 0.90.

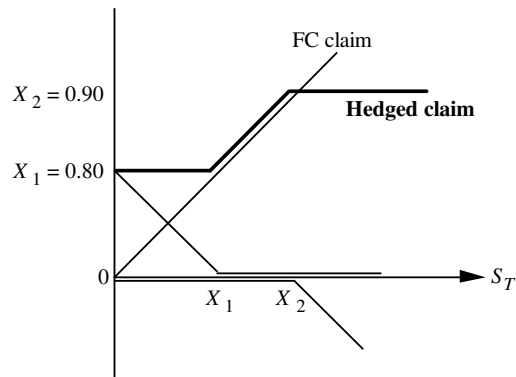
- Show the payoff of the contract graphically.
- Show that it can be viewed as a combination of European-style options.
- Illustrate the value of a foreign currency claim hedged with such a contract.

A.

- If $S_T > X_2$, you lose $S_T - X_2$ since you *have to sell* at the upper bound, which is less than the spot rate. If $S_T < X_1$, you win $X_1 - S_T$, since you *are allowed to sell* at the lower bound, which is above the spot rate. For in-between spot rates, there is neither a gain nor a loss. So the graph looks like the following:



- The cylinder option is a combination of a put at X_1 (representing *your right to sell* at X_1 when $S_T < X_1$) and a *written call* at X_2 (representing *the bank's right to buy* from you at X_2 when $S_T > X_2$ or of *your obligation to sell* at X_2 when $S_T > X_2$). Note that for $X_1 \leq S_T \leq X_2$ both options are worthless, so that the combined value is zero in that domain.
- The hedged claim has the following exposure schedule:



Banks usually choose X_1 and X_2 such that the value of the total package is zero, like for a forward contract, or positive. You could, of course, construct contracts with a negative value (when the value of the call you write exceeds the value of the put, you buy—so that, on balance, the bank pays you something). A cylinder is also called a “collar” or “forward range”; the range $[X_1, X_2]$ is negotiable. The options are European, not American. When $X_1 = X_2 = X$, the forward range collapses to a forward contract with forward price X .

Chapter 9

Currency Options (2): Hedging and Valuation

Quiz Questions

True-False Questions

1. An option's exposure is the sensitivity of a change in the price of the underlying asset to a change in the option's price.
2. The binomial model uses the risk-adjusted probability q as the certainty equivalent for the unknown (true) probability p .
3. The factor u is the risk-adjusted probability of an upward change in the exchange rate.
4. Dynamic hedging assumes that at any discrete moment investors can readjust their portfolio holdings.
5. The delta or exposure of an option is constant.
6. The delta or hedge ratio is the number of calls one needs in order to replicate foreign currency.
7. The probability π is a cumulative probability while $(\sum_{j=a}^n) \binom{x}{y} q^j (1-q)^{n-j}$ is a probability for a single drawing.
8. The value of an American option should always be greater than or equal to its intrinsic value.

A. 1. false; 2. true; 3. false; 4. true; 5. false; 6. false; 7. false; 8. true.

Multiple-Choice Questions

1. The replication approach to valuing a call option means:
 - (a) that the payoffs of the call and its underlying asset are always identical.
 - (b) buying forward a number of units of the underlying asset such that the payoffs of the option and the forward purchase are identical.
 - (c) buying forward a number of units of the underlying asset such that the payoffs of the option and the forward purchase are identical up to a known amount, which is then replicated in the money market.
 - (d) selling the call and buying forward a number of units of the underlying asset such that the payoffs are equal to zero.

A. (c)
2. The forward hedging approach to valuing a call option means:
 - (a) buying the call and selling forward a number of units of the underlying asset such that the payoffs are equal to the value of a domestic T-bill.
 - (b) buying forward a number of units of the underlying asset such that the payoffs of the option and the forward purchase are identical.
 - (c) buying the call and selling forward a number of units of the underlying asset such that the payoffs are identical.
 - (d) selling the call and buying forward a number of units of the underlying asset such that the payoffs are equal to zero.

A. (a).
3. To compute the certainty equivalent of the future payoff you need:
 - (a) the true probability p .
 - (b) the risk-adjusted probability q .
 - (c) the expected probability $E(p)$.
 - (d) the implied probability of p .

A. (b).
4. As the number of periods in the binomial model increases,
 - (a) the resulting probability distribution of the future spot rate becomes bell-shaped.
 - (b) the resulting probability distribution of the call price becomes bell-shaped.
 - (c) the greater the likelihood that the exchange rate will become negative because price changes are additive.
 - (d) the risk-adjusted expected probability q decreases.

A. (a).

Additional Quiz Questions

1. If $S_0 = 100$ and the spot rate can increase by 6 percent or decrease by 3 percent, what is the spot rate at node:
 - (a) (3,3)?
 - (b) (3,2)?
 - (c) (3,1)?
 - (d) (3,0)?

A. (a) 119.1016 ; (b) 108.9892 ; (c) 99.7354 ; (d) 91.2673.
2. Suppose that the current EUR/GBP spot rate is 0.6, the effective risk-free rates of return are $r = 6$ percent and $r^* = 8$ percent, and the spot rate will either increase to 0.62 or decrease to 0.57 at time 1.
 - (a) What is the risk-adjusted probability of a spot rate increase? Decrease?
 - (b) What is the risk-adjusted expected value of the European call with a strike price of 0.59?
 - (c) What is the time-0 value of the call?
 - (d) What is the factor $u(d)$ by which the spot rate increases? Decreases?
 - (e) What is the option's exposure?
 - (f) Would the option's value change if it were American?

A.

 - (a) 0.3778; 0.6222.
 - (b) 0.01133.
 - (c) 0.01069.
 - (d) 1.0333, 0.95.
 - (e) 0.6000.
 - (f) No, because the option's value (0.01069) exceeds its intrinsic value (0.01).
3. Repeat the question above using a put with the same strike price, instead of a call.

A.

 - (a) 0.3778; 0.6222.
 - (b) 0.01244.
 - (c) 0.01174.
 - (d) 1.0333, 0.95.
 - (e) -0.4.
 - (f) No, because the option's value (0.01174) exceeds its intrinsic value (0).

Applications

1. In the one-period example in Section ??, how could you make risk-free money if the call were valued at 10 rather than at 1.905?

A.

Sell one call at LKR 10 and replicate the call by a forward purchase of 1/3 USD and a LKR PN with time-1 face value 2. The cost at time-1 for replicating the call is 1.905 as shown in the text of Section ?. The risk-free money for you is $\text{LKR } 10 - \text{LKR } 1.905 = \text{LKR } 8.095$.

2. In the same example, how would you change your answer if you discovered that the probability of “up” were 0.1, so that the exchange rate looked grossly overvalued?

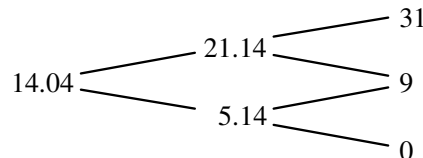
A.

You might be unwilling to buy the stock, or you might be even tempted to sell it short, but the analysis in the preceding exercise remains correct. Given the interest rates and a spot price of LKR 100, any call price different from 1.905 will produce arbitrage opportunities.

3. For the two-period call example in Section ??:

- (a) Show the tree of European call values if $X = 90$.
- (b) Compare this with the call’s intrinsic values at each node.
- (c) Check whether there is a chance of early exercise if the option were American.

A.



The European call’s price always exceeds its intrinsic value due to the fact that the foreign risk-free rate, 0.01, is small compared to the domestic rate, 0.05. If the foreign rate had been zero, you would not have needed the computations to verify this result. *A priori*, you would be sure that $C_t > (S_t - X)^+$.

4. Consider a one-period call option on the British pound. Suppose that the current exchange rate is USD/GBP 2, the exercise price is USD/GBP 1.9, the one-period risk-free rate on the USD is 5 percent, and the one-period risk-free rate on the GBP is 10 percent. Suppose that the spot rate can either go up by a factor of 1.1 (to USD/GBP 2.2) or down by 0.9 (to USD/GBP 1.8).

- (a) Write down the two equations that show how one can replicate the cash flow from the option by investing in the foreign currency and borrowing domestically. What is the value of the call option, using the replication approach?
- (b) Compute the risk-neutral probabilities and use these to value the above call option.

A.

$$(a) F_{0,1} = 2 \frac{1.05}{1.10} = 1.9091; q = \frac{0.3-0}{2.2-1.8}.$$

$$(a1) S_{1,u}: \text{exposure} \times [S_{1,u} - F_{0,1}] + \text{deposit}_{0,1} = \text{call}_{1,u}.$$

$$(a2) S_{1,d}: \text{exposure} \times [S_{1,d} - F_{0,1}] + \text{deposit}_{0,0} = \text{call}_{1,d}.$$

$$(a1) S_{1,u}: 0.75 \times [2.2 - 1.9091] + 0.0818 = 0.3.$$

$$(a2) S_{1,d}: 0.75 \times [1.8 - 1.9091] + 0.0818 = 0.3.$$

The present value of the call equals $0.0818/1.05 = 0.0779$.

$$(b) q = \frac{\frac{1.05}{1.10} - 0.9}{1.10 - 0.9} = 0.272727.$$

$$\text{Present value of the call equals } \frac{0.3 \times 0.273 + 0 \times 0.7273}{1.05} = \frac{0.0818}{1.05} = 0.0779.$$

5. Suppose that the current spot rate is $S_0 = \text{USD/GBP } 2$ and the one-period interest rates today are r is 5 percent and r^* is 10 percent. Also, you are given that in the next period the spot rate will either be USD/GBP 2.2 or USD/GBP 1.8.
 - (a) What is the value today of a one-period put option on the GBP that has a strike price of USD/GBP 1.9?
 - (b) Suppose that you already hold this put option. If you wish to hedge the payoff from the put, so that the net payoff of your portfolio is independent of the exchange rate, how many additional units of the spot should you buy/sell?

A.

$$(a) P_0 = \frac{(1 - 0.272727) \times 0.1}{1.05} = 0.069264.$$

$$(b) \text{Exposure} = \frac{0 - 0.1}{2.2 - 1.8} = 0.25.$$

- Forward hedge: sell GBP 0.25 (forward).

- Spot hedge: borrow GBP $0.25 \times \frac{1}{1.1} = \text{GBP } 0.227272$ units.

6. In this exercise, we numerically verify that the probabilities derived for European calls also work for other contracts by (i) valuing the contracts starting from the value of a call, and (ii) by checking whether a risk-adjusted probability evaluation provides the same answer.

Consider the example used in Section ?? . The data used were $u = 1.1$, $d = 0.9$, $(1 + r) = 1.05$, $(1 + r^*) = 1.0294118$, $S_0 = 100$; for our call, $X = 95$. The tree, including the (risk-adjusted) probabilities for time 2, is reproduced below; ignore the columns added to the right, initially.

EUR T-bill		<i>prob</i>	Call at 95	Put at 95	Forward at 95
100	121	0.36	26	0	26
	110				
	99	0.48	4	0	4
	90				
	81	0.16	0	14	-14

- Compute the call value using the binomial model.
- Compute the two-period forward rate directly (using Interest Rate Parity), and indirectly (using our risk-adjusted probabilities, that is, as $CEQ_0(\tilde{S}_2)$).
- Compute the present value of an “old” forward purchase struck at $F_{t0,2} = 95$ directly (using the formula in Chapter 3), and indirectly (using q).
- Value a European put with $X = 95$ directly (using Put Call Parity), and indirectly (using q).

A.

- $C_0 = \frac{(26 \times 0.36) + (4 \times 0.48) + (0 \times 0.16)}{1.05^2} = 10.23$.
- IRP says that $F_{0,2} = 100 \times \frac{1.05^2}{1.0294118^2} = 104.04$, while the “mean” computed with the risk-adjusted probabilities is:
 $CEQ_0(\tilde{S}_2 = F_{0,2}) = (121 \times 0.36) + (99 \times 0.48) + (81 \times 0.16) = 104.04$.
- Directly, the outcome is the discounted value of the difference between the current forward rate 104.04 and the contract’s delivery price 95: $PV = (1102.5 - 890)/1.052 = 192.7$. Indirectly, you can find the same number:
 $PV = \frac{(26 \times 0.36) + (4 \times 0.48) - (14 \times 0.16)}{1.05^2} = 8.20$.
 (As a parenthesis, compare this computation with the above calculation for the call; clearly, the call is worth more because it avoids the forward contract’s negative outcome in node (2,0), to wit, -4. This is a concept that you should clearly understand by now.)
- From Put Call Parity, the put should be priced as C_0 minus the value of a forward purchase at 95, that is, as:

$$P_0 = 10.23 - 8.20 = 2.03.$$

The risk-adjusted probabilities approach again produces the same value:

$$P_0 = \frac{(14 \times 0.16)}{1.05^2} = 2.03.$$

(The example also stresses the relation between puts, calls, and forward contracts at $X = 95$. The call is worth more than the forward purchase because the negative outflow, minus 14×0.16 in node (2,0), is missing (compare the payoff columns). This is precisely the term captured by the put, as can be seen from the column showing the put's payoff. So a call minus a put is equivalent to the forward purchase—in terms of expiration values as well as of risk-adjusted present values. Again, this merely illustrates something we knew all along.).

7. Consider a four-month call option on the British pound. Suppose that the current exchange rate is USD/GBP 1.6, the exercise price is USD/GBP 1.6, the risk-free rate on the USD is 8 percent p.a., the risk free rate on GBP is 11 percent p.a., and the volatility of the spot rate (and the forward rate) is 10 percent. Using the results in Teknote ??, translate the volatility into an up and down factor (u and d). Then solve the following problems:

- What is the value that you would be willing to pay for this American call option if you used the one-period binomial approach to value it?
- What would you be willing to pay for this option if the volatility were 14.1 percent?

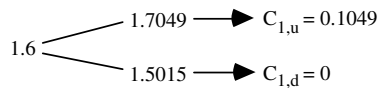
A.

- USD = home currency

$$u = e^{\sigma \sqrt{h}} = e_{0.11 \sqrt{4/12}} = 1.06557; \quad d = \frac{1}{u} = 0.938466.$$

$$q = \frac{\frac{1+(0.08 \times \frac{4}{12})}{1+(0.11 \times \frac{4}{12})} - 0.938}{1.066 - 0.938} = 0.4082.$$

The exchange rate in each node at time 1 is shown below:



The value of a European call at time 0 is: $\frac{0.1049 \times 0.4082}{1.02667} = 0.0417118$. Since the intrinsic value of the call is zero, the value of the American call is also 0.0417118.

- $u = e^{\sigma \sqrt{h}} = e^{0.141 \sqrt{4/12}} = 1.0848117; \quad d = \frac{1}{u} = 0.921819.$

Because the intrinsic value of the call at time 0 is 0, the value of the American call, equals:

$$C_0^{am} = \frac{0.135699 \times 0}{1.02667} = 0.0555761.$$

8. Suppose that the spot rate is USD/CAD 0.75 and the volatility of this exchange rate is 4 percent p.a. The risk-free rate in the US is 7 percent p.a. and in Canada it is 9 percent p.a. Suppose that the exercise price is USD/CAD 0.75 and the American put option matures in nine months.

- (a) Find the value of this option using the one-period binomial approach.
 (b) Find the value of this option using the two-period binomial approach.

A.

- (a) Approximately \$0.0285.
 (b) Approximately \$0.0430.

9. A foreign currency put option is equivalent to a position in the foreign currency T-bill and a certain amount of borrowing/lending of the home currency. Is your replicating position in the foreign currency T-bill long or short? Why? Do you borrow or lend the home currency? Why?

A.

You borrow the foreign currency to offset the negative exposure of the put. You must invest in the local currency (otherwise net investment is negative).

10. Show that $CEQ_t(\tilde{F}_{T_1, T_2}) = F_{t, T_2}$.

A.

This exercise uses the telescope property of expectations: the expectation of the conditional expectation of X is just the expectation of X . Formally: in a risk-neutral world, you would have $F_{T_1, T_2} = E_{T_1}(S_{T_2})$ where $E_{T_1}(\cdot)$ is an expectation conditional on time- T_1 information. Taking expectations at time $t < T_1$, then,

$$E_t(F_{T_1, T_2}) = E_t(E_{T_1}(S_{T_2})) = E_t(S_{T_2}) = F_{t, T_2}.$$

That is, in a risk-neutral world, forward rates are a martingale (a randomly continuously compounded accumulating process without drift). In a risk-avert world, the above results remain valid if the expectations are computed over a risk-adjusted distribution, that is, when $E(\cdot)$ is replaced by $CEQ(\cdot)$.

11. What happens to the value of an option when both S_0 and X change by the same factor, holding u , d , r , and r^* constant?

A.

$q = \frac{\frac{1+rt_f T}{1+r^*_{t,T}} - d}{q-d}$ is unaffected, and the payoffs $(S - X)_+$ or $(X - S)_+$ change by the same factor as S and X . Thus, the CEQ and the current price also change by the same factor.

Chapter 10

Do We Know What Makes Forex Markets Tick?

[no exercises]

Chapter 11

Do Forex Markets Themselves See What's Coming?

Quiz Questions

True-False Questions

1. Technical forecasting models analyze microeconomic variables in an attempt to forecast future changes in the exchange rate.
2. Fundamental analysis models analyze macroeconomic variables in an attempt to forecast future changes in the exchange rate.
3. By a “technical correction,” one means that investors underreact to bad news so that the exchange rate does not drop as low as it should. This means that demand must fall further, in order to correctly value a foreign currency in terms of the home currency.
4. If the exchange rate bottoms out (that is, it hits a low point but begins to rise again), and then increases again by x percent, we can make substantial (and low-risk) profits by buying foreign currency—even when paying “retail” bid-ask spreads.
5. Because we cannot make significant profits from predicting the exchange rate based on past information, the exchange markets are weak-form efficient.
6. Runs tests have confirmed that positive changes in the exchange rate tend to be followed by positive changes, and negative changes by negative changes. This is consistent with the conclusions from autocorrelation tests.
7. The results from runs tests and autocorrelation tests provide unambiguous evidence that the foreign exchange market is inefficient.

8. Central bankers are able to forecast the future spot rate because they have inside information.
9. Central bankers are manifestly able to forecast the future spot rate because they have inside information, but they cannot forecast the current forward rate because they cannot know the future risk-free rates of return.

A. 1. false; 2. true; 3. false; 4. false: not big, and wiped out when costs are high; 5. the first part is false, from some studies: we can make profits. Otherwise the second part does follow. 6. true; 7. false: predictability may reflect momentum in risk premiums or interest rates etc. 8. false: possibly true—but they may also have superior insight; 9. false: nonsense statement, the current forward rate is observed so it does not need any forecasting.

Multiple-Choice Questions

Choose the correct answer(s).

1. Technical analysis:
 - (a) has been proven to be utterly useless as a way of predicting exchange rates.
 - (b) relies on statistical and econometric models rather than on trading rules.
 - (c) is solely based on a forecaster's sentiments about the exchange rate markets.
 - (d) can only work when there is weak-form market efficiency.
 - (e) provides evidence of semi-strong-form inefficiency (when technical analysis works, that is).
 - (f) is none of the above.

A. f.

2. Fundamental analysis:
 - (a) has been proven to be of little value as a way of predicting exchange rates.
 - (b) relies on macroeconomic variables like inflation, interest rates, and real economic output.
 - (c) may rely on a forecaster's sentiments about the exchange rate markets rather than solely on a formal, quantitative model.
 - (d) can only work when there is weak-form market efficiency.
 - (e) provides evidence of semi-strong-form inefficiency (when fundamental analysis works, that is).

A. a.

Chapter 12

(When) Should a Firm Hedge its Exchange Risk?

Quiz Questions

True-False Questions

1. In perfect markets, a manager's decision to hedge a firm's cash flows is irrelevant because there is no exchange rate risk.
2. In perfect markets, a manager's decision to hedge a firm's cash flows is irrelevant because the shareholders can hedge exchange risk themselves.
3. If a large firm keeps track of the exposure of each of its divisions, the firm has better information about each division, and is therefore better able to make decisions.
4. If a firm does not have a hedging policy, the managers may insist on higher wages to compensate them for the risk they bear because part of their lifetime future wealth is exposed to exchange rate risk.
5. If the firm does not have a hedging policy, the managers may refuse to undertake risky projects even when they have a positive net present value.
6. The risk-adjusted expected future tax savings from borrowing in your local currency always equals the present value of the expected tax savings from borrowing in a foreign currency.
7. The cost of hedging is roughly half of the difference between the forward premium and the spot exchange rate.
8. A reinvoicing center assumes the exchange rate risk of the various subsidiaries of a multinational corporation if it allows each subsidiary to purchase or sell

in its “home” currency.

A. 1. false; 2. false; 3. true; 4. true; 5. true; 6. false; 7. false; 8.true.

Valid-Invalid Questions

Determine which statements below are valid reasons for the manager of a firm to hedge exchange rate risk and which are not.

1. The manager should use hedging in order to minimize the volatility of the cash flows and therefore the probability of bankruptcy even though the expected return on the firm’s stock will also be reduced.
2. Firms may benefit from economies of scale when hedging in forward or money markets, while individual shareholders may not.
3. The chance of financial distress is greater when a firm’s cash flows are highly variable, and financial distress is costly in imperfect markets.
4. Shareholders do not have sufficient information about a firm’s exposure.
5. Risk-averse employees demand a risk premium when the volatility of a firm’s cash flows is high.
6. Short selling is often difficult or impossible for the individual shareholders.
7. Hedging a foreign currency inflow is beneficial when the forward rate is at a premium, because it is profitable and therefore desirable. In contrast, such hedging is not desirable when the forward rate is at a discount.
8. Since a forward contract always has a zero value, it never affects the value of the firm—but it is desirable because it reduces the variability of the cash flows.
9. Hedging reduces agency costs by reducing the variability of the firm’s cash flows. Hedging means that the manager bears less personal income risk, making the manager more likely to accept risky projects with a positive net present value.
10. Hedging is desirable for firms that operate in a flat-tax-rate environment because income smoothing means that they can expect to pay less taxes.
11. Managers have an incentive to hedge in order to reduce the variability of the firm’s cash flows because even though a firm may be able to carry forward losses, there is the loss of time value.

A. 1. false: we don't really know whether expected returns would drop; 2. true; 3. true; 4. true; 5. false; 6. true; 7. false: the forward rate is the just risk-adjusted expected value of the future (unknown spot rate); 8. false: a forward contract has a zero value only at inception; it is true though that the contract can reduce the variability of the cash flows; 9. true; 10. false; 11. true.

Multiple-Choice Questions

Choose the correct answer(s).

1. The Modigliani-Miller theorem, as applied to the firm's hedging decision, states that

- (a) in perfect markets and for given cash flows from operations, hedging is irrelevant because by making private transactions in the money and foreign exchange markets, the shareholders can eliminate the risk of the cash flows.
- (b) bankruptcy is not costly when capital markets are perfect.
- (c) a firm's value cannot be increased by changing the proportion of debt to equity used to finance the firm. Thus, the value of the tax shield from borrowing in home currency exactly equals the risk-adjusted expected tax shield from borrowing in foreign currency.
- (d) if the shareholders are equally able to reduce the risk from exchange rate exposure as the firm, then hedging will not add to the value of the firm.
- (e) markets are perfect so hedging by the manager of the firm and the shareholders is irrelevant.

A1. (a), (d).

2. Hedging may reduce agency costs because

- (a) some of the uncertainty of a manager's lifetime income has been diversified away.
- (b) the shareholders will always prefer volatile projects while the debtholders will prefer nonvolatile ones.
- (c) risk-averse employees will demand a risk premium from a firm that is more likely to be in financial distress.
- (d) customers will think twice about purchasing goods from a company that may not be able to offer long-term customer service.
- (e) a reduction in the variability of the firm's cash flows may reduce the likelihood for conflicts between the debtholders and the shareholders.

A2. (a), (e); (c) and (d) are true in themselves but are not related to the concept of agency costs.

3. Which of the following statements represent capital market imperfections?
- (a) Agency costs.
 - (b) The difference between half of the bid-ask spread between the spot and forward markets.
 - (c) The potential costs from renegotiating a loan that has gone into default.
 - (d) The time value lost from having to carry forward losses into a future tax year.
 - (e) Fees for liquidators, lawyers, and courts in the event of bankruptcy.

A3. (b), (c), (e).

Applications

1. Using the following data, compute the cost of hedging for each forward contract in terms of implicit commission and in terms of the extra spread as a percent of the midpoint spot rate.

Maturity	Rates	Bid-ask	Hedging cost	Extra spread
Spot	49.858-49.898	0.040		
Fwd 30 days	49.909-49.965	0.056		
Fwd 60 days	49.972-50.043	0.071		
Fwd 90 days	50.061-50.157	0.096		
Fwd 180 days	50.156-50.292	0.136		

A1.

Maturity	Rates	Bid-ask	Hedging cost	Extra spread
Spot	49.858-49.898	0.040		
Fwd 30 days	49.909-49.965	0.056	0.016	0.016%
Fwd 60 days	49.972-50.043	0.071	0.031	0.031%
Fwd 90 days	50.061-50.157	0.096	0.056	0.056%
Fwd 180 days	50.156-50.292	0.136	0.096	0.096%

2. In the wake of the North American Free Trade Agreement, the firm All-American Exports, Inc. has begun exporting baseball caps and gloves to Mexico. Suppose that All-American is subject to a tax of 30 percent when it earns profits less than or equal to USD 10 million and 40 percent on the part of profits that exceeds USD 10 million. The table below shows the company's profits in USD under three exchange rate scenarios, when the firm has hedged its income and when it has left its income unhedged. The probability of each level of the exchange rate is also given.

	Hedged Profits	Unhedged profits	Probability
S_{hi}	15m	20m	25%
$S_{unchanged}$	10m	10m	50%
S_{lo}	5m	0	25%

- (a) Compute the taxes that All-American must pay under each scenario.
- (b) What are All-American's expected taxes when it hedges its income?
- (c) What are All-American's expected taxes when it does not hedge its income?

A2.

(a)

	Hedged Profits	Unhedged profits	Probability
S_{hi}	6m	8m	25%
$S_{unchanged}$	3m	3m	50%
S_{lo}	1.5m	0	25%

(b) Expected taxes given hedging = 3.375.

(c) Expected taxes without hedging = 3.5.

3. In order to hedge its Mexican peso earnings, All-American is considering borrowing MXN 25 million, but is concerned about losing its USD interest tax shield. The exchange rate is USD/MXN 0.4, $r_{t,T} = 8\%$, and $r_{t,T}^* = 6\%$. The tax rate is 35 percent.

(a) What is All-American's tax shield from borrowing in USD?

(b) What is All-American's tax shield from borrowing in MXN?

(c) What is the risk-adjusted expected tax shield from borrowing in MXN?

A3.

(a) $\text{USD } 10m \times 0.08 = \text{USD } 0.8m$: tax savings $\text{USD } 0.8 \times 0.35 = \text{USD } 280,000$.

(b) $\text{MEP } 25m \times 0.06 = \text{MEP } 1.5m$: tax savings $\text{MEP } 1.5 \times 0.35 = \text{MEP } 525,000$.

(c) $F_{t,T} = 0.4 \times 1.08106 = 0.40755$. The tax shield from interest is worth $\text{MEP } 525,000 \times 0.40755 = \text{USD } 213,964$ in terms of risk-adjusted expectations. In addition, there is an expected appreciation of $\text{MEP } 25m \times (0.40755 - 0.4) = \text{USD } 188,750$, which carries a tax savings of $\text{USD } 66,063$. Thus, the total tax savings, after risk-adjustment, are expected to be $\text{USD } 213,964 + 66,063 = \text{USD } 280,027$.

4. Graham Cage, the mayor of Atlantic Beach, in the US, has received bids from three dredging companies for a beach renewal project. The work is carried out in three stages, with partial payment to be made at the completion of each stage. The current FC/USD spot rates are NZD/USD 1.6, DKK/USD 5.5, and CAD/USD 1.3. The effective USD returns that correspond to the completion of each stage are the following: $r_{0,1} = 6.00$ percent, $r_{0,2} = 6.25$ percent and $r_{0,3} = 6.50$ percent. The companies' bids are shown below. Each forward rate corresponds to the expected completion date of each stage.

Company	Stage 1	Stage 2	Stage 3
Auckland Dredging	NZD 1,700,000	NZD 1,800,000	NZD 1,900,000
forward rate NZD/USD	$F_{0,1} = 1.65$	$F_{0,2} = 1.70$	$F_{0,3} = 1.75$
Copenhagen Dredging	DKK 5,200,000	DKK 5,800,000	DKK 6,500,000
forward rate DKK/USD	$F_{0,1} = 5.50$	$F_{0,2} = 5.45$	$F_{0,3} = 5.35$
Vancouver Dredging	CAD 1,300,000	CAD 1,400,000	CAD 1,500,000
forward rate CAD/USD	$F_{0,1} = 1.35$	$F_{0,2} = 1.30$	$F_{0,3} = 1.25$

(a) Which offer should Mayor Cage accept?

A1.

Present value in USD	Stage 1	Stage 2	Stage 3	Total
For Auckland Dredging	$\frac{1,700,000}{1.65 \times 1.06}$	$\frac{1,800,000}{1.70 \times 1.0625}$	$\frac{1,900,000}{1.75 \times 1.065}$	2,987,974
For Copenhagen Dredging	$\frac{5,200,000}{5.50 \times 1.06}$	$\frac{5,800,000}{5.45 \times 1.0625}$	$\frac{6,500,000}{5.35 \times 1.065}$	3,034,358
For Vancouver Dredging	$\frac{1,300,000}{1.35 \times 1.06}$	$\frac{1,400,000}{1.30 \times 1.0625}$	$\frac{1,500,000}{1.25 \times 1.065}$	3,048,791

Mayor Cage should accept offer from Auckland Dredging.

(b) Was he wise to accept the bids in each company's own currency? Please explain.

A2. Yes, he was wise to accept the bid in each company's own currency. As he is the buyer, once he choose the best bid, he can easily to hedge against the exchange rate risk. It it is also easier for the supplier, who would probably have charged a risk premium for the risk of bidding in a (to her) foreign currency.

Chapter 13

Measuring Exposure to Exchange Rates

13.1 Test Your Understanding: contractual exposure

Quiz Questions

True-False Questions

1. Exchange risk describes how volatile a firm's cash flows are with respect to a particular exchange rate.
2. Exchange exposure is a measure of the sensitivity of a firm's cash flows to a change in the spot exchange rate.
3. Hedging exposure means eliminating all risk from a net position in a foreign currency.
4. If you need to hedge a series of exposures with different maturities and you use duration hedging, it is best to hedge the negative exposures separately from the positive exposures.
5. Contractual exposure is the absolute change in the firm's cash flows for a unit change in the spot exchange rate.
6. Operating exposure is the exposure that results when the forward rate is at a discount with respect to the spot rate at the moment you sign a sales or purchase contract.
7. Contractual exposure is additive for one maturity and one currency.

8. Options are undoubtedly the best choice for hedging foreign currency exposure because the possibility of profiting from a favorable change in the exchange rate remains open without the losses from an unfavorable change in the exchange rate.
9. Reverse exchange risk is the risk that arises when you receive a foreign currency A/R that you left unhedged, and the exchange rate at the time of receipt is unexpectedly low.
10. When interest rates are zero, we can aggregate exposures of a given currency across time.
11. If interest rates are positive but certain, and exchange rates are uncertain, we can aggregate the exposure of one currency across time once we take time value into account.
12. By pooling the aggregate exposure of one currency across time, we can ignore time value, because we have arbitrated away interest rate risk. The only risk that remains is exchange rate risk.

Ans. 1. false; 2. true; 3. true: unless the term “hedging” also refers to partial hedging; 4. true; 5. false; 6. false; 7. true; 8. false: you pay a fair price for such an option, so it is not obvious that an option is superior to a linear hedge; 9. false; 10. true; 11. true; 12. false.

Matching Questions

Suppose that you are a manager at a British firm, and you are responsible for managing exchange rate exposure. Determine whether the following statements are related to accounting exposure, operating exposure, or contractual exposure.

1. Your German subsidiary has recently made new investments.
2. You bought a call option on EUR to hedge an EUR accounts payable.
3. You have just sold goods to an American customer. The customer has ninety days to pay in USD.
4. You have just developed an exciting new product. The success of this product depends on how it is priced in the local currencies of your export markets.
5. You have made a bid to deliver your exciting new product to schools in France during the next academic year. You will learn whether or not the bid has been accepted in three months.
6. You sell wool but face potential competition from Australia. If there are no imports, the price of your wool will be GBP 1. However, Australians enter your market once the exchange rate falls below GBP/AUD 2.

Ans. 1. AE because the machinery is an asset whose value has to be translated for the company's consolidated balance sheet. There could also be transaction exposure if the machinery is still to be paid for and the price is expressed in a third currency. Also, OE since the market value of the investment will depend on exchange rates; 2. CE, initially and afterwards (because the option is not a perfect hedge); 3. CE. Also, AE if the reporting date is within 90 days; 4. OE; 5. OE; 6. OE.

Applications

1. The American firm, American African Concepts, has a one-year EUR A/P totaling EUR 100,000 and a one-year Senegalese A/R totaling CFA 120,000,000. The CFA/EUR exchange rate is fixed at 655.957.

- (a) Can AAC offset its EUR A/P with its CFA A/R?
- (b) If so, how much exposure remains?

A1. (a) Yes, because the CFA/EUR exchange rate is fixed, and the USD/EUR and USD/CFA spot exchange rates are perfectly correlated. Therefore, the A/R and A/P are perfectly hedged up to EUR 100,000 or CFA 65,595,700. (b) An exposure of CFA 54,404,300 still remains.

2. The Dutch manufacturer Cloghopper has the following JPY commitments:

- A/R of JPY 1,000,000 for thirty days.
- A/R of JPY 500,000 for ninety days.
- Sales contract (twelve months) of JPY 30,000,000.
- A forward sales contract of JPY 500,000 for ninety days.
- A deposit that at maturity, in three months, pays JPY 500,000.
- A loan for which Cloghopper will owe JPY 8,000,000 in six months.
- A/P of JPY 1,000,000 for thirty days.
- A forward sales contract for JPY 10,000,000 for twelve months.
- A/P of JPY 3,000,000 for six months.

- (a) What is Cloghopper's net exposure for each maturity?
- (b) How would Cloghopper hedge the exposure for each maturity on the forward market?
- (c) Assume that the interest rate is 5 percent (compound, per annum) for all maturities and that this rate will remain 5 percent with certainty for the next twelve months. Also, ignore bid-ask spreads in the money market. How would the company hedge its exposure on the spot market and the JPY money market? Describe all money-market transactions in detail.

- (d) If the interest rate is 5 percent (compound, per annum) for all maturities and will remain 5 percent with certainty for the next twelve months, how would the company hedge its exposure on the forward market if only one forward contract is used?
- (e) Assume that Cloghopper prefers to use traded options rather than forward contracts. The option contracts are not divisible, have a life of either 90, 180, 270, or 360 days, and for each maturity the face value of a contract is JPY 1,000,000. How could Cloghopper hedge its exposure? Do the options offer a perfect hedge for each maturity?
- (f) Drop the assumption of a flat and constant term structure. If Cloghopper wants to hedge its exchange rate exposure using one forward contract and its interest rate exposure using FRA contracts, how would the analysis of parts (c) and (d) be affected? A verbal discussion suffices.
- (g) The term structure is flat right now (at 5 percent p.a., compound), but is uncertain in the future. Consider the spot hedge of part (c). If, instead of FRAs, duration is used to eliminate the interest risk, how should Cloghopper proceed?

A2.

(a)

Maturity	30 days	90 days	180 days	360 days
1)	1,000,000			
2)		500,000		
3)				30,000,000
4)		-500,000		
5)	500,000			
6)			-8,000,000	
7)	-1,000,000			
8)				-10,000,000
9)			-3,000,000	
Total	500,000	0	-11,000,000	20,000,000

(b) For 30 days, sell JPY 500,000 forward.

For 90 days, no hedging necessary.

For 180 days, buy JPY 11,000,000 forward.

For 360 days, sell JPY 20,000,000 forward.

(c) The total time- t value of Cloghopper's exposure equals

$$\frac{500,000}{1.05^{1/12}} - \frac{11,000,000}{1.05^{6/12}} + \frac{20,000,000}{1.05} = \text{JPY } 8,810,690.$$

Thus, Cloghopper can sell the time- t value of its exposure on the spot market. That is, it borrows JPY 8,810,690 and converts this amount into EUR. After 30 days,

the company makes a partial repayment of JPY 500,000 on its JPY loan; after 180 days it borrows another JPY 11m (at 5 percent compound, for five months); and after 360 days it pays off all its debts, including interest, with the JPY 20m inflow. Thus, no spot transaction is needed at all after the initial hedge—that is, the exposure is eliminated.

(d) Cloghopper could hedge its exposure with one forward contract in many different ways, depending on the maturity of the forward contract it chooses. Following are the computations for 30, 180, and 360 days:

1. Hedge with a 30-days forward contract. Cloghopper first discounts its 180 and 360 days exposure to 30 days:

$$\text{JPY } 500,000 - \frac{11,000,000}{1.05^{5/12}} + \frac{20,000,000}{1.05^{11/12}} = \text{JPY } 8,846,585.$$

Cloghopper then sells this exposure forward at the forward rate for 30 days. After 30 days Cloghopper borrows JPY 8,346,585 and delivers these, together with the JPY 500,000, to its bank which delivers home currency in return. After 180 days, it borrows another JPY 11m (at 5 percent compound, for five months). After 360 days, it receives an inflow of JPY 20m which is exactly enough to pay off the first debt plus interest at JPY 8,728,354 and the second debt plus interest at JPY 11,271,646.

2. Hedge with a 180-days forward contract. Cloghopper first computes the future value of its 30 day exposure at 180 days and the discounted value of its 360 day exposure at 180 days:

$$\text{JPY } 500,000 \times 1.05^{5/12} - 11,000,000 + 20,000,000 \times 1.05^{6/12} = \text{JPY } 9,028,270.$$

Cloghopper then sells this exposure forward at the forward rate for 180 days. After 30 days, the company invests its JPY 500,000 inflow for five months. After 180 days, the proceeds of this investment are delivered to the bank; the company also borrows another JPY 9,028,270 – 500,000 × 1.05^{5/12} = 8,300,421 to fulfill its remaining forward obligations. In addition, it borrows JPY 11m to pay its A/P. After 360 days, all outstanding loans, including interest, are paid back using the JPY 20m from the A/R.

3. Hedge with a 360-days forward contract. Cloghopper first computes the future value of its 30- and 180- day exposures at 360 days:

$$\text{JPY } 500,000 \times 1.05^{11/12} - 11,000,000 \times 1.05^{6/12} + 20,000,000 = \text{JPY } 9,251,224.$$

Cloghopper sells its exposure of JPY 9,251,224 forward at the forward rate for 360 days. After 30 days, it invests its JPY 500,000 inflow at 5 percent p.a. for eleven months; after 180 days, it borrows JPY 11m to settle its A/P. After 360 days, its net debt (including interest) and its forward obligation are all settled using the JPY 20m inflow.

(e) Because the option contract is not divisible, Cloghopper's 30-day exposure of JPY 500,000 may remain unhedged. The alternative is to buy one contract, which leaves the company with a "speculative" JPY 500,000 long call. It can hedge its 180-day exposure by buying eleven call contracts or selling eleven put contracts and its 360-day exposure by buying twenty put contracts or selling twenty call contracts. Cloghopper's 180- and 360-day exposures will be fully hedged.

(f) For all discounting to the current time (in part (c)), the appropriate spot interest rate for the maturity has to be used—ask for deposits, bid for loans. For all future value computations, Cloghopper should use the appropriate forward rates—for example 30 to 180 days, bid, in (d.1). Similarly, forward rates are to be used for all discounting to a future point in time—for example, 30 to 360 days, ask, in (d.1).

(g) As Cloghopper has both positive and negative exposures, these should be hedged separately. Cloghopper could deposit the present value of its negative exposure for 180 days, that is,

$$\text{JPY } 11m \times 1.05^{6/12} = 10,734,901.$$

This deposit perfectly matches this single outflow, so no interest risk remains on the short side.

Cloghopper also computes the present value and the duration of its positive exposures:

$$\begin{aligned} \text{PV} &= 0.5m \times 1.05^{1/12} + 20m \times 1.05 = \text{JPY } 19,545,590 \\ \text{Duration} &= \frac{(1/12) \times \frac{0.5m}{1.05^{1/12}} + 1 \times \frac{20m}{1.05}}{19,545,590} = 0.977 \text{ years, or 356 days.} \end{aligned}$$

Cloghopper should then take out a loan in JPY with, initially, the above PV and time to maturity. Once or twice a month—or more often, if interest rates change drastically—it should reassess the present value and duration, and adjust its loan.

Quiz Questions

True-False Questions

1. A firm that has no operations abroad does not face any operating exposure.
2. Only firms with exports, or firms that compete against foreign exporters, face operating exposure.
3. A firm that denominates all of its contracts in home currency, or hedges all of its foreign currency contracts, faces no operating exposure.
4. Almost every firm faces some operating exposure, although some firms are only exposed indirectly (through the country's general economic activity).
5. As large economies have a big impact on world economic activity, companies in such countries tend to be very exposed to exchange rates.
6. Small economies tend to fix their exchange rate relative to the currency of larger economies, or tend to create currency zones (like the EMS). Therefore, companies in small economies tend to be less exposed to exchange rates.
7. The smaller a country, the more open the economy. Therefore, exposure is relevant for most of the country's firms.
8. Everything else being the same, the larger the monopolistic power of a firm, the smaller its exposure because such a firm has more degrees of freedom in adjusting its marketing policy.
9. Consider an exporting firm that has substantial monopolistic power in its product market. Everything else being the same, the more elastic foreign demand is, the more an exporting firm will profit from a devaluation of its own currency. Similarly, the less elastic foreign demand is, the less an exporting firm will be hurt by an appreciation of its own currency.
10. Most information needed to measure operating exposure can be inferred from the firm's past export and import contracts.

A. 1. false; 2. false; 3. false; 4. true; 5. false; 6. false: the risk may be lower, but not the exposure; 7. true; 8. true; 9. false: not enough information ¹; 10. false.

¹Let profits equal $\Pi = S \times p^*(x) - c(x)$ where $x = \text{exports}$. Profit maximization means $S \frac{\partial p^*(x)}{\partial x} - \frac{\partial c(x)}{\partial x} = 0$. Therefore, $\frac{\partial \Pi}{\partial S} = xp^*(x) + [S \frac{\partial p^*(x)}{\partial x} - \frac{\partial c(x)}{\partial x}] \frac{\partial x}{\partial S} = xp^*(x)$. Without knowing what is held constant, it is impossible to say whether or not revenue $xp^*(x)$ is higher when elasticity is higher.

Multiple-Choice Questions

Choose the correct answer(s).

1. In a small, completely open economy,
 - (a) PPP holds relative to the surrounding countries.
 - (b) A 10 percent devaluation of the host currency will be offset by a 10 percent rise in the host country prices.
 - (c) The value of a foreign subsidiary, in units of the foreign parent's home currency, is unaffected by exchange rate changes.
 - (d) The real value of a foreign subsidiary to an investor from the host country is unaffected by exchange rate changes.
 - (e) In the absence of contracts with a value fixed in the host currency, the real value of a foreign subsidiary to an investor from the parent's home country is unaffected by exchange rate changes.
 - (f) In the absence of contracts with a value that is fixed in foreign currency, the real value of a foreign subsidiary to an investor from the host country is unaffected by exchange rate changes.
 - (g) There is little or no advantage to having one's own currency: exchange rate policy has virtually no effects.

A1. (a) and (g) are correct. (b) is wrong: the price rise will be 11.11 percent; (c) and (d) overlook contracts fixed in nominal terms; (e) and (f) should read "in the absence of contracts fixed in any currency".

2. In a completely closed economy,
 - (a) PPP holds relative to the surrounding countries.
 - (b) A 10 percent devaluation of the host currency will be offset by a 10 percent rise in the host country prices.
 - (c) The value of a foreign subsidiary, in units of the foreign parent's home currency, is unaffected by exchange rate changes.
 - (d) The real value of a foreign subsidiary to an investor from the host country is unaffected by exchange rate changes.
 - (e) In the absence of contracts with a value fixed in host currency, the real value of a foreign subsidiary to an investor from the parent's home country is unaffected by exchange rate changes.
 - (f) In the absence of contracts with a value that is fixed in foreign currency, the real value of a foreign subsidiary to an investor from the host country is unaffected by exchange rate changes.
 - (g) There is little or no advantage to having one's own currency: exchange rate policy has virtually no effects.

A2. (f), (g).

3. In an economy that is neither perfectly open nor completely closed,
 - (a) Consider a company that produces and sells in this economy. Apart from contractual exposure effects, its value in terms of its own (local) currency is positively exposed to the value of other currencies.
 - (b) The value of an importing firm located in this economy could either go up or go down when the local currency devalues: the effect depends on such factors as the elasticity of local demand and foreign supply.
 - (c) Consider a company that produces and sells in this economy. Apart from contractual exposure effects, its value in terms of a foreign currency is positively exposed to the value of its currency expressed in terms of other currencies.

A3. (a), (b): when costs increase, the value of the firm cannot; (c): the home currency value could go up, but this effect may be smaller than the effect of a host country devaluation.

4. Suppose that the value of the firm, expressed in terms of the owner's currency, is a linear function of the exchange rate up to random noise.
 - (a) The firm's exposure is the constant $a_{t,T}$ in $V_T(i) = a_{t,T} + b_{t,T} S_T(i) + e_{t,T}(i)$.
 - (b) The exposure is hedged by buying forward $b_{t,T}$ units of foreign currency.
 - (c) Hedging means that all risk is eliminated.

A4. (a), (b), and (c) are all false.

5. Suppose that the value of the firm, expressed in terms of the owner's currency, is a nonlinear function of the exchange rate up to random noise. Suppose that you fit a linear regression through this relationship, and you hedge with a forward sale with size equal to the regression coefficient.
 - (a) All risk will be eliminated.
 - (b) There is remaining risk, but it is entirely independent of the realized value of the exchange rate.
 - (c) There is remaining risk, but it is uncorrelated to the realized value of the exchange rate.
 - (d) There is no way to further reduce the variance of the firm's hedged value.
 - (e) There is no way to further reduce the variance of the firm's hedged value if only exchange rate hedges can be used.
 - (f) There is no way to further reduce the variance of the firm's hedged value if only linear exchange rate hedges can be used.

A5. (c), (f).

Applications

SynClear, of Seattle, Washington, produces equipment to clean polluted waters. It has a subsidiary in Canada that imports and markets its parent's products. The value of this subsidiary, in terms of CAD, has recently decreased to CAD 5m due to the depreciation of the CAD relative to the USD (from the traditional level of USD/CAD 0.85 to about 0.75). SynClear's analysts argue that the value of the CAD may very well return to its former level if, as seems reasonable, the uncertainty created by Canada's rising government deficit and Quebec's possible secession is resolved. If the CAD recovers, SynClear's products would be less expensive in terms of CAD, and the CAD value of the subsidiary would rise to about 6.5m.

1. From the parent's (USD) perspective, is the exposure of SynClear Canada to the USD/CAD exchange rate positive or negative? Explain the sign of the exposure.

A1. $S_{low} = 0.75$; the value in USD is $5m \times 0.75 = \text{USD } 3.75$.

$S_{high} = 0.85$; the value in USD is $6.5m \times 0.85 = \text{USD } 5.525$.

Thus, the exposure is strongly positive. This is because SynClear Canada is an importing firm. The stronger the CAD, the more competitive US products are in Canada and, therefore, the more profits SynClear Canada will make.

2. Determine the exposure, and verify that the corresponding forward hedge eliminates this exposure. Use a forward rate of USD/CAD 0.80, and USD/CAD 0.75 and 0.85 as the possible future spot rates.

A2. $B = \frac{5.525m - 3.75m}{0.85 - 0.75} = \text{CAD } 17.75m$.

If $S = 0.75$, the value in USD is $3.75 + 17.75 \times (0.80 - 0.75) = \text{USD } 4.6375$.

If $S = 0.85$, the value in USD is $5.525 + 17.75 \times (0.80 - 0.85) = \text{USD } 4.6375$.

3. SynClear's chairman argues that, as the exposure is positive and the only possible exchange rate change is an appreciation of the CAD, the only possible change is an increase in the value of the subsidiary. Therefore, he continues, the firm should not hedge: why give away the chance of gain? How do you evaluate this argument?

A3. The chairman overlooks two facts. First, only part of the gain from an appreciation is eliminated by the hedge. Second, if the appreciation does not materialize, SynClear will have a gain from the forward contract that alleviates the competitiveness problems associated with a low value of the CAD. In short, the hedge swaps part of the gain from an appreciation for a partial gain in case there is no appreciation.

In the remainder of this series of exercises, SynClear Canada's cash flows and market values are assumed, more realistically, to depend on other factors than just the exchange rate. The Canadian economy can be in a recession, or booming, or somewhere in between, and the state of the economy is a second determinant of the demand for SynClear's products. The table below

summarizes the value of the firm in each state and the joint probability of each state:

	State of the economy		
	Boom	Soso	Funk
$S_T=0.85$:Joint probability	0.075	0.175	0.25
Value _T (USD)	5.25	4.75	4.50
$S_T=0.75$:Joint probability	0.25	0.175	0.075
Value _T (USD)	4.25	3.857	3.50

4. What are the expected cash flows conditional on each value of the exchange rate?

A4. USD 4.70m when $S_T = 0.85$, and USD 4.00m when $S_T = 0.75$.

5. Compute the exposure, the optimal forward hedge, and the value of the hedged firm in each state. The forward rate is USD/CAD 0.80.

A5. The exposure is:

$$\begin{aligned}
 B &= \frac{4.70 - 4.00}{0.85 - 0.75} = \text{CAD } 7m. \\
 (V_{\text{hedged}}|S_T = 0.85) &= (V_{\text{unhedged}}|S = 0.85) + 7m \times (0.80 - 0.85) \\
 &= 4.7 - 0.35 \\
 (V_{\text{hedged}}|S_T = 0.75) &= (V_{\text{unhedged}}|S = 0.75) + 7m \times (0.80 - 0.75) \\
 &= 4.0 + 0.35.
 \end{aligned}$$

	State of the economy			Conditional Expectation
	Boom	Soso	Funk	
$S_T=0.85$: probability	0.075	0.175	0.25	n.a
Value _T (USD)	4.95	4.40	4.15	4.35
$S_T=0.75$: probability	0.25	0.175	0.075	n.a
Value _T (USD)	4.60	4.207	3.85	4.35

The conditional expectations have become independent of the exchange rate, but there still is as much sensitivity to the state of the economy as before, in the sense that the deviation of each possible outcome from its conditional expected value is the same as in the absence of hedging.

Chapter 14

Value-at-Risk: Quantifying Overall net Market Risks

Quiz Questions

True-False Questions

1. VaR does not take into account the correlations and cross-hedging between various asset categories or risk factors and is therefore not comparable across different asset classes.
2. One of the main advantages of VaR is that it is sub-additive, i.e., $\rho(X + Y) \leq \rho(X) + \rho(Y)$.
3. VaR does not distinguish between the different liquidities of market positions and only captures short-term risks in normal circumstances.
4. VaR can be extended from a 1-day horizon to a t -day horizon by multiplying by the square root of t if and only if the returns are i.i.d. and are normally distributed.
5. VaR should be complemented by stress testing for identifying potential losses under extreme market conditions.

A. 1. false (correlations may not be captured perfectly, especially correlations in cash scenarios, but saying that they are totally ignores is several bridges too far.)
2. true — if call satisfying elementary logic an advantage. 3. false — one can account for it. 4. false: normality is not required. 5. true.

Multiple-Choice Questions

Which question(s) is (are) correct (if any)?

1. The market risk department of Trustworthy Bank reports a \$5 million overnight VaR figure with 99.5 percent confidence level. The bank
 - (a) Can be expected to lose at most \$5 million in 1 out of the next 100 days
 - (b) Can be expected to lose at least \$5 million in 1 out of the next 200 days
 - (c) Can be expected to lose at most \$2.5 million in 1 out of the next 100 days
 - (d) Can be expected to lose at most \$5 million in 1 out of the next 200 days

A. 2 only
2. Given two portfolios, X and Y, whose returns are bivariate normal (implying that returns on portfolios of them are also normally distributed), do we have:
 - (a) $VaR(X) + VaR(Y) \leq VaR(X + Y)$?
 - (b) $VaR(X) + VaR(Y) = VaR(X + Y)$?
 - (c) $VaR(X) + VaR(Y) \geq VaR(X + Y)$?
 - (d) none of the above?

A. 3.
3. Drop the normality from the preceding question. So, given two portfolios, X and Y, do we have:
 - (a) $VaR(X) + VaR(Y) \leq VaR(X + Y)$?
 - (b) $VaR(X) + VaR(Y) = VaR(X + Y)$?
 - (c) $VaR(X) + VaR(Y) \geq VaR(X + Y)$?
 - (d) none of the above?

A. 3.
4. Which of the following portfolios is the most risky? Assume 240 trading days per year and 5 trading days a week.

Portfolio	Horizon	VaR	Confidence Interval
1	10	16	97.5
2	25	16	95
3	10	16	99
4	15	16	99
5	20	16	97.5

A. The question is unclear. If the question is where you can lose most at a given confidence level, then it's portfolio 2: there you can lose 16 or more with 5% chance. Next come portfolios 1 and 5: they have 2.5% chance to lose 16 or more within the estimated horizon, so the 1%-confidence bound would definitely be more than 16. All this of course assumes that the true liquidation horizon is the one indicated,

and that the $\sqrt{T-t}$ correction works well enough, and that the VaR numbers are otherwise correct.

If the question is which portfolio has the highest daily volatility, we need more computations to tease out that number. In the table below I add three columns to the original ones. One goes to one-day VaR by dividing 16 by \sqrt{days} . The second figures out how many standard deviations were used; in one popular spreadsheet you can program this computation as “=NORMIN($p,0,1$)” where p is the probability indicated in our data table (97.5%, for instance – to be entered as .975). The standard deviation per day then is the dailified VaR divided by the number of standard deviations:

Portf	Horiz	VaR	Confdnc	VaR/ \sqrt{days}	$N^{-1}(p)$	sigma
1	10	16	97.5	5.06	1.96	2.58
2	25	16	95	3.20	1.64	1.95
3	10	16	99	5.06	2.33	2.17
4	15	16	99	4.13	2.33	1.78
5	20	16	97.5	3.58	1.96	1.83

Portfolio 1 then has the highest daily sigma. It's saving feature is its relatively high liquidity, as indicated by its relatively short liquidation horizon.

Applications

1. The Basel accord requires that banks must meet, on a daily basis, a capital requirement based on the Market Risk Charge, given by

$$MRC_t^{IMA} = \text{Max}(k \frac{1}{60} \sum_{i=1}^{60} VaR_{t-i}, VaR_{t-1}) + SRC_t$$

The multiplication factor, k , is set based on the quality of the bank's risk management system, subject to an absolute minimum of 3. Chico Marx, the Governor of the Central Bank of Freedonia, decides one fine day that all banks in Freedonia will henceforth calculate the capital requirement based on a multiplication factor of 5 or above instead of 3 or above. What are the implications of such a move on Freedonian banks?

- A. The minimum amount of capital available may be going up by a factor 1.67, assuming that current VaR is not already unusually high. SRC, if any, would not be directly affected.
2. Graucho, Chico's brother and Freedonia's president, along with his Cabinet Ministers (Harpo, Gummo and Zeppo Marx—picture) wonder why k exceeds

unity, whether there is no typo (the formula says Max instead of Marx), why VaR is for 99%, and what SRC means. Enlighten these Eminences.

A. k takes care, in a very crude way, of non-normalities and worse events than the 99%-worst outcome: one cannot let the bank go belly up one day out of 100. “Max” is an operator, not a typo—but you may already have guessed that one. One takes VaR at 99% instead of, say, 99.95% because densities deep in the tail are too difficult to estimate and because a 99.95% VaR, computed from a normal, is not really a 99.95% confidence bound anyway; so we take the 99% number and arbitrarily triple it. SRC refers to extra risks following from underdiversification.



Source <http://www.marx-brothers.org/>

3. Zeppo doubles as treasurer of Duck Soup Inc.—admittedly owing his position to the fact that he is from the ruling family. Duck Soup Inc. has an asset of \$25 million and he needs to know the 99% worst-case loss over a 1-day period. Assume that the daily price volatility is 2.7% and the FDK/USD exchange rate is 3.4567. Give Zeppo *an* answer and then add all caveats that you think are appropriate.

A. If the volatility had been reliable and the distribution had been normal, the answer would have been $2.5\text{m} \times 0.027 \times 2.33 = 0.157\text{m}$, *ie* 157,000 crowns (if the amount of capital is expressed in crowns; otherwise translate at the spot rate). But of course the sigma is only a doubtful estimate and the world is far from normal. Tell Zeppo to read this chapter and think of the world since September 2007.

4. Harpo, the bright star in the Marx Intellectual Sky, muses that a 99% VaR means 2.33 std's, so the Basel number $k = 3$ stipulates a capital of just 7 std's. Yet, Harpo wonders, Philippe Jorion writes that almost every year some market moves by 10 std's. Thus, Basel is inadequate. Right?

A. Basel may be inadequate, but not for the reason advanced here. Philippe just says that every year some market moves by ten std's, which does not mean that all markets will move by 10 std's, nor that, if they do, they would all do that on the same day. As long as just one market is jumping, and your portfolio is well diversified, you are still fine.

5. Discuss the impact of the following factors on VaR:

(a) Options

(b) Liquidity

A. Options tend to have high volatility and big right-skewness, that is, their pay-offs would have been abnormal even if the underlying assets had been Normal. Low liquidity means either longer liquidation intervals or more price pressure when liquidating in a hurry; either increases the maximum losses.

Chapter 15

Managing Credit Risk in International Trade

Quiz Questions

True-False Questions

1. Trade on open account, with payment after or on delivery, is the standard way of doing business internationally among unrelated parties without an established business relationship because this method of payment has proven its value in domestic trade.
2. Under payment on or after delivery, most of the risks are borne by the exporter.
3. Under payment before shipment, the exporter bears only the risk of contract cancellation prior to shipment.
4. Suppose that, under payment upon delivery, the importer does not accept the goods. Then the exporter has no problem whatsoever, as he still is in possession of the goods.
5. In international trade, there often is a relatively large time gap between production outlays and payment by the final customer. However, it does not generally matter who provides this working capital. In addition, the issue of how to finance working capital is entirely separable from the issue of how the payment is structured.
6. Discounting a bill is similar to selling the bill for a price equal to the discounted value of the nominal (future) value.
7. Discounting a bill simply means giving an advance on the bill equal to the discounted value of the nominal (future) value. In addition, the discounter receives the bill as security for the payment.

8. Discounting a bill is like factoring with financing but without credit insurance, except that discounting of bills can be done transaction by transaction. Likewise, discounting without recourse is like factoring with financing and credit insurance.
9. Forfeiting, or discounting without recourse, is like factoring with financing and credit insurance, except that discounting of bills can be done transaction by transaction.
10. Under international law, a foreign government can never be judged by a court.
11. Under ordinary D/A and D/P (without L/C) the intervening bank still guarantees the payment, and will therefore reject any set of documents that is not perfectly conformable with the contract.
12. A trust receipt is often used to reduce the seller's risks in a D/P arrangement.
13. A Letter of Credit is a statement by a bank that promises to extend a loan to the exporter if certain conditions are met.
14. An irrevocable L/C offers the same security as an acceptance signed by the importer and insured with a government agency against credit risks.
15. An irrevocable, confirmed L/C offers the same security as an acceptance signed by the importer and insured with a government agency against political and credit risks.
16. Under an L/C, the bank agrees to inspect the goods, and to pay the exporter or accept the bill if the goods are fully conformable with the contract.

A. 1. false; 2. true; 3. true; 4. false: they're still far away; 5. false; 6. false: there's recourse, so it's more like secured borrowing; 7. true; 8. yes, if the last statement includes the case-by-case proviso too; 9. true; 10. false; 11. false; 12. one might quibble with the word "often"—otherwise true; 13. false; 14. false: a bank isn't a government-agency. 15. same; 16. false: bank never sees the goods.

Applications

1. What are the risks borne by the exporter and importer, respectively, under payment before shipment and payment on delivery, respectively?
A. Look at the table.
2. What characteristics of trade bills make these instruments well-suited to obtain low-cost financing?
A. Default provisions (recourse, protesting) and transferability.

3. Why is legal redress in international trade disputes more difficult than in domestic trade?

A. Different laws, different language, adverse selection (you're viewed by local lawyers as a chicken to be plucked), delays, enforcement, possibly bias against foreigners.

4. The writing and confirming of L/Cs must achieve more than just risk shifting without overall gains, otherwise these techniques would not exist. What are the advantages?

A. The risk is born by a party better suited to assess the risks and bear them: diversification, bank is in same legal environment as defaulter and has a strong position, being a local bank rather than a distant foreigner.

5. Some of the documents used in D/A, D/P, and documentary credits represent title to the goods. What purpose do the other documents serve?

A. Describe them, attest the quality; get them through customs.

6. Fill in the correct word from the following list: *accept, the drawer, trade bill, promissory note, the drawee, You Owe Me, I Owe You, banker's acceptance, trade acceptance.*

As the word suggests, in many ways a (a) is like a summary of the invoice. The supplier (b) draws the bill on the customer (c). That is, like an invoice, a trade bill is a (d) document. In itself, a trade bill is not as trustworthy as an (e) document, such as a (f), which is written and signed by the debtor. To give a trade bill the same credibility as a (g), the drawer typically sends it to the drawee with a request to (h) it, that is, to add the drawee's signature and thus to acknowledge and confirm the existence of the underlying debt. A trade bill drawn on and accepted by the importer is called a (i); a bill drawn on and accepted by a bank is called a (j).

(a) trade bill; (b) drawer; (c) drawee; (d) You Owe Me; (e) I Owe You; (f) promissory note; (g) see e or f. (h) accept; (i) acceptance; (j) banker's acceptance.

7. Complete the following table, by adding "+," "-", or "0" in each cell. A "+" rating means that the exporter (in part a of the table), or the importer (in part b) is adequately covered against the risk described on the left-hand side of the corresponding line. A "-" rating reflects that the risk is uncovered. A "0" rating reflects a compromise.

	pay after delivery	pay before shipment	D/P	D/A	L/C	confirmed L/C
	a. Exporter's risks					
a.1. Importer refuses goods						
Importer refuses documents						
a.2. Importer defaults						
L/Cs issuing bank defaults						
a.3. No license to import goods						
a.4. No license to remit payment						
	b. Importer's risks					
b.1. Exporter doesn't send goods						
b.2. Goods sent do not conform						
b.3. No license to ship the goods						

A.

	open invoice	pay before shipment	D/P	D/A	L/C	confirmed L/C
	a. Exporter's risks					
a.1. Importer refuses goods	—	+	+	+	+	+
Importer refuses documents	n.a.	n.a.	—	—	+	+
a.2. Importer defaults	—	+	+	—	+	+
L/Cs issuing bank defaults	n.a.	n.a.	n.a.	n.a.	—	+
a.3. No license to import goods	—	+	+	+	+	+
a.4. No license to remit payment	—	+	—	—	—	+
	b. Importer's risks					
b.1. Exporter doesn't send goods	+	—	+	+	+	+
b.2. Goods sent do not conform	+	—	+	+	+	+
b.3. No license to ship the goods	+	—	+	+	+	+

8. (This is a tough one, for readers who actually studied the appendices to Chapter 9 on lognormal option pricing.) The Johannesburg branch of Shanghai Chartered Bank (SCB) is considering a three-month loan to Bechuana Coffee Plantations (BCP), to be backed by BCP's export receipts. The expected harvest is about 100 tons, and the expected world coffee price is about 7,000 crowns/ton.

- (a) SCB must decide how much it can lend if it can use BCP's entire export revenue as security. What precautions could SCB take to make sure that the export revenue is actually used to pay back the loan?

A. get the agreement from the customers to pay to a trustee bank who then first pays off the lending bank.

- (b) One of SCB's analysts is asked to estimate the worst-case export revenue. Unfortunately, both BCP and the coffee market have changed quite a lot since the company's founding 20 years ago, so that the analyst cannot simply use the history of BCP's export revenue to assess the risk.

The analyst assumes that the actual output (\tilde{O}) and the price (\tilde{P}) are log-normally distributed, because this distribution is more consistent with the non-negativity of outputs and prices than a normal distribution and because then the revenue, $(\tilde{O} \times \tilde{P})$, is also conveniently lognormal. On the basis of commodity option prices and output data from similar plantations, the analyst then estimates the parameters of output and prices separately. The plan is to compute the confidence intervals for the normally distributed variable $\ln(\tilde{O} \times \tilde{P}) = \ln(\tilde{O}) + \ln(\tilde{P})$, which has mean and variance equal to $[\mu_o + \mu_p]$ and $[\sigma_o^2 + 2 \text{cov}_{o,p} + \sigma_p^2]$, respectively. From the lower bound on $\ln(\tilde{O} \times \tilde{P})$ the analyst can then infer the lower bound on $(\tilde{O} \times \tilde{P})$. From traded commodity option prices, SCB's analyst infers that the standard deviation of the log price is 10 percent over three months (20 percent p.a.). From past data on planted acreage and output for similar plantations, the standard deviation of BCP's output is estimated to be 15 percent over three months. Using the output and price expectations given above, what are μ_o and μ_p —the expected values of $\ln(\tilde{O})$ and $\ln(\tilde{P})$, rather than \tilde{O} and the price \tilde{P} ?

A. $\mu_p = E(\ln \tilde{P}_T) = \ln P_t + 0.1;$

$E(\tilde{O}_T) = \exp(\mu_o + 1/2\sigma^2)$ so $\mu_o = \ln(E(\tilde{O}_T)) - 1/2 \times 0.15^2$.

- (c) The analyst argues that, since Botswana has only a small share in the coffee market, the variance of the export revenue can be computed as if the covariance between local output and the world price is zero. Is this a conservative assumption or not? (Hint: what would be the sign of the covariance between the world output of coffee and the world price, and between BCP's output and the world price?)

A. The covariance, in non-zero, would be negative if most price shocks reflect supply shocks rather than demand shocks: low output sends up prices. By omitting a negative covariance, the variance of the product is underestimated, if anything.

- (d) How would SCB compute a 90 percent confidence interval for BCP's entire export revenue?

A. 90% confidence means 1.282 standard deviations below the mean, and the standard deviation is estimated as $\sqrt{0.10^2 + 0.15^2} = 0.18$

- (e) It turns out that BCP needs far less than 500,000 crowns. BCP signs a contract with CEH Jouy-en-Josas, a well-known and solid French coffee trader, to deliver 40 tons at the forward price of 6,900 crowns/ton. When computing the maximum amount it can lend on the strength of this forward contract, should SCB take a similar safety margin relative to the expected revenue from this transaction as the one computed in part (e)?

A. You need to look at the creditworthiness of CEH.

- (f) Suppose instead that CEH agrees to buy 50 tons at the (as yet unknown) future spot price for coffee. How should the analyst assess the risk in this case?

A. Just look at price risk for a known quantity 50, not at the product of a random price and a random output quantity — provided that Botswana can always deliver at least 50 tone, of course, which seems pretty obvious.

Chapter 16

International Fixed-Income Markets

Quiz Questions

The questions also cover interest forwards and futures, which were discussed in the appendix to Chapter 4.

True-False Questions

1. The abolition of the Interest Equalization Tax, Regulation Q, the cold war, and the us and uk foreign exchange controls have taken away most of the reasons why euromarkets exist. As a result, we can expect these markets to decline in the near future.
2. Without the us trade deficit, the euromarkets would have developed more slowly.
3. With a floating-rate loan, the bank is free to adjust the interest rate at every reset date in light of the customer's creditworthiness.
4. One of the tasks of the lead bank under a syndicated bank loan is to make a market, at least initially.
5. The purpose of using a paying agent is to reduce exchange risk.
6. Caps and floors are options on interest rates. Because interest rates are not prices of assets, one cannot price caps and floors using an option pricing model that is based on asset prices.
7. Because euroloans are unsecured, the spread over the risk-free rate is a very reliable indicator of the borrower's general creditworthiness.

8. FRAs are not really a good hedge against future interest rates because one does not actually make the deposit or take up the loan.
9. A note-issuing facility forces the borrowing company to borrow at a constant spread, while a revolving underwritten facility gives the borrower the benefit of decreasing spreads without the risk of increasing spreads.
10. The fact that eurobonds are bearer securities makes them less attractive to most investors.
11. Bond stripping is always done with a pair of scissors: you just clip off the coupons.
12. Disintermediation is the cause of the lower creditworthiness of banks, and has lead to capital adequacy rules.
13. Ignoring the small effects of marking to market, the standard quote for a eurocurrency futures price is basically a forward price on a CD.

Ans. 1. false; 2. true; 3. false; 4. false; 5. false; 6. false: any interest rate corresponds with a T-bill price; 7. false; 8. false; 9. false; 10. false; 11. false; 12. false; 13. false.

Multiple-Choice Questions

1. Eurocurrency and euroloan markets are attractive because:
 - (a) the spread between the buy and ask exchange rates is lower than in the interbank exchange market.
 - (b) the bid-ask spread between the lending and borrowing interest rates is lower.
 - (c) eurobanks are not subject to reserve requirements.
 - (d) eurobanks are not subject to capital adequacy rules (the so-called BIS rules).

A1. (b), (c).
2. Eurobanks borrow for short maturities and lend for longer maturities. They can reduce the interest risk by:
 - (a) extending fixed-rate loans.
 - (b) extending floating-rate loans.
 - (c) extending revolving loans.
 - (d) shorting forward forwards (that is, getting a forward contract on a loan, not on a deposit).

- (e) shorting in FRAs.
- (f) going long eurocurrency futures.
- (g) buying forward the currency in question.

A2. (b), (c), (d), (e).

3. A cap on a floating-rate euroloan:

- (a) protects the borrower against high short-term interest rates.
- (b) protects the lender against high short-term interest rates on the funding side.
- (c) is similar to a call option on short-term paper with the cap rate, as nominal rate; and the borrower is the holder of the call option.
- (d) is similar to a put option on short-term paper with the cap rate, as nominal rate; and the borrower is the holder of the put option.
- (e) is similar to a put option on short-term paper with the cap rate, as nominal rate; and the lender is the holder of the put option.

A3. (a), (d).

4. Which of each pair best describes eurobanking?

- (a) retail/wholesale
- (b) individual lender/bank consortium
- (c) reserve requirements/limited or no reserve requirements
- (d) unsecured/secured
- (e) fixed-rate lending/floating-rate lending
- (f) foreign exchange markets/money markets
- (g) open to all companies/open to the better companies only

A4. (a): wholesale; (b) consortium; (c) limited or no reserve requirements; (d) unsecured; (e) floating; (f) money market; (g) better companies.

5. Matching Questions: Choose from the following list of terms to complete the sentences

below: paying agent, managing banks, trustee bank, placing agents, market, lead bank (or lead manager), participating banks, prospectus, gray market, fiscal agent, buy forward, underwrite, lead manager, red herring.

A consortium (or syndicate) that extends a euroloan consists of many banks that could play different functions. In a euroloan, the (a) negotiates with the borrower for tentative terms and conditions, obtains a mandate, and looks for banks to provide the money or undertake to provide the money if there is any shortfall in funds. The banks that provide the actual funding are called (b). Because at the time of the negotiations the funding is not yet

arranged, the (c) often contacts a smaller number of (d) banks who (e) the loan, that is, guarantee to make up for the shortage of funds if there is any such shortfall. The (f), finally, is the bank that receives the service payments from the borrower and distributes them to the participating banks.

Placement of eurobonds is most often via a syndicate of banks or security houses. The lead bank or (g) negotiates with the borrower, brings the syndicate together, makes a (h) (at least initially), and supports the price during and immediately after the selling period. There are often, but not always, (i) that underwrite the issue and often buy part of the bonds for their own account. The (j) call their clients (institutional investors or individuals) and sell the bonds on a commission basis. The (k) takes care of withholding taxes, while the (l) monitors the bond contract. Prospective customers can find information about the issuing company and about the terms and conditions of the bond in the (m). Often an unofficial version of the prospectus is already circulating before the actual prospectus is officially approved; this preliminary prospectus is called the (n). On the basis of this document, investors can already (o) the bonds for a few weeks before the actual issuing period starts. This period of unofficial trading is called the (p) period.

A5. (a) lead bank; (b) participating banks; (c) lead manager; (d) managing; (e) underwrite; (f) paying agent; (g) lead manager; (h) market; (i) managing banks; (j) placing agents; (k) fiscal agent; (l) trustee bank; (m) prospectus; (n) red herring; (o) buy forward; (p) gray-market.

Applications

1. You are an A-quality borrower, and you pay 10 percent on a five-year loan with one final amortization at the end and annual coupons. This is 1 percent above the spread paid by an AAA borrower. What will be the up-front fee for which your bank should be willing to lower the rate by 1 percent?

A1. $0.1 \times \frac{1-1.10^{-5}}{0.10} = 3.79$ percent up front.

2. A bank offers you the following rates for a 5-year loan with annual coupons: 10 percent fixed, or (when you borrow floating-rate) LIBOR + 2 percent. You prefer to borrow floating-rate, as you expect a drop in interest rates. Another bank offers you LIBOR + 1.5 percent, but asks a substantial up-front fee. How can you compute which bank offers the better terms?

A2. The savings of 0.5 percent in the spread is equivalent to $0.005 \times \frac{1-1.10^{-5}}{0.10} = 1.895$ percent up front.

3. You bought an option that limits the interest rate on a future six-month loan to, at most, 10 percent *p.a.*

- (a) If, at the beginning of the six-month period, the interest rate is 11 percent, what is the expiration value of this option?
- (b) What is the option's expiration value if the interest rate turns out to be 8 percent?

A3.

- (a) $\frac{(1/2) \times (0.11 - 0.10)}{1 + (1/2) \times 0.11} = 0.4739$ percent of the nominal value.
- (b) Zero.

4. You bought an option that limits the interest rate on a future six-month deposit to at least 10 percent *p.a.*

- (a) If, at the beginning of the six-month period, the interest rate is 11 percent, what is the market value of this option?
- (b) What is the option's value if the interest rate turns out to be 8 percent?

A4.

- (a) Zero.
- (b) $\frac{(1/2) \times (0.10 - 0.08)}{1 + (1/2) \times 0.08} = 0.9615$ percent of the nominal value.

Chapter 17

Segmentation and Integration in the World's Stock Exchanges

Quiz Questions

True-False Questions

1. In quote-driven markets, the exchange system provides the price for a stock by crossing demand and supply; while in order-driven markets, a market maker provides bid and ask prices.
2. Quote-driven markets are always preferred over order-driven markets because they stand out in immediacy and liquidity.
3. An ADR often comes with a non-unit ration, mainly because the stock price in the US is preferred to be in the USD 10-100 range.
4. There will never be one unified financial center because investors are home-biased, they only want to invest in stocks that are familiar to them.
5. Sarbanes-Oxley is only one reason why New York is losing market share to London and Euronext in terms of IPO proceeds.

A. 1. false (it's the other way round); 2. false (possibly lower transparency and fragmentation of information on supply and demand); 3. true; 4. true; 5. true.

Multiple-Choice Questions

1. A market maker:
(a) Only works on quote-driven markets

- (b) Has a complete overview of the demand and the supply of a stock
- (c) Can always guarantee liquidity and immediacy
- (d) Provides bid and ask prices for a certain stock

A1. (a) and (d) are correct. For (c), note that a market maker should do this but sometimes fail.

2. Check the correct statement(s):

- (a) English-based law is more shareholder-friendly
- (b) The UK and the US have similar standards for creditor protection
- (c) Companies can compensate for weak regulatory institutions in their country
- (d) The main advantages of a unified financial center result from network effects
- (e) A Level I ADR requires more reporting than a Level III ADR
- (f) A Global Registered Share is a US share that gets converted to a version traded outside the US.

A2. (a); (c); (d); and (f) are correct.

Chapter 18

Why—or when—Should we Cross-list our Shares?

Quiz Questions

True-False Questions

1. Cross-listing is always more costly than a domestic listing.
2. The higher stock price after a cross-listing is caused by a drop in the cost of capital (discount rate).
3. All firms that list abroad experience an announcement effect: the announcement of a cross-listing leads to an increase in the share prices of about one percent on average.
4. Cross-listed companies have more analysts following them than domestic companies.
5. If your competitor cross-lists its shares, this is favorable for you: international investors start noticing your country and your business and can create an extra demand for your shares.

Ans. 1. false (home may be NYSE); 2. false (there could be other reason) ; 3. false (the *average* firm does); 4. true; 5. ??.

Multiple-Choice Questions

1. Why can you possibly get a higher price for your shares if you opt for an international listing?

- (a) You can issue a larger amount of shares
- (b) The costs of preparing and getting the listing are lower
- (c) The foreign stock market is larger and thus more liquid than the domestic market
- (d) The international cost of capital is lower due to more diversifiable risks for foreign investors

A1. (c) and (d) are correct. (a) is often correct as a statement in itself, but it's not a reason for getting a higher price.

2. The pre-cross-listing run-up and post-cross-listing decline is stronger for firms that list on the NYSE than on the LSE. This is probably because

- (a) Information provision in New York is better
- (b) Discount rates for stocks trading on the NYSE are lower
- (c) The SEC primarily controls foreign firms
- (d) The announcement effect only occurs for firms that list in the US

A1. (a) is correct—but remember also that the market's attention lapses fast.

Chapter 19

Setting the Cost of International Capital

Quiz Questions

True-False Questions

1. The entire NPV analysis can be conducted in terms of the host (foreign) currency if money markets and exchange markets are fully integrated with the home market.
2. The entire NPV analysis can be conducted in terms of the host currency if money markets, stock markets, and exchange markets are fully integrated with the home market.
3. Forward rates can be used as the risk-adjusted expected future spot rates to translate the host-currency cash flows into the home currency. The home-currency cash flows can then be discounted at the appropriate home-currency discount rate if money markets and exchange markets are fully integrated with the home market.
4. Regardless of the degree of market integration, the host-currency expected cash flows can always be translated into the home currency (by multiplying them by the expected spot rate), and then discounted at the home-currency discount rate.
5. Regardless of the degree of market integration, the host-currency expected cash flows can always be translated into expected cash flows expressed in home currency. The home-currency cash flows can then be discounted at the home-currency discount rate that takes into account all risks.
6. If you use the forward rate as the risk-adjusted expected spot rate, there is

no need to worry about the dependence between the exchange rate and the host-currency cash flows.

7. If markets are integrated and you translate at the forward rate, the cost of capital need not include a risk premium for exchange rate exposure.
8. If markets are integrated and you translate at the forward rate, the cost of capital need not include a risk premium for exposure to any currency.
9. If you discount expected cash flows that are already expressed in home currency, the cost of capital should include a risk premium for exposure to the host-currency exchange rate.
10. If you discount expected cash flows that are already expressed in home currency, the cost of capital should include a risk premium for exposure to all relevant exchange rates.
11. If you translate at the forward rate, you can entirely omit exchange rate expectations from the NPV procedure.
12. Exchange rate risk premia are sizeable. In fact, they are about as large as the (world) market risk premium.
13. A highly risk-averse investor will only accept variance risk if he or she is fully certain to be compensated for this risk.
14. A highly risk-averse investor will never select a high-variance portfolio.
15. A risk-averse investor will select a high-variance portfolio only if the expected excess return is sufficiently high.
16. A risk-averse investor will select a low-return portfolio only if the variance is sufficiently low.
17. A particularly risk-averse investor will always select a low-return portfolio. This is because low return means low risk, and because the investor does not want to bear a lot of risk.

A. 1. false; 2. true; 3. true; 4. false: this statement ignores the covariance term; 5. true; 6. false; 7. false: there may still be some exposure to other exchange rates; 8. false; 9. true; 10. true; 11. false; 12. false; 13. false: "certain" is nonsense; 14. false; 15. true; 16. true; 17. false

For the next set of questions, assume that access to money markets and exchange markets is unrestricted and the host-currency cash flow is risk free. Are the following statements true or false?

1. You can translate at the expected spot rate and discount at a risk-adjusted home-currency cost of capital.

2. You can translate at the forward rate, and discount at a home-currency rate that takes into account exchange risk.
3. You can translate at the forward rate, and discount at the risk-free home-currency rate.
4. You can discount the host-currency cash flows at the foreign risk-free rate, and then translate the result at the current spot exchange rate.
5. You can discount the host-currency cash flows at the foreign risk-free rate, and then translate the result at the expected future spot exchange rate.
6. You can discount the host-currency cash flows at the foreign risk-free rate, and then translate the result at the forward exchange rate.
7. If access to forward markets or foreign and domestic money markets is restricted, then the true value is always overstated if the foreign currency cash flow is translated at the forward exchange rate and then discounted at the domestic risk-free rate.

A. 1. true; 2. false; 3. true; 4. true; 5. false; 6. false; 7. false.

Additional Quiz Questions

1. Suppose that you observe an efficient portfolio. There are two methods with which you can infer the degree of risk aversion of the investor that selects this particular portfolio. What are these two methods?
A1.
 - (a) By looking at how much the investor invests in the market portfolio and how much he invests in the risk-free asset.
 - (b) The ratio of expected excess return to portfolio variance or the ratio of excess return over the covariance of the portfolio return with any individual asset.
2. What's wrong with the following statement: "The CAPM says that the expected return on a given stock j is equal to the best possible replication that one can obtain using the risk-free assets and the set of all risky assets (other than stock j)."
A2. The statement should read: "The CAPM says that the expected return on a given stock j is equal to the best possible replication one can obtain using the risk-free assets and the market portfolio of all risky assets."
3. Below, we reproduce some equations from the derivation of the CAPM. Equation [19.1] is the efficiency criterion. Equation [19.8] is the CAPM. Explain the

equations and the transitions between them.

$$\frac{E(\tilde{r}_j - r)}{\text{cov}(\tilde{r}_j - \tilde{r}_m)} = \theta, \quad (19.1)$$

for all risky assets $j=1, \dots, N$.

$$E(\tilde{r}_j - r) = \theta \text{cov}(\tilde{r}_j, \tilde{r}_m), \quad (19.2)$$

$$= [\theta \text{var}(\tilde{r}_m)] \frac{\text{cov}(\tilde{r}_j, \tilde{r}_m)}{\text{var}(\tilde{r}_m)}, \quad (19.3)$$

$$= [\theta \text{var}(\tilde{r}_m)] \beta_j, \quad (19.4)$$

$$\sum_{j=1}^N x_j E(\tilde{r}_j - r) = \theta, \quad (19.5)$$

$$\sum_{j=1}^N x_j \text{cov}(\tilde{r}_j, \tilde{r}_m) = \theta \text{cov}\left(\sum_{j=1}^N x_j \tilde{r}_j, \tilde{r}_m\right), \quad (19.6)$$

$$= \theta \text{cov}(\tilde{r}_m, \tilde{r}_m), \quad (19.7)$$

$$E(\tilde{r})_j - r = \beta_j [E(\tilde{r}_m) - r]. \quad (19.8)$$

A3. See the text on page 594.

4. Suppose that investors from a country have access to a large set of foreign stocks, and that foreign investors can also buy stocks in that country. Which of the following statements is (are) correct?
- (a) The single-market CAPM, where the market portfolio is measured by the index of all stocks issued by local companies, does not hold.
 - (b) The single-market CAPM, where the market portfolio is measured by the index of all stocks held by local investors, does not hold.
 - (c) The single-market CAPM, where the market portfolio is measured by the index of all stocks held by local investors, is formally correct but not fit for practical use, because the correct index is not readily observable.
 - (d) The single-market CAPM, where the market portfolio measured by the index of all stocks worldwide, is correct provided that there is a unified world market for all stocks.
 - (e) The single-market CAPM, where the market portfolio is measured by the index of all stocks worldwide, is correct provided that there is no (real) exchange risk.

A4. (a) is correct when it says the standard MBA CAPM should not hold; (b) is incorrect when it says the CAPM in terms of the true market portfolio should not hold; (c) is true; (d) is false (ignores real exchange risk issue); (e) is true.

Applications

1. Suppose that you have the following data:

$E(\tilde{r}_j - r)$	(co)variance risks	
0.03	$\text{var}(\tilde{r}_1) = 0.04$	$\text{cov}(\tilde{r}_1, \tilde{r}_2) = 0.02$
0.04	$\text{cov}(\tilde{r}_2, \tilde{r}_1) = 0.04$	$\text{var}(\tilde{r}_2) = 0.06$

Asset 0 is the (domestic) risk-free asset, and asset weights in a portfolio are denoted as x_j , where $j = 0, \dots, 2$. Which of the following portfolios is efficient, and if the portfolio is efficient, what is the investor's degree of risk aversion?

- (a) $x_0 = 0, x_1 = 0.4, x_2 = 0.6$
- (b) $x_0 = 0, x_1 = 0.6, x_2 = 0.4$
- (c) $x_0 = 0, x_1 = 0.5, x_2 = 0.5$
- (d) $x_0 = 0.2, x_1 = 0.4, x_2 = 0.4$
- (e) $x_0 = 0.5, x_1 = 0.25, x_2 = 0.25$
- (f) $x_0 = -1, x_1 = 1, x_2 = 1$
- (g) $x_0 = 1, x_1 = 0, x_2 = 0$
- (h) $x_0 = 2, x_1 = -0.5, x_2 = -0.5$

A1.

	$E()_1/\text{cov}_1$	$E()_2/\text{cov}_2$
(a)	1.071	0.909
(b)	0.938	1.111
(c)	1.000	1.000
(d)	1.250	1.250
(e)	2.000	2.000
(f)	5.000	5.000
(g)	0/0	0/0
(h)	-1.000	-1.000

Portfolios (a) and (b) are inefficient. Portfolio (c) is efficient, and is held by the investor with relative risk aversion equal to unity; (c) is also the tangency portfolio of risky assets. Portfolios (d), (e), and (f) are efficient, because they consist of positive combinations of the tangency portfolio of risky assets and the risk-free asset. Portfolio (g) is efficient, and corresponds to infinite risk aversion. Portfolio (h) is inefficient: the tangency portfolio is sold short rather than held long.

2. Suppose that the capital markets of the following three countries are well integrated: North America (with the dollar), Europe (with the EUR), and Japan (with the yen). Suppose that you choose the yen as the home currency.

- (a) Why does the average investor care about the JPY/USD and JPY/EUR exchange rates (beside how it relates to how his or her wealth is measured in JPY)?
- (b) What moments are needed in a mean-and-(co)variance framework, to summarize the joint distribution of asset returns? Which of these are affected by the portfolio choice?

A3.

- (a) Investors need the exchange rates to translate foreign returns into yens. In addition, American investors will worry about the JPY/USD exchange rate (because they care about their wealth as measured in USD), and Europeans will worry about the JPY/EUR exchange rate (because they care about their wealth as measured in EUR). Thus, the average investor cares about world market return (in JPY) and the changes in the JPY/USD and JPY/EUR exchange rates.
- (b) $E(\tilde{r}_w)$, $\text{var}(\tilde{r}_w)$, $\text{cov}(\tilde{r}_w, \tilde{s}_{\text{JPY/USD}})$, $\text{cov}(\tilde{r}_w, \tilde{s}_{\text{JPY/EUR}})$, $E(\tilde{s}_{\text{JPY/USD}})$, $E(\tilde{s}_{\text{JPY/EUR}})$, $\text{var}(\tilde{s}_{\text{JPY/USD}})$, and $\text{var}(\tilde{s}_{\text{JPY/EUR}})$. The first four are affected by an individual's portfolio choice.

3. Suppose that your assistant has run a market-model regression for a company that produces sophisticated drilling machines, and finds the following results (t-statistic in parentheses):

$$\begin{aligned}\tilde{r}_j &= \alpha + \beta \tilde{r}_m + \gamma s + \tilde{e}_j, \\ \tilde{r}_j &= 0.002 + 0.56 \tilde{r}_m + 4.25 \tilde{s} + \tilde{e}_j. \\ (0.52) \quad (1.25) \quad (2.06)\end{aligned}$$

Your assistant remarks that, as the estimated beta is insignificant, the true beta is zero. The exposure, in contrast, is significant, and must be equal to the estimated coefficient. How do you react?

A4.

You cannot simply conclude that $\beta = 0$. The low t-statistic says that, on the basis of only the sample information, it is possible that the true beta is zero. But you know more than a computer or calculator (which evaluate only the sample information). As an intelligent human being, you would not expect the true beta for a highly cyclical sector (machine tools) to be zero, or even much below unity. Thus, the estimate 0.56 is probably better than the conjecture $\beta = 0$. An industry β would be more reliable.

The high t-statistic for the exposure (γ) means that one can reject, beyond what most statisticians would call a reasonable doubt, the hypothesis that the true exposure is zero. However, from a purely statistical point of view, the true exposure could still be 0.5, or 0.75, or 1 in fact, with $\sigma = 4.25/2.063$

= 2.06, anything in the range of 4.25 (2×2.063) is statistically acceptable. However, your common sense tells you that true exposures are unlikely to exceed unity. Thus, the estimated beta may be erring on the downward side, and the estimated γ almost surely errs on the upward side.

4. Suppose that the world beta for a German stock (in euro) equals 1.5, and its exposures to the dollar, the yen, and the pound are 0.3, 0.2, and 0.1, respectively.
 - (a) What is the best replicating portfolio if you can invest in a world-market index fund, as well as in dollars, yens, pounds, and euros?
 - (b) What additional information is needed to identify the cost of capital?
- A5.
 - (a) $x_w = 1.5$, $x_{USD} = 0.3$, $x_{JPY} = 0.2$, $x_{GBP} = 0.1$, and $x_{DEM} = 1 - 1.5 - 0.3 - 0.2 - 0.1 = -1.1$.
 - (b) The expected excess returns on each of these assets (including, for the currencies, the risk-free rates).
5. Suppose that there are two countries, the us (which is the foreign country) and Canada. The exposure of the company X_{US} , in terms of USD, is estimated as follows:

$$\tilde{r}_{XUS}^* = 0.12 + 0.30\tilde{s}_{USD/CAD} + \tilde{\epsilon}.$$

What is the company's exposure in terms of CAD?

A6. Over short periods, the percentage change in the CAD/USD rate is approximately equal to the negative of the change in the CAD/USD exchange rate. Thus, a -1 percent rise in the USD/CAD value means a -1 percent drop in the USD/CAD rate, and on average a -0.3 percent drop in the stocks USD price. Thus, the total effect on the CAD return from XUS of a 1 percent rise of the USD is $1 - 0.30 = 0.70$: $r_{XUS} = a + 0.7, \tilde{s}_{CAD/USD} + \epsilon$.

Chapter 20

International Taxation of Foreign Investments

Quiz Questions

True-False Questions

1. The term “permanent establishment” (PE) is just tax-speak for “branch.” That is, every branch is a PE and vice versa.
2. As soon as there is a permanent physical presence abroad, there is a PE.
3. A PE has a separate accounting system, while a branch does not.
4. If a person lives or earns income in more than one country, there may be double taxation.
5. The source principle says that any person earning money in a particular country is taxable in that country on his or her worldwide income.
6. Withholding taxes are levied by the host country on the taxpayer’s worldwide income.
7. The legal basis for withholding taxes on non-labor income paid to foreigners is the residence principle.
8. The Capital Import Neutrality principle says that the foreign branch ought to be taxed as if it were a locally owned company.
9. The Capital Export Neutrality principle says that the foreign branch ought to be taxed as if it were a locally owned company.

10. The Capital Export Neutrality principle says that there should be no fiscal benefit or penalty associated with the fact that ownership and operations straddle two countries.
11. The deferral principle applies equally to the exclusion system and the credit system.
12. The disagreement on how to compute the income of a foreign branch arises only under the credit system.
13. The disagreement on how to compute the income of a foreign branch arises under both the credit system and the exclusion system.
14. The disagreement on how to compute the income of a foreign subsidiary arises only under the credit system.
15. The disagreement on how to compute the income of a foreign subsidiary arises under both the credit system and the exclusion system.

Ans. 1. false; 2. false; 3. false; 4. true; 5. false; 6. false; 7. false; 8. true; 9. false; 10. false: this is a definition of universal neutrality; 11. false: also arises under exclusion in the branch case; 12. false; 13. true; 14. true; 15. false.

Below, a *marginal* tax rate is to be understood as the *additional* taxes you pay per cent or penny or öre of additional foreign income from one particular host country. The average tax rate is to be understood as the total tax paid on all foreign income as a percentage of the foreign income. For the questions that relate to the credit system, it is assumed that foreign income is taxed separately from domestic income. Verify whether the following statements are true or false.

16. Under a 100-percent-exclusion system, the marginal tax rate on foreign income is the foreign corporate tax rate (τ_c^*).
17. Under a 100-percent-exclusion system, the marginal tax rate on foreign income is the foreign corporate tax rate (τ_c^*) plus the foreign withholding tax (τ_w^*).
18. Under a 100-percent-exclusion system, the marginal tax rate on foreign income is given by

$$1 - (1 - \tau_c^*)(1 - \tau_w^*) = \tau_c^* + \tau_w^* - \tau_c^*\tau_w^*$$

19. Under a credit system, the marginal tax rate on foreign income is the home-country corporate tax rate τ_c .
20. Under a credit system, the marginal tax rate on foreign income is the higher of either the home-country corporate tax rate τ_c or the marginal foreign tax.
21. Under a credit system, the marginal tax rate on foreign income is bounded from above and below by the home-country corporate tax rate τ_c and the marginal foreign tax.

22. Under a credit system, the average tax rate on foreign income is the home-country corporate tax rate τ_c .
23. Under a credit system, the average tax rate on foreign income is either the home-country corporate tax rate τ_c or the average foreign tax—whichever is higher.
24. Under a credit system, the average tax rate on foreign income is bounded from above and below by the home-country corporate tax rate τ_c and the average foreign tax.

Ans. 16. false: ignores withholding taxes; 17. false: corporate and withholding tax rates are not additive; 18. true; 19., 20., 21. false: the marginal tax rate may even be zero, notably if the additional foreign income from a particular country can use tax credits that would have been entirely unused in the absence of the additional income; 22. false: could be higher, if there are unused tax credits; 23. false: you could also pay a rate in between the two tax rates: (a) if the average foreign rate is below the domestic rate, you pay the domestic rate, (b) if the average foreign rate is above the domestic rate, you have excess tax credits, (c) if the excess tax credits can be fully used, you still pay only the domestic rate (on average). (d) if they can be used only partially (or with a delay), you pay more than the domestic rate but less than the average foreign rate, (e) if the excess tax credits are fully lost, you pay the (average) foreign rate; 24. true: see (8).

Additional Quiz Questions

1. Suppose that foreign activity is conducted through a wholly owned subsidiary. Which assumptions are needed to achieve both Capital Import and Capital Export Neutrality?
 - (a) The home and host corporate tax rates are the same.
 - (b) There is no withholding tax on dividends.
 - (c) The tax basis is computed in exactly the same way in both countries.
 - (d) There is full payout.
 - (e) There are no interest payments, no license payments, no lease payments, and no management fees between wos and parent.
 - (f) A credit system applies to nondividend remittances from wos to parent.

A1. (a), (b), and (c) are needed for a branch. For a subsidiary, either (c) or (f) are needed.
2. What does one mean by the residence principle and the source principle? What do these principles imply for the taxation of income on

- (a) Pure (direct) exports?
- (b) Exports through a dependent agent?
- (c) Exports through a branch/PE?
- (d) Foreign activities through a subsidiary?

A2. Residence means that you are taxed where you live, usually on your worldwide income. Source means that you pay tax wherever you earn money and wherever the host country invokes the principle.

- (a) Income from direct will only be taxed in the home country only, under either principle
- (b) idem, unless the dependent agent represents a permanent establishment
- (c) Income will be taxed in the host country on the basis of the source principle and in the home country on the basis of the residence principle.
- (d) In the host country, the subsidiary's profits (using the host-country's income tax) and its remittances (using the host-country's withholding tax) to the parent will be taxed on the basis of both the residence and source principles, and in the home country, the remittances will be taxed on the basis of the residence principle.

3. Explain, using a numerical example of your own, how differences between the host- and home-country rules for the allocation of overhead can impair the neutrality of a credit system or an exclusion system.

A3. Just do it.

4. How do companies take advantage of the basic exclusion system for dividends? Which additional tax rules can be applied to prevent these unintended uses?

A4. Firms make pre-tax royalty, interest or lease payments to a holding company in a tax haven. The holding company pays a minimal tax on this income and then remits it in the form of tax-free dividends. To close this loophole, countries often refuse to sign bilateral tax treaties with tax havens such that an exclusion on income from a subsidiary in a tax haven is only partial. In addition, tax authorities also use look-through rules.

5. How can one reduce excess foreign tax credits by transforming domestic income into foreign income? Which additional tax rules can be applied to prevent such tactics?

A5. For instance, a US firm could replace its domestic USD-denominated bonds by foreign-issued USD bonds of the same quality so that domestic interest income is replaced by (low-taxed) "foreign" interest income. Then the firm can use its excess foreign tax credits from its foreign operations to avoid taxes on this interest income. One tax rule to disallow this is to define foreign income in baskets (such as active or passive). Any tax credits from one basket cannot be transferred to another.

6. Conventional wisdom says that tax planning means minimizing foreign taxes. Is this true under the exclusion system? Is it true under the credit system? If your answer was yes in both cases, is there no difference between these systems regarding the tax savings you make by tax planning?

A6. Tax planning means minimizing foreign taxes under both systems, but each takes a different approach. Under the credit system, additional home taxes are due if foreign taxes are less than the domestic norm. That is, the firm cannot keep foreign tax savings if they are below the domestic norm. Under the exclusion system, all foreign tax savings on profits and dividends can be kept.

7. The bartender at your favorite pub sneers that, by using transfer pricing, a company can always eliminate its excess foreign tax credits. Do you agree, or do you think that your friend is forgetting something? Why?

A7. No, because the tax authorities may find the costs exceed an arm's length level, and reject part of the costs. In such a case, taxes will be higher than before the cost reallocation. Plus, as the prices of the goods increase, so will the import taxes.

Applications

1. A foreign-owned company earns 100,000 in its host country. The host-country corporate tax is 50 percent, the withholding tax 20 percent, and the home-country tax is 40 percent.
 - (a) What is the total tax if there is no relief from double taxation?
 - (b) Still assuming full double taxation, what tax could have been avoided if the business had been conducted through a branch/PE?
 - (c) Go back to the case of a wos. What is the total tax burden if there is full payout and if the exclusion principle applies in the home country?
 - (d) What is the total tax burden if there is full payout and if the exclusion privilege is only 80 percent?
 - (e) What is the total tax burden if there is full payout and the home country uses a credit system?
 - (f) In question (e), does it matter whether the home country taxes foreign income separately from domestic income?

A1.

	(a)	(b)	(c)	(d)	(e)
Foreign income	100	100	100	100	100
Foreign income tax (50%)	< 50 >	< 50 >	< 50 >	< 50 >	< 50 >
Foreign income after tax	50	50	50	50	50
Gross dividend paid out	50	50	50	50	50
Withholding tax (20%)	< 10 >	n/a	< 10 >	< 10 >	< 10 >
Net dividend	40	50	40	40	40
Add: direct tax credit	n/a	n/a	n/a	n/a	10
indirect tax credit	n/a	n/a	n/a	n/a	50
Tax basis	40	50	0	8	100
Normal home tax (40%)	16	20	0	3.2	0
Credit: direct	n/a	n/a	n/a	n/a	< 10 >
indirect	n/a	n/a	n/a	n/a	< 50 >
Net home tax	16	20	0	3.2	0
Excess tax credit	n/a	n/a	n/a	n/a	20*
Total taxes paid	76	70	60	63.2	60 **

* Assuming excess tax credit cannot be used elsewhere

** Assuming the excess tax credits can be used elsewhere.

(f) If domestic and foreign income are first added together before taxes are computed and tax credits invoked, the probability of being able to use excess foreign taxes is higher.

2. Suppose that the corporate tax schedule in Finland is as follows:

- 25 percent tax on income below EUR 50,000.
- 30 percent tax on income between EUR 50,000 and EUR 100,000.
- 35 percent tax on all income exceeding EUR 100,000.

- What is the tax if a Finnish corporation's income is EUR 200,000, whereof 100,000 are profits on domestic sales and 100,000 are profits on exports to Hong Kong (without PE in Hong Kong)?
- Assume that Hong Kong levies a flat 15 percent corporate tax, and no withholding tax on dividends, and that Finland applies a pure exclusion system. Is there any incentive to set up a branch/PE in Hong Kong? If so, what is the worldwide tax?
- Add to question (b) a rule under which Finland preserves the progressiveness of the tax schedule (see Figure ??). Is there still an incentive to set up a branch/PE in Hong Kong? If so, what is the worldwide tax?
- Repeat question (c) and assume that Hong Kong's tax schedule is identical to Finland's, and that Hong Kong also preserves progressiveness. Is there still an incentive to set up a branch/PE in Hong Kong? If so, what is the worldwide tax?

A2.

(a)	$(50,000 \times 0.25) + (50,000 \times 0.30) + (100,000 \times 0.35) =$	FIM 62,500
(b)	Yes, there is an advantage. Taxes are as follows:	
	In Finland: $(50,000 \times 0.25) + (50,000 \times 0.30) =$	FIM 27,500
	In Hong Kong: $100,000 \times 15 \text{ percent} =$	FIM 15,000
	World-wide:	FIM 42,500
(c)	The advantage is smaller. From (a), the average tax rate applicable to a world-wide income of FIM 200,000 is 31.25 percent. Thus, the total tax will be as follows:	
	In Finland: $100,000 \times 0.3125 =$	FIM 31,250
	In Hong Kong: $100,000 \times 15 \text{ percent} =$	FIM 15,000
	World-wide:	FIM 46,250
(d)	The advantage is eliminated. From (a), the average tax rate applicable to a world-wide income of FIM 200,000 is 31.25 percent. Thus, the total tax will be as follows:	
	In Finland: $100,000 \times 0.3125 =$	FIM 31,250
	In Hong Kong: $100,000 \times 15 \text{ percent} =$	FIM 31,250
	World-wide:	FIM 62,500

3. The company Think Tankards has a stable foreign income, which is taxed at a low rate abroad. In each of the three preceding income years, it effectively paid USD 50m in additional US taxes on foreign income, and it expects to do the same for the years to come. For the current year, however, there is a USD 100m excess foreign tax credit. How is this excess credit treated under each of the following carry-forward/carry-back rules? What is the present value of the loss if future tax breaks are discounted at 15 percent?

- (a) No carry-back, one-year carry-forward.
- (b) No carry-back, two-year carry-forward.
- (c) One-year carry-back, two-year carry-forward.
- (d) Two-year carry-back, two-year carry-forward.

A3.

- (a) USD 50m will be used with a one-year delay, implying a loss of time value of $50m - 56.522m = \text{USD } 6.522m$. The remaining USD 50m is lost forever. Thus, the total time-value loss is USD 56.522m.
- (b) USD 50m will be used with a one-year delay, implying a loss of time value of $50m - 56.522m = \text{USD } 6.522m$. The remaining USD 50m will be used with a two-year delay, implying a loss of time value of $50m - 62.193m = \text{USD } 12.193m$. Thus, the total time-value loss is USD 18.715m.
- (c) USD 50m is carried back one year and triggers a refund. The remaining USD 50m will be used with a one-year delay, implying a loss of time value of $50m - 56.522m = \text{USD } 6.522m$.

- (d) USD 50m is carried back one year, and the remaining USD 50m is carried back two years, thus triggering a total refund of USD 100m. There is no loss of time value.
4. A Belgian bank holds EUR 10 billion worth of seven-year EUR government bonds, with a direct yield of 10 percent (that is, its annual interest income is EUR 1b).
- (a) Until a tax reform in 1992, the bank could transform its interest income into dividend income, which enjoyed a 90 percent exclusion privilege. Specifically, the bank sold its bonds to a Dublin dock company (DDC), which was fully owned by an Irish holding company (IHC), which in turn was fully owned by the Belgian bank (BB). Interest income received by the DDC was taxed at 10 percent, and then paid out as a dividend to IHC, which did not pay any taxes (100 percent exclusion within Ireland). IHC then paid the dividend to its owner, BB. Assume no withholding tax between Belgium and Ireland, and a 90 percent dividend exclusion and a 40 percent corporate tax rate in Belgium. What was the annual tax gain?
- (b) A tax consultant suggested that BB would gain even more by swapping its seven-year, 10 percent EUR bonds into NZD, which at that time yielded 20 percent. Thus, the consultant argued, the gains would be doubled. What crucial feature is overlooked in this argument? (Hint: you need an insight from Chapter 4.)

A4.

	before	after
DDC Interest Income	n/a	1,000m
Taxes (10%)	n/a	< 100 >
DDC income after tax	n/a	900m

- (a)
- | | | |
|----------------------------|------------|------------------------|
| Dividend received by BB | 0 | 900m |
| Interest income from bonds | 1,000m | 0 |
| Taxable income from bonds | 1,000m | 90m (10% of dividends) |
| Belgian tax | 400m | 36m |
| Total taxes paid | 400m (40%) | 136m (13.6%) |

Thus, the annual gain is 264m.

- (b) The consultant overlooks exchange rate changes. The 10 percent on BEF 10b is BEF 1b without any exchange risk. In contrast, the 20 percent on the initially equivalent amount of NZD is expected to depreciate (in a risk-adjusted sense). Thus, the annual tax saving is expected to gradually decrease. In addition, the principal (in NZD) is expected to have depreciated substantially by the time the bonds expire, while the value of the BEF bond portfolio will not depreciate.

- (c) If interest income and capital gains/losses are subject to the same tax rates, then there is no gain or loss from swapping in the sense that the value of the portfolio does not increase at the moment the swap is signed. This follows from the (initial) zero-value property of a swap: the higher NZD interest rate is offset, in a risk-adjusted sense, by the expected depreciation of the NZD, and this equivalence remains if everything is taxed at the same rate. However, under the DDC/IHC set up, interest income is taxed at 13.6 percent, while the capital loss (after seven years, when the IHC is liquidated) is a fully realized capital loss, with a 40 percent tax shield. Thus, it pays to increase the interest income and create capital losses.
5. Your two foreign outposts, a branch in Germany and one in Singapore, each have sales of 100. The host-country tax rates are 40 percent and 20 percent, respectively.
- (a) If your home country uses the credit system and has a 30 percent tax, how would you (try to) allocate total costs (120) over the two subsidiaries? Assuming an unlimited potential to shift costs, is there an incentive to allocate all costs to one branch?
- (b) Assume that your country uses a credit system, and that you have very little leeway in reallocating costs over the two branches. So you consider increasing the transfer price charged by Singapore to Germany. Imports into the European Union are taxed at 25 percent. Would you increase or decrease the transfer price?
- (c) In question (b), at what level of the import duty τ_m is the advantage wiped out?
- (d) Same question as (a), except that your home country applies a 90 percent exclusion rule?

A5.

- (a) By shifting costs worth Δ from Singapore to Germany, Singapore profits go up while German profits go down by Δ implying that Singapore taxes go up by $\Delta \times 0.20$ while German taxes go down by $\Delta \times 0.40$. Minimal foreign taxes reduce the risk of foreign excess taxes. Thus, by maximizing Δ , you minimize costs allocated to Singapore. However, there should not be any losses in Germany: there is no negative tax in Germany, nor is there any negative tax credit at home for foreign losses. In addition, there is no more gain if the average foreign tax rate falls below 30 percent, and this critical level is achieved when German and Singapore profits are equal.
- (b) By increasing the transfer price charged to Germany by Δ , Singapore taxes go up by $\Delta \times 0.20$, as before. However, there is an additional

$\Delta \times 0.25$ paid in import duties, thus German costs go up by $\Delta \times 1.25$, saving $\Delta \times 1.25 \times 0.4 = \Delta \times 0.50$ in German income taxes. Thus, the gain is now $\Delta \times 0.05$ rather than $\Delta \times 0.20$, because most of the gain is eliminated by the import duty.

- (c) If $(\Delta \times 0.20) + (\Delta \times \tau_m) = \Delta(1 + \tau_m) \times 40\%$, that is, if $\tau_m = 33.33$ percent.
 - (d) It is still advantageous to shift profits to Singapore. The gain keeps increasing, the more profits you allocate to Singapore even when the average foreign tax rate drops below 30 percent.
6. Your only source of foreign income is a marketing wos in Hong Kong, where the tax rate is 20 percent. At home you pay 35 percent. There is no withholding tax.
- (a) Under the 100 percent exclusion method, would you use a high transfer price or a low transfer price for sales to the subsidiary?
 - (b) Same question as (a), except that the credit method applies.
 - (c) Same question as (a), but there is a 10 percent import duty on sales to Hong Kong.

A6.

- (a) Shifting profits to low-tax Hong Kong is advantageous. Thus, you would use a lower transfer price.
 - (b) If there is full payout, there is no gain from shifting profits to low-tax Hong Kong. The only advantage would be to postpone payout and, thus, postpone the additional 15 percent in home country taxes.
 - (c) By lowering the amount invoiced to Hong Kong by Δ , home taxes decrease by $\Delta \times 0.35$, while import duties decrease by $\Delta \times 0.10$ and Hong Kong income taxes increase by $\Delta \times 1.10 \times 0.20$. The gain is $\Delta \times (0.35 + 0.10 - 1.10 \times 0.20) = \Delta \times 0.23$, which is positive (and larger than the difference in the corporate taxes).
7. Suppose that the German parent has sales equaling 200, and the Tunisian branch, 100. Direct costs are 80 and 30, respectively. German tax authorities allocate overhead, which amounts to 120, on the basis of sales, while in Tunisia allocation is proportional to direct cost. German and Tunisian taxes are 40 percent. Are you vexed by or happy with this discrepancy between the rules? Consider both the credit system and the exclusion system.

A7. Germany gets allocated $120 \times \frac{2}{3} = 80$ of the overhead, and you will be taxed on an income of $(200 - 80 - 80) = 40$. Tunisia can deduct $120 \times 0.31 = 32.72$ for the purpose of Tunisian taxation, and you will be taxed on $(100 - 30 - 32.72) = 37.28$. Thus, not all of the overhead is tax deductible. Under the German rules, the parent re-assess the Tunisian income as $(100 - 30 - 40) = 30$.

	Head office	Tunisian taxes	Germany's view on Tun. income
Sales	200	100	100
Direct cost	< 80 >	< 30 >	< 30 >
Allocated overhead	< 80 >	< 32.72 >	< 40 >
Taxable	40	37.28	30
Tax (40 %)	16	14.91	12

Under the credit system, the total foreign tax (14.91) is too high relative to the German tax, creating an excess tax credit problem even though both tax rates are equal. If there is enough low-tax income from elsewhere, this excess tax credit may still be recovered.

Under the exclusion system, only 30 is exempt from German taxation even though 37.72 was taxed in Tunisia. The excess tax cannot be recuperated in any way.

8. A US corporation has two foreign marketing branches, one in France and one in Hong Kong. The current situation is summarized as follows (all numbers in thousands of USD):

	Hong Kong	France	US (domestic income)
Sales	1,000	5,000	10,000*
Costs: purchases from parent	500	2,500	n/a
other expenses	100	500	6,000
depreciation	100	500	1,000
Profits	300	1,500	3,000
Corporate taxes	45 (15%)	600 (40%)	900 (30%)
Profits after taxes	255	900	2,100

*including sales to subsidiaries

- The US tax rate is 30 percent, and taxation of foreign and domestic income is separated, with the foreign tax credit applied to the tax on foreign income only. Is there still a US tax due, or is there an unused tax credit?
- The parent is currently making a profit on its "sales" to the branches, but considers changing the profit allocation. The company thinks that it can increase or decrease the transfer price by up to 5 percent without creating any problems with the tax authorities, on the condition that the transfer price remains the same for both branches. Should the company increase the price or decrease it?
- Is your conclusion in (a) or (b) affected if domestic and foreign income is taxed together (that is, the tax is computed on worldwide income, and then the tax credit is applied)?

A8.

- (a) Under the US tax code, the total tax on foreign income should be $(300 + 1,500) \cdot 30\% = 540$, which is less than the taxes already paid abroad, $45 + 600 = 645$. Thus, there is an unused tax credit of 105.
- (b) A 5 percent increase in the transfer price leads to the following result:

	Hong Kong	France	US (domestic income)
Sales	1,000	5,000	10,150*
Costs: purchases from parent	525(+5%)	2,625(+5%)	n/a
other expenses	100	500	6,000
depreciation	100	500	1,000
Profits	275	1,375	3,150
Corporate taxes	41.25 (15%)	550 (40%)	945 (30%)
Profits after taxes	233.75	825	2,205
US tax due	495.00 (30% on 275 + 1,375)		
Credit	591.25		
Excess foreign taxes	96.25		

*Total foreign and domestic taxes are 1,536.25.

This is 8.75 less than before the transfer price is increased.

- (c) A 5 percent decrease in the transfer price leads to the following result:

	Hong Kong	France	US (domestic income)
Sales	1,000	5,000	9,850*
Costs: purchases from parent	475(-5%)	2,375(-5%)	n/a
other expenses	100	500	6,000
depreciation	100	500	1,000
Profits	325	1,625	2,850
Corporate taxes	48.75 (15%)	650 (40%)	855 (30%)
Profits after taxes	275.25	975	1,995
US tax due	585.00 (30% on 325 + 1,625)		
Credit	698.75		
Excess foreign taxes	113.75		

*Total foreign and domestic taxes are 1,553.75. In this case, total taxes are highest.

Because total taxes paid and the excess foreign taxes are least, the company should increase in the transfer price.

- (d) There would be no unused tax credit, and the corporation would pay 30 percent on its world-wide income no matter how transfer prices are set. Transfer pricing would only affect how much of the 30 percent is paid abroad and how much is paid at home.

9. Sales and costs are 200 and 100, respectively, for the Tunisian, and 100 and 60 for the Hong Kong branch. The tax rates are 50 percent in Tunisia, and 25 percent in Hong Kong. The parent's home country, Germany, has a 40 percent tax rate and applies the credit system.

- (a) Verify that there is an excess tax credit of 4.
- (b) Verify that when the parent shifts costs worth 40 from Hong Kong to Tunisia, the original excess tax credit has been replaced by a foreign tax shortfall of 6.
- (c) Suppose that the Tunisian tax authorities unexpectedly reject the additional costs (40), so that this part of the costs is not deductible anywhere. What is the total tax?

A9.

	Tunisia	Hong Kong	Total
Before reallocation:			
Sales	200	100	300
Costs	< 100 >	< 60 >	< 160 >
Declared Profit	100	40	140
Host country tax	< 50 > (50%)	< 10 > (25%)	
Total foreign taxes	60		
German tax due	$56 = (140 \times 0.4)$		
Excess tax credit	$4 = 60 - 56$		

After reallocation if it is accepted:

	Tunisia	Hong Kong	Total
Sales	200	100	300
Costs	< 140 >	< 20 >	< 160 >
Declared Profit	60	80	140
Host country tax	< 30 > (50%)	< 20 > (25%)	
Total foreign taxes	50		
German tax due	$56 = (140 \times 0.4)$		
Excess tax credit	$6 = 56 - 50$		

After reallocation if the Tunisian authorities object:

	Tunisia	Hong Kong	Total
Sales	200	100	300
Costs (declared)	< 140 >	< 20 >	< 160 >
Declared Profit	60	80	140
Rejected costs	40		
Tax basis	100	80	
Host country tax	< 50 > (50%)	< 20 > (25%)	
Total foreign taxes	70		
German tax due	$56 = (140 \times 0.4)$		
Excess tax credit	$14 = 70 - 56$		

Chapter 21

Putting it all Together: International Capital Budgeting

Quiz Questions

True-False Questions

1. Net Present Value analysis assumes that the risk of the project is constant.
2. ANPV and WACC are essentially substitutes; neither is superior to the other.
3. The sum of a project's profits, when accumulated over time without taking time value into account, is identical to the sum of the project's cash flows.
4. The sum of a project's investments and disinvestments in working capital, when accumulated over time without taking time value into account, is zero.
5. When the firm has the choice between either gradually depreciating an investment or charging the investment off entirely to the year's Profit and Loss account, the first choice is generally recommended. It does not affect the total amount paid in taxes (over the project's entire life), and it avoids unnecessary fluctuations in profits.
6. When applying NPV, you should take great care in reallocating the firm's general overhead, and charge a fair portion of this overhead to the new project—for instance, proportionally with sales or direct costs.
7. When valuing a project, you should not include in the cash flow estimates of the (arm's length) profits made by other business units on their sales to the new unit. That is, the project should be viable even when it must pay normal (arm's length) prices for the components it buys.

8. Adjusted NPV contains corrections for qualitative aspects that were ignored in the first-stage NPV calculations.
9. Since borrowing reduces corporate taxes, one should always compute the tax savings ($\text{borrowing capacity} \times \text{interest rate} \times \text{tax rate}$), and add their present value to the first-stage NPV.
10. The WACC correctly measures the gain to the shareholders from undertaking a project, if and only if (1) the project is either a perpetuity or a one-period venture; (2) the tax shield is always fully used; and (3) all gains accrue to the shareholders.
11. Exports occur through a dependent agent or through a branch, while operating through a subsidiary falls into the category of international marketing.
12. A firm that is very good at marketing will often become a franchisee; likewise, a firm that is very good at developing a new technology or that possesses a valuable brand name will typically become a licensee.
13. The licensor or franchiser typically receives a stated fraction of the project's profits.
14. Having a foreign branch is like having a dependent agent abroad, except that the foreign operations are incorporated as a separate company.
15. The incremental value principle says that since the gains from tax planning and "tax-treaty shopping" are unambiguously related to the project, these gains should be considered in the decision to accept or reject.
16. When conducting an NPV analysis, one should be as realistic as possible, and subtract, for example, the license fees, interest payments and amortization of intracompany loans, and management fees from the project's cash flows.
17. Since the money paid to bank(s) to service loan(s) does not accrue to the shareholders, one should subtract these payments from the operational cash flows before computing the NPV.
18. A sound rule of thumb is that the company should borrow in a weak currency for two reasons. First, the firm can expect a capital gain when the loan is paid back. Second, the high interest payments mean that there is a large interest tax shield.
19. To account for expropriation risk, one simply deducts the insurance premium (after taxes) because this premium is equal to the market's risk-adjusted expected cost of expropriation.
20. The best way to account for transfer risk is to add a risk premium to the discount rate. The next best way is to subtract the expected losses on blocked funds from the operating cash flows.

21. Leading and lagging are ways to speculate on changes in transfer prices.

A. 1. true; 2. false; 3. true; 4. true; 5. false: you lose time value by voluntarily speeding up taxes; 6. false: only incremental overhead matters (the increase in overhead caused by the project); 7. false: We use the NPV rather than the ill-defined "arm's length" profits. The discounting implicitly subtracts the normal return on investment and normal reward for risk from the supplying units cash flows. If the NPV of the supplying units cash flows is truly equal to zero, they will not affect the project NPV. So no harm is done by including them. If, on the other hand, the supplying units cash flows do have a positive NPV, we clearly have to include them; 8. false; 9. false; 10. false; 11. false; 12. false; 13. false; 14. false; 15. false; 16. false: the license payments have to be added back to the project cash flows; 17. false: one decides on the basis of a full-equity analysis; 18. false: in terms of risk-adjusted expectations, there is no difference in the currency of borrowing if the spot and forward markets are in equilibrium and the capital gains tax is the same as the tax on interest income; 19. false; 20. false; 21. false.

Additional Quiz Questions

1. What are the reasons why the tax savings from corporate borrowing are often smaller than the present value of (borrowing capacity \times borrowing rate \times tax rate)?

A1.

- Not all of the tax shield may be used if the earnings before interest are not large enough.
- There is a loss of time value when an interest tax shield is carried forward.
- The formula only looks at corporate taxes and ignores the total tax burden.
- Generally, part of the tax subsidy will accrue to the shareholders and part to the bondholders, but just how much each will receive is unknown.

2. Why does a firm often combine, for example, exports, foreign marketing, and licensing—rather than choosing only one of the above methods of operations?

A2.

Each mode of foreign activity is not mutually exclusive, and a company may create synergies by combining various modes. These synergies include: reducing the total tax burden, reducing political risk, and distributing the risk and the revenues.

3. What are the main differences between an independent agent and a dependent agent? A dependent agent and a branch? A branch and a subsidiary? A subsidiary and a joint venture?

A3.

	Independent agent	Dependent agent	Branch	WOS	JV
Type of activity	Sells units on its own account	Sells units on its own account	Produces and/or sells for the parent firm	Produces and/or sells on its own account	Produces and/or sells on its own account
Company legal present in host country	No	No	Yes, but not separate from the parent	Yes, as a separate company that is owned by the parent firm	Yes, but as a separate company with two or more parents

4. Why is it better to separate the analysis of intracompany financial arrangements from the analysis of the operations and the analysis of the effects of external financing?

A4.

- (a) Intra-company financial arrangements should be examined separately from the operational aspects because the royalties or interest on an intra-company loan are a "cost" to the subsidiary, but at the same time, income to the parent. Also, royalties and interest payments result in lower host country taxes, but greater taxes on home country income.
- (b) 1) Tax planning is complex and technical; 2) the assumptions concerning the size and timing of dividends may be tenuous and the potential closing of tax loopholes may eliminate any savings from tax planning; and, 3) tax savings should only viewed as a welcome boon, and not the element which will make or break an NPV calculation.
5. Describe how the proactive and reactive management of transfer risk differ.

A5. If a country with foreign country reserve problems is going to begin blocking some forms of remittances, it is helpful if a company has already established a tradition of proactive transfer risk management using techniques like leading and lagging or using a bank as a front for a loan. The reason is that once capitals controls have been imposed, if a company changes its remittance policy, the host government will recognize the changes as tactics for avoiding controls and disallow transfers of funds. Likewise, when a host country blocks some or all payments, you will no longer have the opportunity

to dress up an intra-company loan as a loan from a bank. Thus, this has to be done pro-actively.

6. What cash flows are not shown in the projected Profit-and-Loss accounts for the project, but should nevertheless be taken into account when doing an NPV analysis?

A6. Depreciation should be added back because it is not a real cost, and the initial costs and the actual production costs should be recognized as they occur.

Applications

1. Consider Example ???. Suppose that intracompany transactions represent one-fourth of the project's variable costs, and every delivery valued at the arm's-length price of 100 yuan increases the profits of the supplying unit by 50 yuan; that is, variable costs are half of the transfer price. Additional deliveries of coating material will not require any additional investment, nor will they affect the company's overhead. Evaluate the profits that the parent makes on its intracompany sales, and incorporate them into the NPV analysis.
2. To take into account leads and lags (investments in working capital), assume that:
 - The supplying unit ships the coating, on average, six months before the subsidiary sells its final product (that is, shipment occurs at times 1, 2,..., 5).
 - Production of the coating consists of grinding and mixing, and takes virtually no time; the supplying unit usually has about one month's worth of raw material in inventory, and pays its own suppliers thirty days after delivery. Workers are paid every week. Thus, the supplying unit's cash outflows also take place at times 1, 2,..., 5.
 - The new business unit pays sixty days after delivery; taking into account one month for the actual shipment, this means that the supplying unit is paid at times 1.25, 2.25,..., 5.25.

A1. The data imply the following cash flows from the sales to the new unit:

**Present value of the additional cash flows generated in supplying
the business unit**

Reporting year	(a) Sales	(b) Variable costs	(c) Over- head	(d) Depre- ciation	(e) Taxable	(f) Tax (35%)
1	65	33	0	0	33	11
2	100	50	0	0	50	18
3	110	55	0	0	55	19
4	60	30	0	0	30	11
5	30	15	0	0	15	5
PV	218	109				38

Sales of coating by the supplying unit to the proposed new business unit represent one-fourth of the projects variable costs; that is, (a) is one-fourth of column (b) from Table 21.1. The variable costs of producing this coating are half the transfer price, that is, (b) = (a)/2, (e)=(a) - (b) - (c) - (d), and (f) = (e) × 0.35.

On the basis of the figures in this exhibit, value the profits the parent makes on its intracompany sales as follows:

$$NPV = \sum(a) - \sum(b) - \sum(f) = 218 - 109 - 38 = \text{ESP } 71.$$

3. Again consider Example ?? . We add a second interaction. Specifically, assume that Weltek UK is currently exporting to China, via an independent agent. If Weltek chooses to continue exporting instead of setting up production in China, unit variable costs will be higher (due to transportation cost, tariffs, etc.); and sales will be lower than expected because the agent is not as interested in promoting Weltek's goods as Weltek itself. On the other hand, no investments in fixed assets and marketing organization are required if exporting remains the mode of operation, and exporting does not create any extra overhead. Weltek's profits from exporting, and the corresponding taxes, are presented below.

year t	(a) Sales	(b) Variable costs	(c) Over- head	(d) Depre- ciation	(e) Taxable	(f) Tax (35%)
1	420	231	0	0	189	66
2	551	303	0	0	248	87
3	463	255	0	0	108	73
4	243	134	0	0	109	38
5	128	70	0	0	58	20
PV	1,169	673	0	0	0	153

$$(e) = (a) - (b) - (c) - (d); (f) = (e) > 0.35.$$

4. Due to shipping delays and the increased inventory levels needed in view of the distance, production for exports takes place six months before the moment of sale to the final Spanish customer (that is, at times 1, 2,..., 5). Production costs lead production by three months. Compute the PV of the export profits lost when the project is undertaken, and decide whether Weltek UK should still consider direct investment in Spain. Use a 20 percent cost of capital.

A2. The present values of the cash flows are:

$$PV = \sum(a) - \sum(b) - \sum(f) = 1169 - 673 - 153 = 343.$$

Now evaluate the project. The true NPV of the incremental cash flows equals (in millions of ESP)

- The NPV of the cash flows realized in Spain	-13
- Plus the PV of the profits Weltek makes at home,	71
- Minus the PV of the profits Weltek loses by no longer exporting	-343
Total:	-285

Thus, under this modified scenario, the investment project is no longer profitable.

5. An Andorra company, Walden Inc., considers a proposal to produce and sell market inverters in Prisonia. The Prisonian dollar (PRD) is fully convertible into any OECD currency, and the country's capital market is unrestricted and well integrated with western markets. The life of the project is three years. The initial investment consists of land (PRD 1,000) with an expected liquidation value of PRD 1,100; plant, equipment, and entry costs equal PRD 6,000, and are to be depreciated at 66 percent in year 1, 33 percent in year 2, and 1 percent in year 3. Estimated figures for sales, variable costs, and overhead are as follows.

	(a1)	(a2)	(b)	(c)	(d)	(e)
Book year	Sales	Sales of the land	Variable costs	Overhead	Depreciation	Taxes
1	5,500	—	2,500	1,000	3,960	-784
2	10,000	—	4,200	1,200	1,980	1,048
3	12,800	—	5,600	1,300	60	2,336
4	—	134	—	—	—	400

*proceeds from the sale of the land

Sales occur, on average, in the middle of the year; variable costs are disbursed one month earlier, and customers pay three months later. Overhead and taxes are paid in the middle of the year. The investment occurs in the middle of year 0, and liquidation occurs in the middle of the fourth year. The discount rate is 15 percent for the operating cash flows, and 10 percent for the investment itself. (The initial loss can be carried forward, but this is already reflected in year-2 taxes.) Is this a viable proposal?

A3.

$$=: < 6,672.24 >$$

$$=: 18,694.30$$

$$=: < 8,516.90 >$$

$$=: < 3,989.60 >$$

$$=: 373.21$$

$$\text{NPV} = -113.23 < 0$$

Chapter 22

Negotiating a Joint-Venture Contract: the NPV Perspective

Quiz Questions

Suppose that company A can realize an NPV of 200 from doing the project on its own, while company B can realize 100. The NPV from joint operations is 400. There are no taxes.

True-False Questions

1. In a pure-equity contract, A will get two-thirds of the equity of the JV, while B will get one-third.
2. In a pure-equity contract, A will get two-thirds of the synergy gain from the JV, while B will earn one-third.
3. A's bargaining position is stronger than B's (because of its higher threat point), so A will get more than half of the synergy gain.
4. In a pure-equity contract, A will usually receive half of the synergy gain from the JV unless A's bargaining position is stronger or weaker than B's - that is, unless A is less impatient or more impatient than B.
5. In a nonproportional contract, A will not usually agree to receive only one-half of the synergy gain of the JV.
6. In order to agree to a 50/50 joint venture, A will expect an additional payment of 100 from B.
7. In order to agree to a 50/50 joint venture, A will need a side payment of 100 from the joint venture.

Ans. 1. false: $A's\ gain = 400 - 200 \neq B's\ gain = 400 - 100$; 2. false: unequal impatience may explain a non-equal split, but this has nothing to do with pure-equity contract; 3. false: same reason as question 2; 4. true; 5. false: non-proportional ways of splitting do not invalidate the equal-gain principal; 6. false: this would give A a gain of $[400 - 200] + 100 \neq B's\ gain = [400 - 200] - 100$; 7. true: $A's\ gain = [-200] + 100 = B's\ gain = -100$.

Additional Quiz Questions

1. Why does the investment analysis of a joint venture comprise more than just an NPV analysis?
A1. Because the JV partners have to agree on how the total NPV of the project must be shared.
2. What additional assumptions are needed to make the following statement true: "In a joint venture where neither partner can achieve anything without the other's help, the ownership should be divided 50/50."
A2. Given that 1) the contract is pure equity; 2) the markets are integrated; 3) the taxes are the same for each.
3. In negotiating a license contract, one should consider the opportunity cost, that is, money that could have been earned by signing a license contract with another company. How is this accounted for in our approach?
A3. The alternatives, NPV_A and NPV_B , are the opportunity costs.
4. Why might a company prefer licensing over direct investment?
A4. Because the taxes may be lower for licensing fees than for dividends. Plus, licensing fees are less risky. Thus, they may be more favorable given asymmetric information and capital restrictions.
5. Tax rules, in themselves, favor corner solutions where either equity or licensing income is not used. Still, we often observe that both are used. Give some reasons why a contract may include both equity and non-equity features.
A5. Not all decisions are driven by tax considerations. A non-equity solution would mean that one party would have no control in the JV, or the royalty fees may not be deemed "at arm's length". In the pure equity solution, the government may impose limits on the equity share ϕ or a high level of foreign ownership may lead to an undesirable image in the local market.

Applications

The exercises below focus on the logic used in this chapter rather than on number crunching. You should try to solve them without using any of the analytical solutions from the text.

1. Suppose that company A's project has an NPV of 200 on its own, while company B can realize 100. The synergy gain is 200. There are no taxes, the financial markets are integrated, and A and B have equal bargaining strengths.
 - (a) How much of the total NPV (500) should go to A, and how much to B?
 - (b) To achieve this, what should the equity holdings be in a pure-equity JV?
 - (c) Suppose that A and B agree that A will receive licensing fees from the JV worth 80 (in present value).
 - i. How much of the total NPV (500) is left to be shared in proportion to the original cash inputs?
 - ii. Write down the equal-gains principle, and solve for ϕ .
 - iii. Verify whether the synergy gains are shared equally.
 - (d) Suppose, instead, that A and B agree on a 50/50 joint venture. What is the present value of the licensing income or management fees that A must receive in order to accept this equity structure?

A1.

- (a) Company A should get $NPV_A + 100 = 200 + ?$.
- (b) Company A should get $? = 60$ percent of the equity, B should get 40 percent. Then $0.6 \times 500 - 200 = 0.4 \times 500 - 100$.
- (c) (1) The NPV of the JV is now paid out as follows: 80 to the licensor (A), and the balance, $500 - 80 = 420$, to the shareholders on a $\phi/(1-\phi)$ basis. (2) The equal-gains principle says:

$$[\phi 420 + 80]200 = (1-\phi)420100$$

$$\Rightarrow 2\phi 420 = 420(200 - 100 + 80)$$

$$\Rightarrow \phi = 0.5 + 51.88 = 52.38\%.$$

- (3) Company A gets 52.38% $420 + 80 = 300$, as it should (see question (a)). B gets $(1 - 0.5238) \times 420 = 200$.

(d)

$$0.5 \times (500 - L) + L200 = 0.5 \times (500 - L)100$$

$$0.5L200 = 0.5L100$$

$$L = 200 - 100 = \text{difference between threat points} = 100.$$

2. Suppose that company A's project has an NPV of 200 on its own, while company B can realize 100. The synergy gain is 200. There are no taxes, and the financial markets are integrated. Assume, however, that B has a better bargaining position, and is able to obtain 45 percent of the equity in the first-pass negotiations (the pure-equity joint venture).
- (a) What part of the synergy gains goes to A, what part to B?
 - (b) Suppose that, in the second-stage negotiations, A asks for a license contract worth 80 (in present-value terms). How should the equity shares be adjusted to preserve the division of the synergy gains (that is, to make both parties equally well-off as in the pure-equity solution)?
 - (c) Which licensing contract is compatible with a 50/50 joint venture and the bargaining strengths used in part (a) of this question?

A2.

- (a) Company A gets $0.55 \times 500 = 275$, which is only 75 above its threat point. That is, a fraction, $75/200 = 37.5$ percent, of the synergy gain now goes to A.
 - (b) The NPV of the JV is now paid out as follows: 80 goes to the licensor (A), and the balance, $500 - 80 = 420$, is distributed on a $\phi/(1 - \phi)$ basis. To make both parties equally well-off as in the pure-equity solution, we need to set ϕ such that $[\phi 420 + 80] = 275$, which implies that $\phi = 46.43$ percent.
 - (c) To make both parties equally well-off as in the pure-equity solution, we need to set L such that $0.5 \times [500 - L] + L = 275$, which implies that $L = 50$.
3. In Freedonia and Prisonia there are no taxes, and the capital markets are well-integrated across the two countries. Two multinational utility firms, FreeCorp and PriCorp, have woss that compete in the Prisonian market for electric power. Right now, the aggregate annual revenue of both producers is 1,050m/year, without any growth prospects. The current market value of FreeCorp's wholly owned subsidiary is 200m, while PriCorp's wos is worth 100m. Both companies are fully equity-financed. FreeCorp and PriCorp are negotiating a merger of their Prisonian subsidiaries. This would stop competition and would allow the producers to increase the price of electric power by 10 percent. Total sales would drop slightly, to 1,000m/year, but the higher profit margin would lead to a JV with a market value of 400m.
- (a) Assume initially that the newly formed JV would be a fully equity-financed firm (no bonds, royalties, management fees, etc.). The merchant bank that acts as the adviser proposes that, as FreeCorp's assets are currently worth 200m and PriCorp's assets 100m, FreeCorp should get two-thirds of the shares.

- i. Evaluate this proposal: who gets how much of the synergy gains?
 - ii. Formulate a counterproposal if you disagree.
- (b) The Prisonian Foreign Investment Act restricts the equity share of foreign owners to 50 percent at most.
 - i. How much of the synergy gain accrues to each parent if $\phi = 50$ percent and if there is no other contract (like a license contract, for instance)?
 - ii. As a result of the above contract, what is the side payment that PriCorp must make to FreeCorp, one way or another, so that the gains are fairly shared?
- (c) PriCorp proposes that FreeCorp receive an annual management fee of 0.5 percent of annual sales as payment for the accounting software contributed by FreeCorp. Given perpetual sales of 1,000m/year and a yield on perpetual bonds equal to 10 percent, the present value of this perpetual management fee is

$$\frac{0.5\% \times 1,000\text{m}}{10\%} = 50\text{m}$$

However, the proposal is vague about whether the management fee is paid out by the JV or by PriCorp.

- (1) From FreeCorp's point of view, does it make a difference whether the management fee is paid out by the JV or by PriCorp?
- (2) If it makes a difference, evaluate the proposed management fee for each case, and formulate a counterproposal.

A3.

- (a) FreeCorp gains $2/3 \times 400\text{m} - 200\text{m} = 66.67$, PriCorp gains only $1/3 \times 400\text{m} - 100\text{m} = 33.33$. However, to obtain an equal split, we need $\phi \times 400\text{m} - 200\text{m} = (1 - \phi) \times 400\text{m} - 100\text{m}$, which requires $\phi = 1/2 + ?? = 62.5$ percent. Then FreeCorps gains = $0.624 \times 400\text{m} - 200\text{m} = 250\text{m} - 200\text{m} = 50\text{m}$, which is the same as PriCorps gain, $0.375 \times 400\text{m} - 100\text{m} = 150\text{m} - 100\text{m} = 50\text{m}$.
- (b) FreeCorp gains $0.50 \times 400\text{m} - 200\text{m} = 0$, while PriCorp gains $0.50 \times 400\text{m} - 100\text{m} = 100\text{m}$. Thus, PriCorp should make an additional payment of 50m to FreeCorp.
- (c) (1) It makes a difference. If the payment is made by the JV, then the JV's residual income goes down by 50, and Freecorp's dividend from the JV by 25. That is, FreeCorp actually pays itself half of any royalty paid by the JV, so it only receives 25m net. (2) The royalty should be set at 100m if it is paid by the JV.