Chapter 1 Spot Exchange Markets

Quiz Questions

Q1. Using the following vocabulary, complete the following text: *forward; market maker or broker; least cost dealing; 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)."

A1. (a) market maker or currency broker; (b) wholesale; (c) retail; (d) spot; (e) forward; (f) least cost dealing; (g) arbitrage.

Q2. From a Frenchman's point of view, which of each pair of quotes is the direct quote? Which is the indirect quote?
(a) FRF/GBP 9; GBP/FRF 0.11.
(b) USD/FRF 0.17; FRF/USD 5.9.
(c) FRF/BEF 0.17; BEF/FRF 5.9.

A2. (a) direct; indirect.
(b) indirect; direct.
(c) direct; indirect.

Q3. You are given the following spot quote: DEM/CAD 2.2035–2.2070.
(a) The above quote is for which currency?
(b) What is the bid price for DEM in terms of the CAD?

A3. (a) DEM/CAD equals the number of DEM per 1 CAD; therefore, the above quote is for CAD in terms of German marks.
(b) The bid price for DEM in terms of CAD is CAD/DEM 1/2.2070 = 0.453.

Q4. You read in your newspaper that yesterday's spot quote was CAD/GBP 1.60–1.65.
(a) This is a quote for which currency?
(b) What is the ask rate for CAD?
(c) What is the bid rate for GBP?

A4. (a) This is a quote for GBP in terms of CAD.
(b) The ask rate for CAD is 1/1.60 = 0.625.
(c) The bid rate for GBP is 1.60.

Q5. A bank quotes the following rates. Compute the DEM/JPY bid cross rate (that is, the bank's rate for buying JPY).

	Bid	Ask
DEM/CAD	1.3	1.32
CAD/JPY	0.01	0.012

A5. Synthetic $[\text{DEM/JPY}]_{\text{bid}} = [\text{DEM/CAD}]_{\text{bid}} \times [\text{CAD/JPY}]_{\text{bid}} = 1.3 \times 0.01 = 0.013$.

Q6. 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?

A6. 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:

1. The bank sells JPY, and it buys USD at JPY/USD 245.
2. 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.

1. The bank sells CHF, buys USD at CHF/USD 2.5110.
2. 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.

Q7. A bank is currently quoting the spot rates of DEM/USD 3.2446–3.2456 and BEF/USD 65.30–65.40. What is the lower bound on the bank's bid rate for the BEF in terms of DEM?

A7. DEM/BEF bid rate is the rate at which the bank buys BEF for DEM.

1. The bank sells DEM, and it buys USD at DEM/USD 3.2446.
2. The bank sells USD, and it buys BEF at BEF/USD 65.40.

Thus, the rate is: $\frac{\text{DEM/USD } 3.2446}{\text{BEF/USD } 65.40} = \text{DEM/BEF}_{\text{bid}}\ 0.0496$.

Q8. Suppose that an umbrella costs USD 20 in Atlanta, and the USD/CAD exchange is 0.75. How many CAD do you need to buy the umbrella in Atlanta?

A8. $\text{CAD/USD} \times \text{USD/umbrella} = \frac{\text{USD/umbrella}}{\text{USD/CAD}} = \frac{20}{0.75} = \text{CAD } 26.67$.

Q9. Given the bid-ask quotes for JPY/GBP 160–180, at what rate will:
(a) Mr. Smith purchase GBP?
(b) Mr. Brown sell GBP?
(c) Mrs. Green purchase JPY?
(d) Mrs. Jones sell JPY?

A9. (a) JPY/GBP 180; (b) JPY/GBP 160; (c) JPY/GBP 160 or GBP/JPY 0.00625; (d) JPY/GBP 180 or GBP/JPY 0.00556.

Exercises

E1. You have just graduated from the University of Florida and are leaving on a whirlwind tour of Europe. You wish to spend USD 1,000 each in Germany, France, and Great Britian (USD 3,000 in total). Your bank offers you the following bid-ask quotes: USD/DEM 0.58–0.60, USD/FRF 0.16–0.18, and USD/GBP 1.48–1.51.

(a) If you accept these quotes, how many DEM, FRF, and GBP do you have at departure?
(b) If you return with DEM 300, FRF 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 DEM 300 once you return home, you want to sell them in Paris. At the train station, you are offered FRF/DEM 3.33–3.55, while a bank three blocks from the station offers FRF/DEM 3.39–3.49. At what rate are you willing to sell your DEM 300? How many FRF will you receive?

A1. (a) DEM 1,666.67; FRF 5,555.56; GBP 662.25.
(b) 174 + 160 + 111 = USD 445.
(c) You will sell at FRF/DEM 3.39; you will receive FRF 1,017.

E2. Abitibi Bank quotes JPY/DEM 63.95–64.72, and Bathurst Bank quotes DEM/JPY 0.0152–0.0154.

(a) Are these quotes identical?
(b) If not, is there a possibilty for least cost dealing or arbitrage?
(c) If there is an arbitrage opportunity, how would you profit from it?

A2. (a) No, Abitibi Bank's quotes imply DEM/JPY 0.0155 - 0.0156.
(b) Since both rates quoted by Abitibi exceed those offered by Bathurst, there is an arbitrage opportunity.
(c) Buy JPY from Bathurst Bank at DEM/JPY 0.0154 and sell them to Abitibi Bank at DEM/JPY 0.01545. Equivalently, buy DEM from Abitibi at 64.72 and sell them to Bathurst at 64.935.

The following spot rates against the GBP are excerpted from the financial press of Wednesday, April 20, 1994. Use the quotes to answer the questions in Exercises 3 through 5.

	Closing mid-point	Change on day	Bid/offer spread
Europe			
Austria ATS	17.7046	-0.0779	967-124
Belgium BEF	54.7634	-0.2764	230-037
Denmark DKK	9.8653	+0.047	603-702
Finland FIM	8.1350	+0.0134	257-443
France FFR	8.6213	-0.0333	178-248
Germany DEM	2.5144	-0.0144	133-154
Greece GDR	368.429	-1.877	972-886

Bid-ask spreads show only the last three decimal places.

E3. What are the bid-ask quotes for:

(a) ATS/GBP?
(b) BEF/GBP?
(c) DKK/GBP?
(d) FIM/GBP?

A3. (a) ATS/GBP 17.6967–17.7124.
(b) BEF/GBP 54.7230–54.8037.
(c) DKK/GBP 9.8603–9.8702.
(d) FIM/GBP 8.1257–8.1443.

E4. What are the bid-ask quotes for:
(a) GBP/ATS?
(b) GBP/BEF?
(c) GBP/DKK?
(d) GBP/FIM?

A4. (a) GBP/ATS 0.056458–0.056508.
(b) GBP/BEF 0.018247–0.018238.
(c) GBP/DKK 0.101315–0.101417.
(d) GBP/FIM 0.122785–0.123066.

E5. What are the cross bid-ask rates for:
(a) FFR/DEM?
(b) FIM/GDR?
(c) BEF/DKK?
(d) ATS/DEM?

A5. The cross market can have customers only if
(a) $3.42602 \leq \text{FFR/DEM}_{\text{bid}} < \text{FFR/DEM}_{\text{ask}} \leq 3.43166$.
(b) $0.02203 \leq \text{FIM/GDR}_{\text{bid}} < \text{FIM/GDR}_{\text{ask}} \leq 0.02213$.
(c) $5.54453 \leq \text{BEF/DKK}_{\text{bid}} < \text{BEF/DKK}_{\text{ask}} \leq 5.55819$.
(d) $7.03532 \leq \text{ATS/DEM}_{\text{bid}} < \text{ATS/DEM}_{\text{ask}} \leq 7.04741$.

Mind-Expanding Exercises

ME1. When discussing triangular arbitrage and least-cost dealing, we considered only the spot market.
(a) Is it also possible to construct synthetic forward deals?
(b) If so, what are the synthetic forward bid and ask rates?
(c) How should the actual (direct) forward rates be related to the synthetic rates?

A1. (a) Yes. Just replace S by F. For example, if you buy, convert USD into DEM, for delivery and payment 180 days from now, and you convert these DEM into JPY for delivery and payment for 180 days from now, you have synthetically created a forward contract to convert USD into JPY.
(b) First, determine whether you need to divide or multiply by comparing the dimensions of the rates that you are given to the dimensions of the synthetic rate that you want to compute. Then apply the *Law of the Worst Possible Combination*: for a synthetic bid rate use the ask rate whenever you must divide, and the bid rate whenever you must multiply.
(c) In equilibrium, there are no arbitrage opportunities, so $F_{\text{bid}} \leq$ [synthetic F_{ask}], and [synthetic F_{bid}] $\leq F_{\text{ask}}$—that is, the direct and the synthetic quotes must overlap to some extent. In addition, the direct market will have customers for both buying and selling only if $F_{\text{bid}} \geq$ [synthetic F_{bid}] and $F_{\text{ask}} \leq$ [synthetic F_{ask}]—that is, at any typical moment, the direct quotes must be entirely within the synthetic spreads.

ME2. A spot transaction can always be thought of as paying an amount of one currency to the bank, and in return for an amount of a second currency. Let us define the amount you pay to the bank as your input into the transaction, and the amount you receive in return as the output you get from the transaction. Let us further denote amounts of cash money of currency X by X_t. For example, define USD_t as an amount of immediately available dollars, GBP_t as an amount of immediately available pounds, and so on.

Let us first familiarize ourselves with the concepts of input and output amounts:

(a) If you sell an amount USD_t for a total proceeds of DEM_t, which is the input amount? Which is the output amount?
(b) If you buy an amount USD_t for a total payment of DEM_t, which is the input amount? Which is the output amount?
(c) If you sell an amount DEM_t for GBP_t, which is the input amount? Which is the output amount?

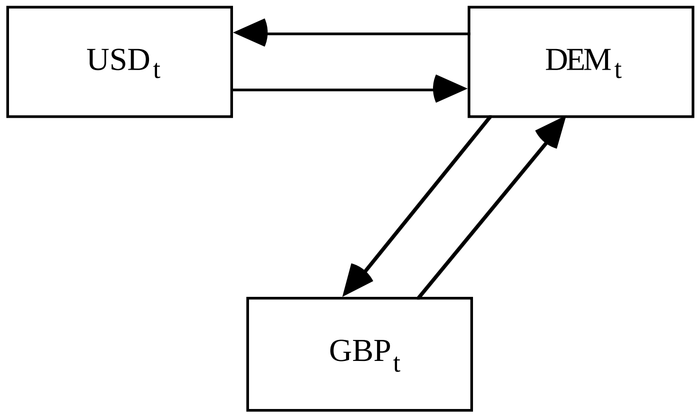
We now have to discover which exchange rate, bid or ask, goes with each transaction:

(d) Define a "factor" to be either S or $1/S$. If the spot rates quoted to you are $S[USD/DEM]_{bid}$ and $S[USD/DEM]_{ask}$, by what factor do you multiply the input amount to compute the corresponding output amount,
   - when you buy DEM with USD?
   - when you sell DEM for USD?

   (Specify whether you multiply by S or $1/S$, and whether you use bid or ask.)
(e) If the spot rates quoted to you are $S[DEM/GBP]_{bid}$ and $S[DEM/GBP]_{ask}$, by what factor do you multiply the input amount to compute the corresponding output amount,
   - when you buy GBP with DEM?
   - when you sell GBP for DEM?
(f) In your answer to the two previous questions, verify the Law of the Worst Rate:
   - Whenever the multiplication factor is S rather than $1/S$—that is, whenever you multiply an input amount by an exchange rate—you use the smaller exchange rate (the bid rate).
   - Whenever the factor is $1/S$ (that is, whenever you divide), you take the larger exchange rate (the ask rate).

In short, the relevant rate is the one that produces the smaller output from a given input. Let us now consider triangular arbitrage and least cost dealing.

(g) Suppose that you convert an amount USD_t into DEM_t, and then immediately convert this latter amount into pounds, what is the ultimate output (in pounds)?
(h) Suppose you then convert the proceeds GBP_t, obtained in question (g), back into dollars. What are the proceeds in dollars?
(i) Use your answer in (h) to verify the *Law of the Worst Possible Combination*.



In the triangular diagram above, a spot transaction is represented by an arrow that starts from the input amount and ends in the output amount. For example, to represent a spot conversion of USD into DEM, we draw an arrow from the box USD_t (your input) to the box DEM_t (the output to you). The diagram helps you in fully understanding arbitrage and least-cost dealing computations.

(j) Complete the diagram by adding, next to each arrow, the factors by which you multiply the input amount to compute the output amount. (That is, if you divide an input by an exchange rate S, define the multiplication factor to be 1/S, like in questions (d) and (e)). The rates to be used are S[USD/DEM], S[DEM/GBP], or S[USD/GBP], each time bid or ask.

(k) On the diagram, trace the sequences of transactions described in questions (g) and (h). For example, in question (g), the route followed is $USD_t \rightarrow DEM_t \rightarrow GBP_t$. Verify that the ultimate output amount is obtained by multiplying the original input amount by all factors shown next to the arrows you are following.

(l) On the diagram, point out the alternative routes that you consider when you do a least-cost dealing computation for converting DEM into GBP.

(m) On the diagram, point out the route that you follow when you verify whether or not there is a triangular arbitrage opportunity when converting USD into DEM, DEM into GBP, and GBP back into USD.

(n) In the above arbitrage computations, what is the ultimate dollar output when you start with an initial dollar input of $USD_t = 1$? (Hint: follow the arrows, and multiply by the factors next to each of them.) Then derive the no-arbitrage condition.

(o) In doing triangular arbitrage transactions like the one in question (n), does it matter what the starting point is?

(p) Suppose you do arbitrage and least cost dealing over four currencies rather than three. For example, suppose that you add the JPY to the diagram. Is there any additional insight obtained from a comparison of, say, the "quadrangular" sequence $USD_t \rightarrow DEM_t \rightarrow JPY_t \rightarrow GBP_t \rightarrow USD_t$ to the triangular sequence $USD_t \rightarrow DEM_t \rightarrow GBP_t \rightarrow USD_t$?

A2. (a) Input: USD_t ; output: DEM_t.

(b) Input: DEM_t ; output: USD_t.

(c) Input: DEM_t ; output: GBP_t.

(d) Buy DEM: the output DEM_t = (input USD_t) $\times \dfrac{1}{S[\text{USD/DEM}]_{\text{ask}}}$;

Sell DEM: the output USD_t = (input DEM_t) $\times$ $S[USD/DEM]_{bid}$.

(e) Buy GBP: the output GBP_t = (input DEM_t) $\times \dfrac{1}{S[DEM/GBP]_{ask}}$;

Sell GBP: the output DEM_t = (input GBP_t) $\times$ $S[DEM/GBP]_{bid}$.

(f) Just do it.

(g) From question (d), the output DEM_t = (input USD_t) $\times \dfrac{1}{S[USD/DEM]_{ask}}$;

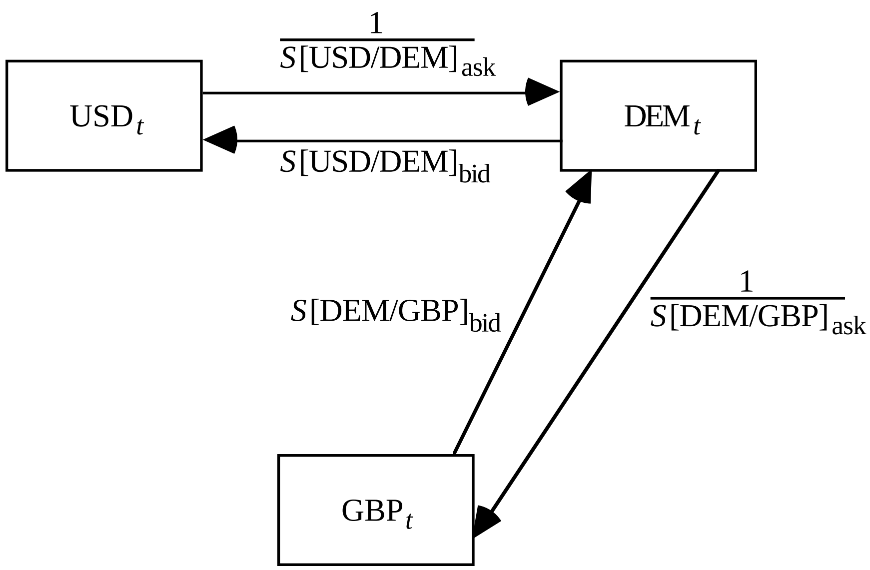
From question (e), output GBP_t = (input DEM_t) $\times$ $S[DEM/GBP]_{bid}$;

Thus, output GBP_t = (input USD_t) $\times \dfrac{1}{S[USD/DEM]_{ask}} \times \dfrac{1}{S[DEM/GBP]_{ask}}$.

(h) Output USD_t = $GBP_t \times S[USD/GBP]_{bid}$; thus, output USD_t = (input USD_t) $\times \dfrac{1}{S[USD/DEM]_{ask}} \times \dfrac{1}{S[DEM/GBP]_{ask}} \times S[USD/GBP]_{bid}$.

(i) You divide by the (higher) ask rate, and you multiply by the (lower) bid rate.

(j)



(k) Just do it.

(l) Compare $DEM_t \to GBP_t$ to $DEM_t \to USD_t \to GBP_t$.

(m) $USD_t \to DEM_t \to GBP_t \to USD_t$.

(n) Output $USD_t = 1 \times \dfrac{1}{S[USD/DEM]_{ask}} \times \dfrac{1}{S[DEM/GBP]_{ask}} \times S[USD/GBP]_{bid}$. (Notice that the *Law of the Worst Possible Combination* applies.) This USD output amount should be no more than the original input amount, USD 1. Thus, the condition is

$$\frac{1}{S[\text{USD/DEM}]_{\text{ask}}} \times \frac{1}{S[\text{DEM/GBP}]_{\text{ask}}} \times S[\text{USD/GBP}]_{\text{bid}} \leq 1.$$

(o) No. By analyzing, for instance, the route $\text{DEM}_t \to \text{GBP}_t \to \text{USD}_t \to \text{DEM}_t$ instead of $\text{USD}_t \to \text{DEM}_t \to \text{GBP}_t \to \text{USD}_t$, the exchange rate factors you use are the same as before. You just modify the order in which the three exchange rate factors appear in the computations. Since you are computing a product of the three factors, the order is not important.

(p) No. When comparing the sequence $\text{USD}_t \to \text{DEM}_t \to \text{JPY}_t \to \text{GBP}_t \to \text{USD}_t$ to $\text{USD}_t \to \text{DEM}_t \to \text{GBP}_t \to \text{USD}_t$, you are basically comparing the direct transaction $\text{DEM}_t \to \text{GBP}_t$ to its synthetic counterpart, $\text{DEM}_t \to \text{JPY}_t \to \text{GBP}_t$. This is just triangular least-cost dealing. Thus, quadrangular computations are just variations on triangular computations.

Chapter 2 Forward Contracts in Perfect Markets

Quiz Questions

Q1. Suppose that the CAD/GBP rate is 2, and the 360-day interest rates are 10 percent for the CAD, and 21 percent for the GBP.
(a) What is the forward rate for 360 days?
(b) What is the swap rate?
(c) What is the (percentage) forward premium?
(d) What is the annualized forward premium?
(e) How well does the simple interest differential (-11 percent) perform as a yardstick for evaluating the forward premium quoted by a bank?

A1. (a) 1.8182.
(b) –0.18182.
(c) –9.091 percent.
(d) –9.091 percent.
(e) In this case, not very well. Because the maturity of the forward contract is relatively long and the *per annum* interest rates are high, the *p.a.* interest differential is not an accurate estimate of the annualized percentage forward premium.

Q2. Suppose that the JPY/USD rate is 200, and the 90-day interest rates are 8 percent *p.a.* for the JPY, and 10 percent for the USD.
(a) What is the forward rate for 90 days?
(b) What is the swap rate?
(c) What is the (percentage) forward premium?
(d) What is the annualized forward premium?
(e) How well does the simple interest differential (-2 percent) perform as a yardstick for evaluating forward premium quoted by a bank?

A2. (a) 199.024.
(b) –0.9756.
(c) –0.488 percent.
(d) –1.952 percent.
(e) The interest differential is a much more accurate approximation of the equilibrium annualized forward premium.

Q3. When quoting a swap rate, some veteran traders do not even bother to mention whether they have a discount or a premium in mind. How can you tell whether you should add the swap rate or subtract it?

A3. By looking at the interest differential.

Q4. Which of the following statements are true:
(a) Interest Rate Parity implies that the forward exchange rate converges to the spot exchange rate as the delivery date for the forward contract approaches.
(b) Because the volume of trading on the spot market is greater than on the forward, the spot market "drives" the forward market.
(c) Interest Rate Parity means that the foreign and domestic interest rates must be equal.
(d) The causality implied by Interest Rate Parity means that the forward rate can be predicted from the spot exchange rate and the foreign and domestic interest rates.

A4. (a) True.
(b) & (d) are false because IRP does not imply causality.
(c) No. IRP is an arbitrage condition stating that the forward exchange rate is the spot rate adjusted for the interest differential on the domestic and foreign interest rates (with matching maturities).

Q5. From the perspective of a German company, which of the following are examples of covered or hedged transactions that do not involve any foreign exchange risk?
(a) A USD 1 million accounts receivable.
(b) A forward purchase of JPY 1 billion to be used for a accounts payable due in three months.
(c) A DEM 5 million investment.
(d) A FRF 10 million investment which will expire in six months along with a FRF 5 million accounts payable due in six months.

A5. (a) Unless the German company sells the USD 1 million forward or use them to pay an accounts payable, the USD are unhedged.
(b) The accounts payable is hedged.
(c) The investment is in the country's home currency, so it is not subject to exchange risk.
(d) Because the company can use half of the FRF 10 million investment to pay the accounts payable, half of the investment is hedged, but the remaining FRF 5 million is unhedged.

Exercises

E1. You are given the following data: the spot exchange rate is BEF/DEM 21; the *p.a.* simple interest rate on a three-month deposit is 8 percent in Belgium and 6 percent in Germany. Compute:
(a) The time-T DEM value of a DEM_t 1 investment.
(b) The time-t BEF value of a BEF_T 1 loan.
(c) The forward rate for a three-month forward contract.
(d) The time-T BEF proceeds from a DEM_T 1 forward sale, given the forward rate computed in (a).
(e) The present value of the proceeds in question (d).
(f) The time-t BEF value of a DEM_t 1 spot sale.
(g) The value, in BEF_t, of the proceeds of a DEM_T 1 loan.

A1. (a) DEM 1.015.
(b) BEF 0.980.
(c) BEF/DEM 21.103.
(d) BEF 21.103.
(e) BEF 20.689.
(f) BEF 21.
(g) BEF 20.690.

E2. You are given the following data: the spot exchange rate is CAD/DEM 0.75; the p.a. simple interest rate on a six-month deposit is 4 percent in Canada and 6 percent in Germany. Compute:
(a) The forward rate for a three-month forward contract.
(b) The time-T CAD value of a CAD_t 1 investment.

(c) The time-t DEM value of a DEM_T 1 loan.
(d) The time-T DEM value of a CAD_T 1 forward sale, given the forward rate computed in (a).
(e) The time-t DEM value of a CAD_t 1 spot sale.

A2. (a) CAD/DEM 0.7427.
(b) CAD 1.02.
(c) DEM 0.9709.
(d) DEM 1.346.
(e) DEM 1.333.

E3. A Japanese manufacturer has an accounts receivable of USD 1 million due in 90 days. The spot and forward exchange rates are JPY/USD 110 and 109.8, respectively, and the simple interest rate for a three-month deposit is 2 percent *p.a.* in Japan and 3 percent *p.a.* in the US.
(a) If the manufacturer sells the USD 1 million forward for 90 days, how many JPY will she receive at time T?
(b) How could she replicate a forward sale in the spot and money markets?
(c) Is the manufacturer indifferent between (a) and (b)?
(d) If the manufacturer has a preference, is this an example of least cost dealing or arbitrage?

A3. (a) JPY 109.8 million.
(b) Borrow the present value of USD 1 million, convert the US proceeds into JPY at the spot rate, and invest these JPY for 90 days. That is:

$$USD_t = \frac{\text{USD 1 million}}{1.0075} = \text{USD } 992{,}556;$$

$$JPY_t = \text{USD } 992{,}555.83 \times 110 = \text{JPY } 109.181 \text{ million; and}$$

$$JPY_T = \text{JPY } 109.181 \text{ million} \times 1.005 = \text{JPY } 109.727 \text{ million.}$$

(c) No. The forward sale results in more JPY.
(d) Least cost dealing. The starting point is the USD 1 million which is to be hedged, and the goal is to find the route which is cheapest.

E4. Given the following data, are there any arbitrage opportunities? If so, how would you make a risk-free profit?

		Spot rate S_t	Forward rate, $F_{t,T}$	$r_{t,T}$	$r^*_{t,T}$
(a)	BEF/DEM	20.5	20.60	3.5%	2.5%
(b)	JPY/NLG	57.5	57.10	1.25%	3.0%
(c)	ITL/FRF	283.0	285.73	4.5%	3.5%
(d)	CHF/GBP	2.2	2.18	2.0%	3.0%

A4. (a) From the spot and interest rate data, we can create a synthetic contract at the forward rate of $20.5 \times \frac{1.035}{1.025} = 20.7$. Relative to the synthetic rate, the direct forward rate is too low. In order to make a risk-free profit, you buy forward DEM 1 at BEF 20.6 and sell DEM forward at the synthetic rate 20.7. This means that you have made a risk-free profit of BEF_T 0.1 at time T.

(b) From the spot and interest rate data, we can create a synthetic contract at the forward rate of $57.5 \times \frac{1.0125}{1.03} = 56.52$. Relative to the synthetic rate, the direct forward rate is too high. In order to make a risk-free profit, you sell forward NLG 1 at JPY 57.1 and purchase NLG forward at the synthetic rate, 56.52. This means that you have made a risk-free profit of JPY_T 0.58 at time T.

(c) $283 \times \frac{1.045}{1.035} = 285.73$ (no arbitrage opportunities).

(d) $2.2 \times \frac{1.02}{1.03} = 2.18$ (no arbitrage opportunities).

E5. In the years between the two World Wars, UK investment bankers and brokers attracted USD deposits by offering the GBP interest rate plus the (annualized) percentage (%) forward premium. Would the resulting USD rate be too high or too low? Check how well the formula works when:

(a) The deposit has a thirty-day life, and UK and US rates are 3 percent and 2.5 percent (annualized), respectively.

(b) The deposit has a 360-day life, and UK and US rates are 12 percent and 8 percent (annualized), respectively.

A5. (a) Remember that the UK uses a USD/GBP rate. Interest grossed up with the forward premium equals:

$$\frac{1}{T-t}\, r_{\text{GBP}} + \frac{\frac{1}{T-t}(r_{\text{USD}} - r_{\text{GBP}})}{1 + r_{\text{USD}}} = 3\% + \frac{2.5\% - 3\%}{1 + \frac{1}{12}(3\%)} = 0.025012$$

or approximately 2.5%. Thus, the resulting USD interest rate is somewhat high.

(b) Interest grossed up with the forward premium is:

$$\frac{1}{T-t}\, r_{\text{GBP}} + \frac{\frac{1}{T-t}(r_{\text{USD}} - r_{\text{GBP}})}{1 + r_{\text{USD}}} = 12\% + \frac{8\% - 12\%}{1 + 12\%} = 0.084286$$

or approximately 8.43%. Thus, the resulting USD interest rate is again too high.

Mind-Expanding Exercise

ME1. You have a long open position, that is, you are expecting a future foreign currency inflow. Under what conditions would you be indifferent between hedging this position via a forward transaction and hedging it via the money markets if the position is:

(a) A foreign currency inflow.

(b) A foreign-currency accounts receivable that you would like to finance, that is, you would like to borrow now against the expected proceeds of the accounts receivable inflow (sell forward and borrow against proceeds in domestic currency, versus borrow foreign currency and sell the proceeds in the spot market, etc.)

A1. (a) For simplification, assume that at time T, the foreign currency inflow = DEM_T 1. There are two alternatives for hedging:

1. Sell the foreign currency inflow at the forward rate: the proceeds are $1 \times F_{t,T} = BEF_T$.
2. Borrow an amount equivalent to the foreign currency inflow discounted at the foreign interest rate:

$$DEM_t = \frac{1}{1 + r^*_{t,T}}.$$

Then convert the loan proceeds at the spot rate: BEFt = $DEM_t \times S_t$. Finally, invest it at the domestic interest rate $1 + r_{t,T}$ such that you have:

$$BEF_T = BEF_t \times (1 + r_{t,T}) = \frac{1}{1 + r^*_{t,T}} \times S_t \times (1 + r_{t,T})$$

If $F_{t,T} = S_t \times \frac{1 + r_{t,T}}{1 + r^*_{t,T}}$, then both alternatives are equivalent. Or in other words, at time T, you must deliver 1 unit of foreign currency (as agreed upon in the forward contract or in order to repay our foreign currency borrowing), and you receive $\frac{1}{1 + r^*_{t,T}} \times S_t \times (1 + r_{t,T})$ units of home currency (again, as agreed upon in the contract or as the proceeds of our home currency investment).

(b) For simplification, assume that at time T, the foreign currency accounts receivable equals DEM_T 1. There are two alternatives for financing this:

1. Sell forward one unit of foreign currency at $F_{t,T}$ to create a BEF inflow of $BEF_T = F_{t,T}$. Next, borrow against this future inflow at the domestic interest rate $1+r_{t,T}$ such that you have:

$$BEF_t = F_{t,T} \times \frac{1}{(1+r_{t,T})}.$$

2. Borrow against this future inflow at the foreign interest rate $1 + r^*_{t,T}$ and convert the proceeds, $DEM_t = \frac{1}{1 + r^*_{t,T}}$, at the spot rate S_t. You receive:

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

If $F_{t,T} = S_t \times \frac{1 + r_{t,T}}{1 + r^*_{t,T}}$, then the amount in part [1] becomes $S_t \times \frac{1 + r_{t,T}}{1 + r^*_{t,T}} \times \frac{1}{1 + r_{t,T}}$ $= S_t \times \frac{1}{1 + r^*_{t,T}}$, which is the same as the converted proceeds from the foreign borrowing in part [2].