# 5

# Using Forwards for International Financial Management

In this chapter, we discuss the five main purposes for which forward contracts are used: arbitrage (or potential arbitrage), hedging, speculation, shopping around, and valuation. These provide the topics of sections 5.2 to 5.6, respectively. But first we need to spend some time on practical issues: the quotation method, and the provisions for default risk (section 5.1).

## 5.1 Practical Aspects of Forwards in Real-World Markets

### 5.1.1 Quoting Forward Rates with Bid–Ask Spreads

With bid–ask spreads, a forward rate can still be quoted "outright" (that is, as an absolute number), or as a swap rate. The outright quotes look like spot quotes in that they immediately give us the level of the forward bid and ask rates; for instance, the rates may be CAD/USD (180 days) 1.1875–1.1895. Swap rates, on the other hand, show the numbers that are to be added to or subtracted from the spot bid and ask rates in order to obtain the forward quotes. One ought to be careful in interpreting such quotes, and make sure that the correct number is added to or subtracted from the spot bid or ask rate.

**Example 5.1.** Most papers nowadays show outright rates, but Antwerp's *De Tijd* used to publish swap rates until late 2005. Table 5.1 shows an example, to which I have added a column of midpoint swap rates and Libor 30-day interest rates (simple, p.a.). Swap rates are quoted in foreign currency since the quotes against the euro are conventionally in FC units; and they are in basis points, i.e., hundredths of cents.

To compute the outright forward rates from these quotes, one adds the first swap rate to the spot bid rate, and the second swap rate to the spot ask rate. The excerpt shows the midpoint spot rate rather than the bid–ask quotes. Suppose, however, that the bid and ask spot rates are (1.17)74–78 for the USD. Then the

| Termijnkoersen | | | | | | | | | | Bron: Dexia | | LIBOR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 maand | | 2 maand | | 3 maaand | | 6 maand | | 12 maand | | Spot rate | 30d |
| Amerikaanse dollar | 19.20 | 19.28 | 37.30 | 37.50 | 58.82 | 59.07 | 115.00 | 115.60 | 229.60 | 231.00 | 1.1776 | 4.20 |
| Australische dollar | 46.00 | 46.60 | 84.20 | 85.10 | 128.00 | 130.00 | 239.00 | 242.00 | 464.00 | 468.00 | 1.5988 | 5.55 |
| Brits pond | 13.40 | 13.60 | 24.20 | 24.50 | 36.50 | 36.80 | 65.70 | 66.40 | 121.00 | 123.00 | 0.6846 | 4.81 |
| . . . | | | | | | | | | | | | |
| Japanse Yen | -29.10 | -28.80 | -57.20 | -56.80 | -89.10 | -88.60 | -177.00 | -176.00 | -370.00 | -366.00 | 139.7800 | 0.03 |
| Nieuw-Zeelandse dollar | 80.10 | 81.10 | 148.00 | 149.00 | 226.00 | 228.00 | 425.00 | 429.00 | 818.00 | 829.00 | 1.7035 | 7.48 |
| . . . | | | | | | | | | | | | |
| Zweedse Kroon | -52.10 | -47.80 | -132.00 | -126.00 | -189.00 | -181.00 | -372.00 | -356.00 | -655.00 | -607.00 | 9.5162 | 1.60 |
| Zwitserse frank | -21.40 | -21.10 | -39.70 | -38.90 | -60.00 | -59.70 | -114.00 | -111.00 | -211.00 | -205.00 | 1.5491 | 0.80 |
| *eur* | | | | | | | | | | | | 2.335 |

**Figure 5.1.** Swap quotes, bid and ask, from *De Tijd*.

outright forward rates, one month, are computed as follows:

$$\text{Bid:}\quad 1.1774 + 0.000\,192\,0 = \text{USD/EUR } 1.177\,592\,0,$$
$$\text{Ask:}\quad 1.1778 + 0.000\,192\,8 = \text{USD/EUR } 1.177\,992\,8.$$

**DIY Problem 5.1.** Check the interest rates, and note which ones are higher than the EUR one. Figure out which forward rates should be above par and which below. Verify that the signs of the swap rates are correct, especially once you remember that the EUR is the FC (also for the GBP quote).

Note from the example that whenever we observe a premium we always add the smaller of the two swap rates to the spot bid rate, and the larger swap rate to the spot ask rate. As a result, the forward spread is wider than the spot spread (figure 5.2). Likewise, in case of a discount, the number we subtract from the spot bid rate is larger, in absolute value, than the number we subtract from the spot ask rate; and this again produces a wider spread in the forward market than in the spot market (figure 5.2). Finally, note that the difference between the swap rates becomes larger the longer the contract's time to maturity. This illustrates the *second law of imperfect exchange markets*: the forward spread is always larger than the spot spread, and increases with the time to maturity.

One explanation of this empirical regularity is that the longer the maturity, the lower the transaction volume; and in thin markets, spreads tend to be high. A second reason is that, over short periods, things generally do not change much, but a lot can happen over long periods. Thus, a bank may be confident that the customer will still be sound in 30 days, but feel far less certain about the customer's creditworthiness in five years. In addition, the exchange rate can change far more over five years than over 30 days; so the further off the maturity date, the larger the potential loss if and when default happens and the bank is forced to close out, i.e., reverse, the forward contract it had signed with the customer at $t_0$.[1] Thus, banks build a default-risk premium into their

[1] Note that the exchange risk is only relevant if and when the customer defaults. Normally, a bank closes its position soon after the initial deal is signed, but this close-out position unexpectedly turns out to be an open one if and when the customer's promised deal evaporates. In short, exchange risk only arises as an interaction with default risk.

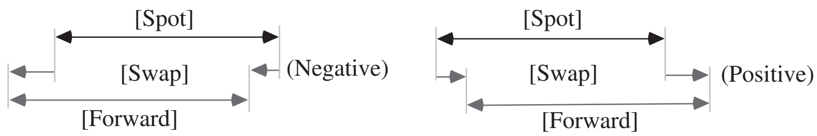



**Figure 5.2.** The bid–ask spread in a forward is wider than in a spot. For negative swap rates the bid is the bigger one, in absolute terms, while for positive swap rates the ask is the bigger one. This is equivalent to observing a larger total bid–ask spread in the forward market.

spreads, which, therefore, goes up with time to maturity. Later on we will see by how much the spreads can go up maximally with time to maturity.

The second law keeps you from getting irretrievably lost when confronted with bid–ask swap quotes, because the convention of quoting is by no means uniform internationally. Sometimes the sign of the swap rate (+ versus −; or p versus d) is entirely omitted, because the pros all know the sign already. Or sometimes the swap rates are quoted, regardless of sign, as "small number–big number," followed by p (for premium) or d (for discount). When in doubt, just test which combination generates the bigger spread.

Let us now address weightier matters: how is credit risk handled?

### 5.1.2 Provisions for Default

Forward dealers happily quote forward rates based on interbank interest rates, even if their counterpart is much more risky than a bank. Shouldn't they build risk spreads into the interest rates, as they do when they lend money? The answer is no (or, at most, not much): while the bank's risk under a forward contract is not entirely absent, it is still far lower than under a loan contract. Banks have, in effect, come up with various solutions that partially solve the problem of default risk.

**The right of offset.** First and foremost, a forward contract has an unwritten but time-hallowed clause saying that if one party defaults, then the other party cannot be forced to complete its own part of the deal; moreover, if that other party still sustains losses, the defaulting party remains liable for these losses. Thus, if the customer defaults, the bank that sold FC forward can now dispose of this amount in the spot market (rather than delivering it to the defaulting customer) and keep the revenue. There is still a potential loss if and to the extent that this revenue ($S_T$) is below the amount promised ($F_{t_0,T}$), but even if nothing of this can be recouped in the bankruptcy court the maximum loss is $(F_{t_0,T} - S_T)$, not $F_{t_0,T}$.[2]

[2] To obtain a security with the same credit risk for a synthetic forward contract, the bank would have to insist that the customer hold the deposit part of its synthetic contract in an escrow account, to be released only after the customer's loan is paid back. The forward contract is definitely the simpler way to achieve this security, which is one reason why an outright contract is more attractive than its synthetic version.

**Example 5.2.** Citibank has sold forward JPY 100m at USD/JPY 0.0115 to Fab4 Inc., a rock band, to cover the expenses of their upcoming tour; but on the due date Citi discovers they have declared bankruptcy. Since bankers are traditionally careful (really), Citi had bought forward the yen it owed Fab4. Given the bankruptcy, Citi has no choice but to sell these JPY 100m spot at, say, $S_T = 0.0109$. The default has cost Citi $100\text{m} \times (0.0115 - 0.0109) =$ USD 60,000. In contrast, if Fab4 had promised JPY 100m in repayment of a loan, Citi might have lost the full $100\text{m} \times 0.0115 =$ USD 1.15m. Since, under the forward contract, Citi can revoke its own obligation the net loss is always smaller, and could even turn into a gain.

**Interbank: credit agreements.** In the interbank market, the players deal only with banks and corporations that are well-known to one another and have signed credit agreements for (spot and) forward trading, that is, agreements that they will freely buy and sell to each other. Even there, credit limits are set per bank to limit default risk.

**Firms: credit agreements or security.** Likewise, corporations can buy or sell forward if they are well-known customers with a credit agreement providing—within limits—for spot and forward trades, probably alongside other things like overdraft facilities and envelopes for discounting of bills or for letters of credit. The alternative is to ask for margin. For unknown or risky customers, the margin may be as high as 100%.

**Example 5.3.** Expecting a depreciation of the pound sterling, Burton Freedman wants to sell forward GBP 1m for six months. The 180-day forward rate is USD/GBP 1.5. The bank, worried about the contingency that the pound may actually go up, asks for 25% margin. This means that Mr. Freedman has to deposit $1\text{m} \times$ USD/GBP $1.5 \times 0.25 =$ USD 375,000 with the bank, which remains with the bank until he has paid for the GBP. The interest earned on the deposit is Mr. Freedman's. This way, the bank is covered against the combined contingency of the GBP rising by up to 25% *and* Mr. Freedman defaulting on the contract.

**Restricted use.** Even within an agreed credit line, "speculative" forward positions are frowned upon, unless a lot of margin is posted. Banks see forwards as hedging devices for their customers, not as speculative instruments.

**Short lives.** Maturities go up to 10 years, but in actual fact the life of most forward contracts is short: most contracts have maturities of less than one year, and longer-term contracts are entered into only with customers that have excellent credit ratings. To hedge long-term exposures one then needs to roll over short-term forward contracts. For example, the corporation can engage in three consecutive one-year contracts if a single three-year contract is not available.

**Example 5.4.** At time 0, an Indian company wants to buy forward USD 1m for three years. Suppose that the bank gives it a three-year forward contract at $F_{0,3} =$ INR/USD 40. Suppose the bank's worst nightmares come true: the spot rate goes down all the time, say, to 38, 36, and 34 at times 1, 2, and 3, respectively. If, at time 3, the company defaults, the bank is stuck with USD 1m worth INR 34m rather than the contracted value, 40m. Thus, the bank has a loss of $(F_{0,3} - S_3)$ = INR 6m.

Suppose instead that, at $t = 0$, the bank gave a one-year contract at the rate $F_{0,1} = 40.3$. After one year, the customer pays INR 40.3m for the currency, takes delivery of the USD 1m, and sells these (spot) at $S_1 = 38$. After verification of the company's current creditworthiness, the bank now gives it a new one-year contract at, say, $F_{1,2} = 37.2$. At time $t = 2$, the customer takes the second loss. If it is still creditworthy, the customer will get a third one-year forward contract at, say, $F_{2,3} = 35.9$. If there is default at time 3, the bank's loss on the third contract is just 1.9m rather than the 6m it would have lost with the three-year contract.

From the bank's point of view, the main advantage of the alternative of rolling over short-term contracts is that losses do not accumulate. The uncertainty, at time 0, about the spot rate one year out is far smaller than the uncertainty about the rate three years out. Thus, *ex ante* the worst possible loss on a three-year contract exceeds the worst possible loss on a one-year contract. In addition, the probability of default increases with the time horizon—in the course of three years, a lot more bad things can happen to a firm than in one year, *ex ante*—and also with the size of the loss. For these three reasons, the bank's expected losses from default are larger the longer the maturity of the forward contract.

The example also demonstrates that rolling over is an imperfect substitute to a single three-year forward contract. First, there are interim losses or gains, creating a time-value risk. For instance, the hedger does not know at what interest rates he or she will be able to finance the interim losses or invest the interim gains. Second, the hedger does not know to what extent the forward rates will deviate from the spot rates at the rollover dates: these future forward premia depend on the (unknown) future interest rates in both currencies. Third, the total cumulative cash flow, realized by the hedger over the three consecutive contracts, depends on the time path of the spot rates between time 1 and time 3.

* * *

All this has given you enough background for a discussion of how and when forward contracts are used in practice. Among the many uses to which forward contracts may be put, the first we bring up is arbitrage, or at least the potential of arbitrage: this keeps spot, forward, and interest rates in line.

## 5.2 Using Forward Contracts (1): Arbitrage

One question to be answered is to what extent interest rate parity still holds in the presence of spreads. A useful first step in this analysis is to determine the synthetic forward rates.

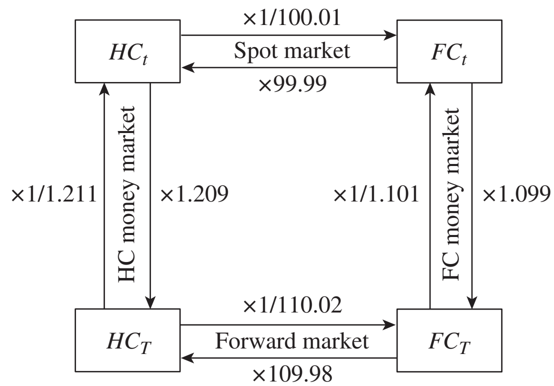



**Figure 5.3.** Spot/forward/money market diagram with bid–ask spreads.

### 5.2.1 Synthetic Forward Rates

It should not come as a surprise to you that, in the presence of spreads, the synthetic forward rates are the worst possible combinations of the basic perfect-markets formula. We can immediately see this when we do the two trips on the diagram in figure 5.3. These figures are familiar from the last chapter, but now we use bid rates that are slightly below the formerly unique exchange or interest rates, and ask rates slightly above these old values. What are the synthetic rates?

**Synthetic bid.** The synthetic-sale trip is $FC_T \to FC_t \to HC_t \to HC_T$, and it yields

$$HC_T = FC_T \times \frac{1}{1.101} \times 99.99 \times 1.209, \tag{5.1}$$

$$\Longrightarrow \quad \text{synthetic } F_{t,T}^{\text{bid}} = \frac{HC_T}{FC_T} = 99.99\,\frac{1.209}{1.101} = 109.798. \tag{5.2}$$

**Synthetic ask.** The synthetic-purchase trip is $HC_T \to HC_t \to FC_t \to FC_T$, and it yields

$$FC_T = HC_T \times \frac{1}{1.211} \times \frac{1}{100.01} \times 1.099, \tag{5.3}$$

$$\Longrightarrow \quad \text{synthetic } F_{t,T}^{\text{ask}} = \frac{HC_T}{FC_T} = 100.01\,\frac{1.211}{1.099} = 110.202. \tag{5.4}$$

We see that, in computing the synthetic bid rate, we retain the basic CIP formula but add the *bid* or *ask* qualifiers that generate the lowest possible combination: *bid* × *bid / ask*. Likewise, in computing the synthetic ask rate we pick the highest possible combination: *ask* × *ask / bid*. In short,

$$\text{synthetic } [F_{t,T}^{\text{bid}}, F_{t,T}^{\text{ask}}] = \left[S_t^{\text{bid}}\frac{1+r_{t,T}^{\text{bid}}}{1+r_{t,T}^{*\text{ask}}}, S_t^{\text{ask}}\frac{1+r_{t,T}^{\text{ask}}}{1+r_{t,T}^{*\text{bid}}}\right]. \tag{5.5}$$

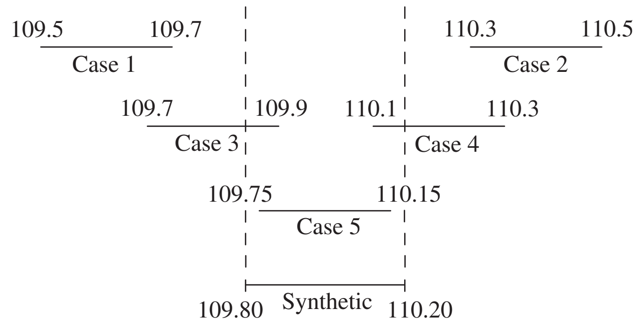



**Figure 5.4.** Synthetic and actual forward rates: some conceivable combinations.

### 5.2.2 Implications of Arbitrage and Shopping Around

In figure 5.4, we illustrate the by-now familiar implications of the arbitrage and shopping-around mechanisms.

1. Arbitrage ensures that the synthetic and actual quotes can never be so far apart that there is empty space between them. Thus, given the synthetic quotes 109.8–110.2, we can rule out case 1: we would have been able to buy directly at 109.7 and sell synthetically at 109.8. Likewise, situations like case 2 should vanish immediately (if they occur at all): we would have been able to buy synthetically at 110.2 and sell at 110.3 in the direct market.
2. The usual shopping-around logic means that, in situations like case 3 and case 4, there would be no customers in the direct market on one side.
   - If there were only one market maker, competing against the synthetic market, case 3 or case 4 could occur if—and as long as—that market maker has excess inventory (case 3) or a shortage (case 4). These situations should alternate with case 5.
   - But the more market makers there are, the less likely it is that not a *single* one of them would be interested in buying.[3] Likewise, with many market makers, situations where none of them wants to sell become very improbable. Thus, cases 3 and 4 should be rare and short-lived, unless there are very few market makers.
3. With many market makers, then, case 5 should be the typical situation: the direct market dominates the synthetic one at both sides.

### 5.2.3 Back to the Second Law

How wide is the zone of admissible prices? The example has a spread of 0.4% between the two worst combinations, but that cannot be realistic at all possible

[3] In case 3, for instance, 109.7 is by definition the best bid; all other market makers must have been quoting even lower if 109.7 is the best bid.

maturities $T - t$. Let us first trace the ingredients behind the computations of the synthetic rates in (5.2) and (5.4). The spot bid–ask spread is, in the example, 0.02 pesos wide, which is about 0.02%. In the $(1 + r)^*$ part of the formula, multiplying by 1.211 instead of 1.209 makes a difference of +0.17% $(1.211/1.209 = 1.0017)$, and the choice of $(1 + r^*)$ has an impact of +0.18%. Add all this up (the effect of compounding these percentages is tiny) and we get the 0.40% spread in the earlier calculations.

In the example, about 0.35 of this 0.40% comes from interest spreads. Bid–ask spreads in money markets fluctuate over time and vary across currencies, but they rise fast with time to maturity. For example, the *Wall Street Journal Europe*, January 25, 2005, mentions a eurodollar spread of just 0.01% p.a. for 30 days and 0.04% p.a. for 180 days, implying effective spreads of less than one-tenth of a basis point for 30 days and 2 basis points for 180 days. So at the one-month end, interest spreads for both currencies add little to the spread between the worst combinations, but at 180 days most of that spread already comes from money markets. For currencies with smaller markets, spot spreads are higher but so are money-market spreads, so it is hard to come up with a general statement. Still, synthetic spreads do rise fast with time to maturity.

The widening of the spread between the worst combinations does give banks room to also widen the bid–ask spread on their actual quotes. As we already argued, there are good economic reasons why equilibrium spreads would go up with the horizon: markets are thinning, and the compound risk of default and exchange losses increases.[4] All this, then, explains the second law: banks have not only the room to widen the spreads with time to maturity but also an economic reason to do so.

This finishes our discussion of arbitrage and the law of one price. The second usage to which forward contracts are put is hedging, as discussed in the next section.

## 5.3 Using Forward Contracts (2): Hedging Contractual Exposure

The issue in this section is how to measure and hedge contractual exposure from a particular transaction. There is said to be contractual exposure when the firm has signed contracts that ensure a known inflow or outflow of FC on a well-defined date. There are other exposures too, as discussed in chapter 13; but contractual exposure is the most obvious type, and the most easily hedged.

We describe how to measure the exposure from a single transaction, how to add up the contractual exposures from different contracts if these contracts mature on the same date and are denominated in the same currency, and how

[4] Note that the risk is compound: a risk on a risk. The simple exchange risk under normal circumstances (i.e., assuming no failure) is hedged by closing out in the forward or, if necessary, synthetically. Exchange risk pops back up only if there is default and the bank unexpectedly needs to reverse its earlier hedge.

the resulting net transaction can be hedged. Of course, a firm typically has many contracts denominated in a given foreign currency and these contracts may have different maturity dates. In such a case, it is sometimes inefficient to hedge individually the transactions for each particular date. In section 17.3, we show how one can define an aggregate measure of the firm's exposure to foreign-currency-denominated contracts that have different maturity dates, and how one can hedge this exposure with a single transaction.

### 5.3.1 Measuring Exposure from Transactions on a Particular Date

By exposure we usually mean a number that tells us by what multiple the HC value of an asset or cash flow changes when the exchange rate moves by $\Delta S$, everything else being equal. We denote this multiple by $B^*_{t,T}$:

$$B^*_{t,T} = \frac{\Delta \tilde{V}_T}{\Delta \tilde{S}_T}. \tag{5.6}$$

Note that the deltas are for constant $T$, and remember that $T$ is a known future date. That is, we are not relating a change in $S$ over time to a change in $V$ over time; rather, we compare two possible situations or scenarios for a future time $T$ that differ as far as $S$ is concerned. In continuous-math terms, we might have in mind a partial derivative. In sci-fi terms, we are comparing two closely related parallel universes, each having its own $S_T$. Economists, more grandly, talk about comparative statics.

This is the general definition, and it may look rather otherworldly. To reassure you, in the case of contractual exposure $B^*_{t,T}$ is simply the FC value of the contract at maturity.

**Example 5.5.** Assume that your firm (located in the United States) has an A/R next month of JPY 1m. Then, for a given change in the USD/JPY exchange rate, the impact on the USD value of the cash flows from this A/R is 1m times larger. For example, if the future exchange rate turns out to be USD/JPY 0.0103 instead of the expected 0.0100, then the USD value of the A/R changes from USD 10,000 to 10,300. Thus, the exposure of the firm is

$$B^*_{t,T} = \frac{10{,}300 - 10{,}000}{0.0103 - 0.0100} = 1{,}000{,}000. \tag{5.7}$$

To the mathematically gifted, this must have been obvious all along: if the cash flow amounts to a known number of FC units $C^*$, then its HC value equals $V_T = C^* \times S_T$, implying that the derivative $\partial V_T / \partial S_T$ or the relative difference $\Delta V_T / \Delta S_T$ both equal $C^*$, the FC cash flow. A point to remember, though, is that while exposure *might* be a number described in a contract or found in an accounting system, it generally is not. We will get back to this when we talk about option pricing and hedging, or operations exposure, or hedging with futures.

An ongoing firm is likely to have many contracts outstanding, with varying maturity dates and denominated in different foreign currencies. One can measure the exposure for each given future day by summing the outstanding contractual foreign-currency cash flows for a particular currency and date as illustrated in example 5.6. Most items on the list are obvious except, perhaps, the long-term purchase and sales agreements for goods and services, with FC-denominated prices for the items bought or sold. By these we mean the contracts for goods or services that have not yet given rise to delivery and invoicing of goods and, therefore, are not yet in the accounting system. Don't forget these! More generally, contracts do not necessarily show up in the accounting system, notably when no goods have been delivered yet or no money-market transaction has yet been made.

The net sum of all of the contractual inflows and outflows then gives us the firm's net exposure—an amount of net foreign currency inflows or outflows for a particular date and currency, arising from contracts outstanding today.

**Example 5.6.** Suppose that a U.S. firm, Whyran Cabels, Inc., has the following AUD commitments (where AUD is the foreign currency):

1. A/R: AUD 100,000 next month and AUD 2,200,000 two months from now.
2. Expiring deposits: AUD 3,000,000 next month.
3. A/P: AUD 2,300,000 next month and AUD 1,000,000 two months from now.
4. Loan due: AUD 2,300,000 two months from now.

We can measure the exposure to the AUD at the one- and two-month maturities as shown below (commercial contracts are in roman, financial in italic):

| | | 30 days | | 60 days | |
|---|---|---|---|---|---|
| | Item | In | Out | In | Out |
| (a) | A/R | 100,000 | — | 2,200,000 | — |
| (b) | Commodity sales contracts | 0 | — | 0 | — |
| (c) | *Expiring deposits* | 3,000,000 | — | 0 | — |
| (d) | *Forward purchases* | 0 | — | 0 | — |
| (e) | *Inflows from forward loans in FC* | 0 | — | 0 | — |
| (f) | A/P | — | 2,300,000 | — | 1,000,000 |
| (g) | Commodity purchase contracts: | — | 0 | — | 0 |
| (h) | *Loan due* | — | 0 | — | 2,300,000 |
| (i) | *Forward sales* | — | 0 | — | 0 |
| (j) | *Outflows for forward deposits in FC* | — | 0 | — | 0 |
| | Net flow | +800,000 | | −1,100,000 | |

Thus, the net exposure to the AUD one month from now is AUD 800,000 and two months from now is AUD −1,100,000.

Note that from a contractual-exposure point of view, the future exchange rate would not matter if the net future cash flows were zero, that is, if future FC-denominated inflows and outflows exactly canceled each other out. This, of course, is what traditional hedging is about, where one designs a hedge whose cash flows exactly offset those from the contract being hedged. Thus, if one could match every contractual foreign currency inflow with a corresponding outflow of the same maturity and amount, then the net contractual exposure would be zero. However, perfect matching of commercial contracts (sales and purchases, as reflected in A/R and A/P and the long-term contracts) is difficult. For example, exporters often have foreign sales that vastly exceed their imports. An alternative method for avoiding contractual exposure would be to denominate all contracts in one's domestic currency. However, factors such as the counterparty's preferences, their market power, and their company policy may limit a firm's ability to denominate foreign sales and purchases in its own home currency or in a desirable third currency. Given that a firm faces contractual exposure, one needs to find out how this exposure can be hedged. Fortunately, one can use financial contracts to hedge the net contractual exposure. This is the topic of the next section.

### 5.3.2 Hedging Contractual Exposure from Transactions on a Particular Date

#### *5.3.2.1 One-to-One Perfect Hedging*

A company may very well dislike being exposed to exchange risk arising from contractual exposure. (Sound economic reasons for this are discussed in chapter 12.) If so, the firm could easily eliminate this exposure using the financial instruments analyzed thus far: forward contracts, loans and deposits, and spot deals. Perfect hedging means that one takes on a position that exactly offsets the existing exposure, and with contractual exposure this is easily done.

**Example 5.7.** We have seen, in example 5.5, that holding a JPY T-bill with a time $T$ face value of JPY 1,000,000 creates an exposure of JPY +1,000,000. Thus, to hedge this exposure, one can sell forward the amount JPY 1,000,000 for maturity $T$.

In the above, the purpose is just to hedge. If the firm also needs cash (in HC), it could then borrow against the future HC income from the hedge. Alternatively, the familiar spot-forward diagram tells us, one could short spot foreign exchange, that is, borrow the present value of JPY 1,000,000, and convert the proceeds into USD, the home currency. At maturity, one would then use the cash flows from the JPY T-bill to service the loan; as a result, there is no more uncommitted JPY cash left, so that no spot sale will be needed anymore, meaning that exposure is now zero.

**Example 5.8.** To hedge its net exposure as computed in example 5.6, Whyran Cabels could hedge the one-month exposure with a 30-day forward sale of AUD 800,000, and the two-month exposure by a 60-day forward purchase of AUD 1,100,000.

#### *5.3.2.2 Issue #1: Are Imperfect Hedges Worse?*

Forward contracts, or FC loans and deposits, allow you to hedge the exposure to exchange rates perfectly. There are alternatives. Futures may be cheaper, but are less flexible as far as amount and expiry date are concerned, thus introducing noise into the hedge; also, futures exist for heavily traded exchange rates only. Options are "imperfect" hedges in the sense that they do not entirely eliminate uncertainty about future cash flows; rather, as explained in chapter 8, options remove the downside risk of an unfavorable change in the exchange rate, while leaving open the possibility of gains from a favorable move in the exchange rates. This may sound fabulous, until one remembers there will be a price to be paid, too, for that advantage.

**Example 5.9.** Whyran Cabels could buy a 30-day put option (an option to *sell* AUD 800,000 at a stated price) and a 60-day call option (an option to *buy* AUD 1,100,000 at a stated price). Buying these options provides a lower bound or floor on the firm's inflows from the AUD 800,000 asset, and an upper bound or cap on its outflows from the AUD 1,100,000 liability.

If one is willing to accept imperfect hedging with downside risk, then one could also cross-hedge contractual exposure by offsetting a position in one currency with a position (in the opposite direction) in another currency that is highly correlated with the first. For example, a British firm that has an A/R of CAD 120,000 and an A/P of USD 100,000 may consider itself more or less hedged against contractual exposure given that, from a GBP perspective, movements in the USD and the CAD are highly correlated and the long positions roughly balance the short ones. Similarly, if an Indian firm exports goods to Euroland countries, and imports machinery from Switzerland and Sweden, there is substantial neutralization across these currencies given that the movements in these currencies are highly correlated and the firm's positions have opposite signs.

#### *5.3.2.3 Issue #2: Credit Risk*

So far, we have limited our discussion to contractual exposure, and ignored credit risk. The risk of default, if nontrivial, creates the following dilemma:

- If you leave the foreign currency A/R unhedged (open) and the debtor does pay, you will be worse off if the exchange rate turns out to be unexpectedly low. This is just the familiar exchange risk.
- On the other hand, if you do hedge but the debtor defaults, you are still obliged to deliver foreign exchange to settle the forward contract. As soon as you hear about the default, you know that this forward contract, originally meant to be a hedge, has become an open (quasi-speculative) position. So you probably want to *reverse* the hedge, that is, close out by adding a reverse forward.[5] But by that time the erstwhile hedge contract may have a negative value, in which case reversing the deal leads to a loss.

[5] You could also close out with a combination of money- and spot-market deals, or negotiate an early settlement with your banker, but this necessarily produces essentially the same cash flows as those from closing out forward. Lastly, you could leave the position open until the end,

When there is default on the hedged FC, the lowest-risk option is indeed to *reverse* the original hedge position. For instance, if an A/R was hedged by a forward sale and if the exposure suddenly evaporates, you immediately buy the same amount for the same date. But there is about a 50% chance that this would be at a loss, the new forward rate being above the old one. This risk, arising when a hedged exposure disappears, is called *reverse risk*.

**Example 5.10.** Suppose you had hedged a promised RUR 10m inflow at a forward rate of 0.033 EUR/RUR. Now you hear the customer is defaulting. So now you want to buy forward RUR 10m to neutralize the initial sale, but you soon discover that, by now, the forward rate for the same date has risen to 0.038. So if you reverse the position under these conditions, you are stuck with a loss of $10\text{m} \times (0.038 - 0.033) =$ EUR 50,000.

If the default risk is substantial, one can eliminate it, at a cost,[6] by obtaining bank guarantees or by buying insurance from private or government credit-insurance companies. Foreign trade credit insurance instruments that allow one to hedge against credit risk are discussed in chapter 15.

Credit risk means that contractual forex flows are not necessarily risk free. But this is just the tip of the iceberg: in reality, the dividing line between contractual (or, rather, known) and risky is fuzzy and gradual in many other ways. We return to this when we discuss operations exposure in chapter 13.

#### *5.3.2.4 Issue #3: Hedging of Pooled Cash Flows—Interest Risk*

We have already seen how one should aggregate the exposure from transactions that have the same maturity date and that are denominated in the same currency. Typically, however, a firm will have exposures with a great many different maturities. Computing and hedging the contractual exposure for each day separately is rather inefficient; rather, the treasurer would probably prefer to group the FC amounts into time buckets, say, months for horizons up to two years, quarters for horizons between two and five years, and years thereafter. Then only one contract would be used to hedge the entire bucket.

**Example 5.11.** There are two obvious potential savings from grouping various exposures over time:

- If there are changes in sign of the flows in the bucket, *netting over time* saves money. Suppose that on day 135 you have an inflow of SEK 1.8m and on the next day an outflow of SEK 1.0m. Rather than taking out two forward hedges for a total gross face value of SEK 2.8m, it would be more sensible to sell

---

and then buy spot currency to deliver as promised under the forward contract. The problem with this avenue is that the worst possible losses become bigger; so early termination of some form is usually preferred.

[6] Accounting-wise this is a cost; but if the premium paid is worth the expected loss, the NPV of this deal would be low or zero.

forward just SEK 0.8m for day 135, and keep the remaining SEK 1m inflow to settle the debt the next day. You would save the extra half-spread on SEK 2m.

- *Scale economies in transaction costs.* Even if there are no changes in sign—for example, if the firm is a pure exporter—the total commission cost of doing one weekly deal of SEK 500,000 will be lower than the cost of doing five daily deals of about SEK 100,000.

One should be aware that if pooling over time is carried too far, a degree of interest-rate risk is introduced. Suppose, to keep things simple, that Whyran Cabels faces an inflow of SEK 100m at the beginning of year $t + 5$, and one of SEK 50m at the end of that year. They could hedge this by selling forward SEK 150 dated July 1. Interest risk creeps in here because the SEK 100m that arrives on January 2 will earn interest for six months, while Whyran will have to borrow about SEK 50m because they sold forward the SEK 50m for a day predating the actual inflow. If the horizon is substantial and the potential amount of interest at play becomes nontrivial, the company can hedge the interest-rate risk by forward deposits and loans. The example that follows assumes you know these instruments; if not, skip the example or return to appendix 4.7 first.

**Example 5.12.** Suppose the forward interest rates $5 \times 5.5$ years are 3.50–3.55% p.a., and the forward interest rates $5.5 \times 6$ years are 3.75–3.80% p.a.[7] Then Whyran Cabels can do the following:

1. Arrange a deposit of SEK 100m, 5 against 5.5 years, at the bid rate of 3.5% p.a., that is, 1.75% effective over six months. This will guarantee an SEK inflow of 101.75m on July 1.
2. Arrange a loan with final value SEK 50m, 5.5 against 6 years at the ask rate of 3.8% p.a., that is, 1.9% effective over six months. The proceeds of the loan, on July 1, will be 50m/1.019 = 49,067,713.44.
3. Sell forward the combined proceeds of the deposit (SEK 101.75m) and the loan (SEK 49.07m) for July 1.

#### 5.3.2.5 *Issue #4: Value Hedging versus Cash-Flow Hedging?*

An extreme form of grouping occurs if the company hedges all its exposures by one single position. One simple strategy would be the following:

- Compute the PV, in forex, of all FC contracts. Call this $PV_c^*$ ("c" for contract).
- Add an FC position in the bond or forward market with $PV_h^*$ ("h" for hedge).
- The naive full hedge solution would then be to set $PV_h^* = -PV_c^*$.

[7] See the appendix to chapter 4 on forward interest rates.

**Example 5.13.** Suppose the spot interest rates are 3.4% p.a. compound for five years and 3.45% p.a. compound for six years. Then, assuming these are the company's only FC positions, Whyran Cabels can hedge its five- and six-year SEK debts as follows:

1. Compute $PV_c^* = 100m/1.034^5 + 50m/1.0345^6 = 125.4m$ SEK.
2. Arrange a loan with the same PV. If the loan is for one year and the one-year interest rate is 3%, the face value is $125.4 \times 1.03 = 129.2m$.

The reasoning behind this hedging rule is that if the spot exchange rate moves, the effect on the PVs of the contractual position and the hedge position will balance out, thus leaving the firm's total PV unaffected. It is, however, important to realize that this argument assumes that the FC PVs of the hedge and contractual positions are not changing, or at least that any changes in these $PV^*$s are identical. However, foreign interest rates can change, and these shifts are likely to differ across the time-to-maturity spectrum. And even if the shifts were identical for all interest rates, the PV of the five- and six-year items would still change by far more than the one-year position. Thus, PV hedging may again induce a big interest-rate risk. This is why the full hedge with just PV-matching was called "naive," above.

This can be solved by throwing in an interest-risk management program. But maturity mismatches can also lead to severe liquidity problems if short-term losses are realized while the offsetting gains remain, for the time being, unrealized. A simpler solution would accordingly be to abandon the PV-hedging policy. If every single exposure is hedged by a hedge for the same date, then the impact of interest-rate changes is the same for $PV_h^*$ and $PV_c^*$. This would still be approximately true if exposures are grouped into buckets that are not too wide, and if the hedge has a similar time to maturity.[8] This is why, in example 5.12, we hedged the five- and six-year loan by a position at 5.5 years. In fact, since the five-year flow is much larger than the six-year flow (100m versus 50m), the hedge horizon should perhaps be closer to five years than to six. For example, one could go for a duration-matched hedge, the one that protects the company against small, parallel shifts in the term structure.[9]

**Example 5.14.** Assuming the same data, Whyran Cabels can do the following:

1. Compute
$$PV_c^* = \frac{100m}{1.034^5} + \frac{50m}{1.0345^6} = 125.4m \text{ SEK}.$$

[8] Also, group inflows and outflows into separate buckets before you compute durations. (Durations for portfolios with positive and negative positions with similar times to maturity can lead to absurdly large numbers, because of leverage.) Then add a hedge on the side with the smaller PV, in absolute size.

[9] If duration is not a familiar concept, close your eyes and think of England; then skip the example.

2. Compute the duration:

$$\frac{100\text{m}/1.034^5}{125.4\text{m}} \times \frac{5}{1.034} + \frac{50\text{m}/1.0345^6}{125.4\text{m}} \times \frac{6}{1.0345} = 5.15 \text{ years}$$

(5 years, 54 days).

3. Arrange a loan with the same PV and duration. If five- and six-year rates move by the same (smallish) amount, then the effect of a shift in the term structure will equally affect the hedge instrument and the hedged positions.

As a final note, we add that complete value hedging, where the company takes one single position per currency to cover all the risks related to that currency regardless of their time to maturity, is mostly a textbook concept, even in financial companies. What does happen is hedging of net exposures that expire at dates that are close to each other; few CFOs are venturing to go any further. The complexity of the interest hedge and the need to continuously update the interest and currency positions are obvious issues. Also, bear in mind that even if the PVs of the combined exposures and of the hedge could be kept in perfect agreement, there is still the problem that the expiry dates do not match. Cash losses may be matched by capital gains, but the latter are unrealized and unrealizable, implying that there could be serious liquidity problems. Another issue with company-value hedging is that even "contractual" exposures are never *quite* certain, as we have already noted; moreover, most cash flows foreseen for a few months out are not contractual anyway, and uncertainties about noncontractual foreseen flows are often deemed to be too high to make hedging safe or reliable to managers. We return to the issues associated with noncontractual cash flows in chapter 13. Value hedging, in short, mainly exists in academic papers, where the managers and bankers have already read the article and therefore are as well informed as the author of the article assumes them to be. In reality, value hedging is confined to a few, very simple, well-understood structures like risk-free forex positions or derivatives rather than being applied to the company as a whole.

This finishes our discussion of the second way companies and individuals use forward contracts, hedging. Later on in this book we will discuss other applications of hedging, including hedging of operating exposure (chapter 13) and hedging for the purpose of managing and pricing of derivatives (chapters 8, 9, and 14). The third possible application of forward contracts is speculation, as discussed in the next section.

## 5.4 Using Forward Contracts (3): Speculation

What is speculation? One possible definition is that a speculator takes a position in currencies (or commodities or whatever) for purely financial reasons, not because she needs the asset or wants to hedge another position. In that sense, speculators are the agents that pick up the positive or negative net position, long minus short, left by all hedgers taken together. The forward contracts must be priced such that total net demand by hedgers and speculators is zero.

On reflection, however, almost all investments are for purely financial reasons, so by that definition almost all investors are speculators. So while this is a perfectly valid definition, it does not necessarily match what the average person has in mind when hearing the word speculation. Many people would say that speculation involves risk-seeking, in contrast to hedging, where risk is reduced rather than sought. Again, we should refine this: even buying the market portfolio involves taking risk, so by that standard most investors are again speculators. Perhaps, then, the crucial element that distinguishes speculation from ordinary investment is the giving up of diversification, that is, taking positions that deviate substantially from weights chosen by the average investor in a comparable position.

If this is what we mean by speculation, the question arises whether such speculation can be rational for risk-averse investors. Shouldn't normal investors diversify rather than putting an unusual amount of money into a few assets? The answer is that speculation, or underdiversification, can be rational provided there is a sufficient expected return that justifies giving up diversification. Extra expected returns arise from buying underpriced assets or short selling overpriced assets. But the underdiversified speculator must realize that, by deeming some assets to be under- or overpriced, her or his opinion is necessarily in disagreement with the market's. Indeed, if the entire market had concurred that asset X is underpriced and asset Y overvalued, then you would not find any counterparts to trade at these rates, and prices would already be moving so as to eliminate the mispricing. In short, an underdiversified speculator thinks that (a) she or he spots mispricing which the market, foolishly, has not yet noticed, (b) the market will soon see the error of its ways and come around to the speculator's view, and (c) the gains from that hoped-for price adjustment justify the underdiversification resulting from big positions in the mispriced assets.

In this section we discuss speculation on the spot rate, the forward rate, and the swap rate. In the examples, we take speculation to mean intentional underdiversification.

### 5.4.1 Speculating on the Future Spot Rate

**Example 5.15.** Suppose Milton Freedman is more optimistic about the euro than the market (see figure 5.5(a)). As we know, the profit from buying forward will be $\tilde{S}_T - F_{t,T}$. Almost tautologically, the market thinks that the expected profit, after a bit of risk adjustment, is zero, otherwise the forward price would already have moved. But Milton thinks that, in reality, there is more of the probability mass to the right of $F_{t,T}$, and less to the left, than the market realizes. Since the potential for

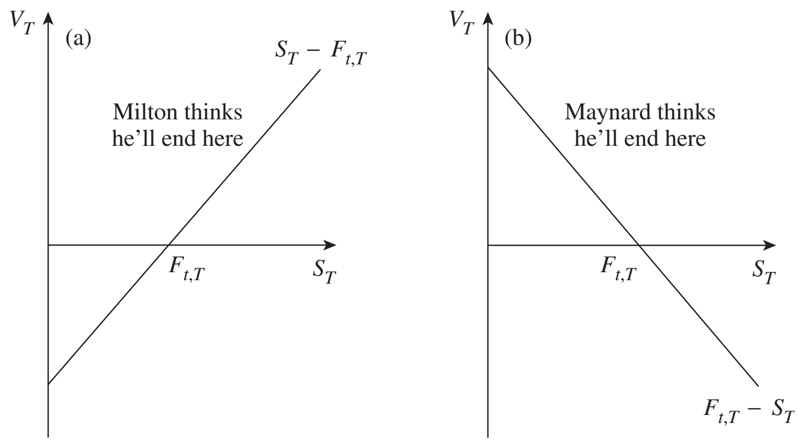



**Figure 5.5.** Speculating in the spot market: (a) buy forward; (b) sell forward.

profit is underestimated and the room for losses overrated, Milton thinks a forward purchase is a good deal, warranting a big position.

**Example 5.16.** Suppose Maynard Keenes is less optimistic than the market about the dollar (see figure 5.5(b)). The profit from selling forward will be $F_{t,T} - \tilde{S}_T$ with a risk-adjusted expectation of zero, according to the market. But Maynard knows more than the market (or at least he thinks he does): depreciations are more probable, and appreciations less likely, than the market perceives. Betting on depreciations, Maynard sells forward.

In both cases, the speculator thinks that the chances of ending in the red are overrated and the chances of making a profit underrated.[10] Note also that the forward position is closed out at the end by a spot transaction: at time $T$, Milton has to sell spot to realize the gain he hopefully made; and Maynard must buy spot at $T$ because under the initial forward contract he has promised to deliver. In hedge applications, in contrast, no spot deal is needed because there already is a commercial contract which generates an in- or outflow at $T$.

Of course, speculation can also be done in the spot market. Relative to buying spot, a forward purchase has the additional feature of automatic leverage: it is like buying an FC deposit already financed by an HC loan. Likewise, one alternative to selling forward is to borrow FC and sell the proceeds spot; but the extra feature in the forward sale is that the foreign currency is automatically borrowed. Here, the leverage is in FC. In either case, the leverage is good, at the private level, in the sense that positions can be bigger; but of course the risk increases correspondingly. The leverage also allows more people to speculate. This is, socially, a good thing if these extra players really do know more than the market does: then speculators are pushing prices in the right

[10]To the purists: yes, the argument is sloppy, I should talk about partial expectations, not chances of profits. But you all know what I mean.

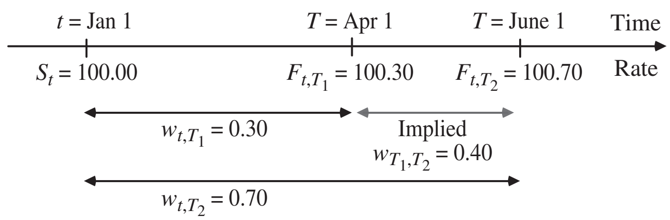



**Figure 5.6.** Speculating on a rise in the swap rate.

direction. And even if their opinions are, on average, no better than the other players, speculators would still help: the larger the number of people allowed to vote on a price, the smaller the average error.

### 5.4.2 Speculating on the Forward Rate or on the Swap Rate

Suppose that—at time $t$, as usual—you want to speculate not on a future spot rate $\tilde{S}_T$ but on a future forward rate: you think that, by time $T_1$, the forward rate for delivery at $T_2$ will have gone up relative to the current level. So we speculate on $\tilde{F}_{T_1,T_2}$ instead of $\tilde{S}_{T_1}$. For example (see figure 5.6), current time may be January and the current rate for delivery on June 1 (= $T_2$) may be 100.7, but you feel pretty confident that, by April 1 (=$T_1$), the rate for delivery in early June will be higher than that. You would

- buy forward now (at $t$) for delivery on June 1, and
- early April, close out—that is, sell forward for June 1—at a rate that right now (in January) is still unknown.

This way, in April you will lock in a cash flow of $\tilde{F}_{T_1,T_2} - F_{t,T_2}$, which will then be realized at the end of June. For example, if in April the June rate turns out to be 101.6, up from 100.7, you make 101.6 − 100.7 = 0.9 per currency unit; or if, against your expectations, the rate falls to 100.1, you lose 0.6 per currency unit. The general net result, in short, will be $\tilde{F}_{T_1,T_2} - F_{t,T_2}$, locked in at $T_1$ and realized at $T_2$.

Of course, speculating on a drop in the forward rather than a rise works in reverse: you would sell forward now (at $t$) for delivery in June, and in April you would then close out and lock in the time-1 gain (or loss), $F_{t,T_2} - \tilde{F}_{T_1,T_2}$ to be realized at $T_2$.

Note that this boils down to speculation on the sum of the spot rate and the swap rate. Most of the uncertainty originates from the spot rate, however. So what would you do if you wanted to speculate on just the swap rate, not obscured by the spot exchange rate? And what exactly is the underlying bet?

The nature of the bet would be different. If you simply speculate on a rise in the spot rate, you bet on a difference between the current (risk-adjusted) expectation and the subsequent realization. If you speculate on the future swap rate, in contrast, you are placing a bet on future revisions of the expectation. Consider the example in figure 5.6. On January 1, the swap rate for delivery on April 1 is 0.30, implying that the risk-adjusted expected rise is 0.30 over that horizon. On the same date, the six-month swap rate is 0.70, implying a risk-adjusted expected rise by 0.70 over six months. Implicit in these numbers is a risk-adjusted expected rise of 0.70 − 0.30 = 0.40 between April 1 and June 30. Suppose that you feel pretty certain that, by April 1, the market will revise its expected three-month rise upward. Your bet is that, on April 1, the three-month swap rate will exceed 0.40.

How would you do it? The answer, as we verify in the next example, is as follows:

- you speculate on a rise of the entire forward rate (spot plus swap), as before;
- but you immediately also hedge away the spot-rate risk component by a forward sale for delivery in April, leaving you with exposure to just the swap rate;
- you gain if and to the extent that the future swap rate exceeds the difference between the current swap rates (June–April).

To explain this via an example, let us again consider a bet that the swap rate will rise.

**Example 5.17.** Current data:

| Spot | Date $T_i$ | Forward | Swap rate |
|---|---|---|---|
| 100 | April 1 | 100.3 | 0.3 |
| id | June 30 | 100.7 | 0.7 |
| Spread June–April | | 0.4 | 0.4 |

The table below lists the two ingredients in the combined strategy (the speculative bet on a fire in the forward rate, and the spot hedge) and, for each of these, the actions undertaken now and in April, plus the payoffs. The payoff of the first component is the difference between the April forward (for delivery in June) and the initial one, 100.07; the April rate is immediately written as $\tilde{S}_{\text{Apr}} + \tilde{w}_{\text{Apr–Jun}}$, where $\tilde{w}$ is the swap rate:

| Ingredient | Action at $t$ | Action at $T_1$ (Apr) | Payoff at expiry |
|---|---|---|---|
| Bet on $F_{\text{Apr}} \uparrow$ | Buy forward Jun | Sell forward Jun | $[\tilde{S}_{\text{Apr}} + \tilde{w}_{\text{Apr–Jun}}] - 100.7$ |
| Hedge $S_{\text{Apr}}$ | Sell forward Apr | Buy spot | $100.3 - \tilde{S}_{\text{Apr}}$ |
| Combined: | Forward-forward swap "out" | Spot-forward swap "in" | $\tilde{w}_{\text{Apr–Jun}} - [100.7 - 100.3]$ $= \tilde{w}_{\text{Apr–Jun}} - [0.7 - 0.3]$ |

We see that the ultimate profit is the realized swap rate in excess of the difference of the original ones, 0.7 − 0.3 = 0.4.

An interesting reinterpretation is obtained if we look at the "actions" in the example's table not row by row as we have done so far, but column by column (that is, by date).

- Start with the future actions (those planned for April). Clearly, what we will do in April is a spot-forward swap: we will buy spot and simultaneously sell forward. (This is called a swap "*in*" because the transaction for the nearest date, the spot one, takes us into the FC.)
- What we do right now, at $t$, is not dissimilar: we sell forward for one date and simultaneously buy forward for another. This is called a *forward-forward swap*, and this particular one is called "*out*" because the transaction for the nearest date is a sale, which takes us out of the FC.

Thus, instead of saying that we bet on a rise in the April forward rate and hedge the April spot component, we could equally well say that we now do a forward-forward swap, April against June, and that on April 1 we reverse this with a spot-forward swap.

## 5.5 Using Forward Contracts (4): Minimizing the Impact of Market Imperfections

In the previous chapter we discovered that, in perfect markets, shopping around is pointless: the two ways to achieve a given trip produce exactly the same output. Among the imperfections we introduce in this section are (a) bid–ask spreads, (b) asymmetric taxes, (c) information asymmetries leading to inconsistent default-risk spreads, and (d) legal restrictions. Each of them makes the treasurer's life far more interesting than we might have surmised in the previous chapter.

### 5.5.1 Shopping Around to Minimize Transaction Costs

This type of problem is easily solved by using the spot/forward/money-markets diagram. A safe way to proceed is as follows.

1. Identify your current position; this is where your trip starts.
2. Identify your desired end position.
3. Calculate the outputs for each of the two routes that lead from your START to your END.
4. Choose by applying the "more is better" rule: more output for a given level of input is always desirable.

**Example 5.18.** Ms. Takeshita, treasurer of the Himeji Golf & Country Club (HG&CC), often faces problems like the following:

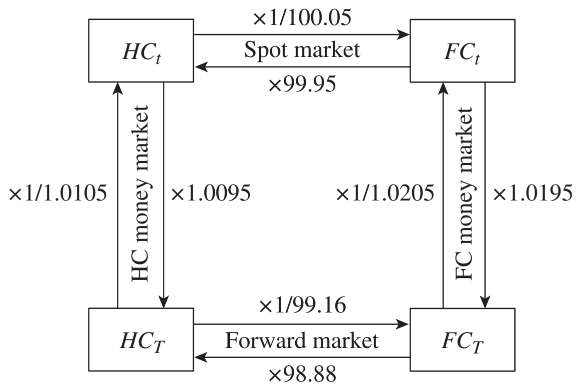



**Figure 5.7.** Spot/forward/money market diagram: Ms. Takeshita's data.

- A foreign customer has promised a large amount of USD (= FC), but today the club needs JPY cash to pay its workers and suppliers and does not like the exchange risk either. Should the club borrow dollars or yen?
- The next day there are excess JPY liquidities that should be parked, risk free. Should HG&CC go for a yen deposit or a swapped dollar one?
- Two days later the club wants to earmark part of its JPY cash to settle a USD liability expiring in six months. Should they keep yen and buy forward or move into dollars right away?
- One week later, HG&CC receives USD from a customer, and orders new irons payable in USD 180 days. Should the current USD be deposited and used later on to settle the invoice?

On her laptop she sees the following data:

| | | | |
|---|---|---|---|
| Spot | JPY/USD 99.95 – 100.05 (spread 0.10) | 180d | JPY/USD 98.88 – 99.16 (spread 0.18) |
| JPY, 180d | 1.90 – 2.10% p.a., simple (0.95 – 1.05% effective) | USD, 180d | 3.90 – 4.10% p.a., simple (1.95 – 2.05% effective) |

Having taken this course, Ms. Takeshita organizes the data into the familiar diagram (figure 5.7) and sets to work. Her calculations, which take her (or her computer) a mere 90 seconds, are neatly summarized in table 5.1.

Note how all computations start with one unit. The true amounts are all missing from the calculations and even from the data, thus forcing you to focus on the route. In practice, once you have found the best route, you can then rescale everything to the desired size. For instance, in application 1, if the future FC income is USD 1.235m, the output is proportionally higher too.

In this context, let me point out a mistake frequently made in solving problems like application 3. Assume the liability is USD 785,235. We have just found that the best way to move spot yen into future dollars is via the forward market, and the output per JPY input is 0.010 189 905. We can easily calculate the

**Table 5.1.** Ms. Takeshita's calculations.

| Problem; start, end | Alternatives and output |
|---|---|
| Finance FC-denominated A/R ($FC_T$ to $HC_t$) | * Via $FC_t$: $\frac{1}{1.0205} \times 99.95 = 97.942\,185$ ♥♥<br>* Via $HC_T$: $98.88 \times \frac{1}{1.0105} = 97.852\,548$ |
| HC deposit ($HC_t$ to $HC_T$) | * Direct: 1.009 500 ♥♥<br>* Synthetic: $\frac{1}{100.05} \times 1.0195 \times 98.88 = 1.007\,577\,8$ |
| Invest in FC ($HC_t$ to $FC_T$) | * Via $FC_t$: $\frac{1}{100.05} \times 1.0195 = 0.010\,189\,905$ ♥♥<br>* Via $HC_T$: $1.0095 \times \frac{1}{99.16} = 0.010\,180\,51$ |
| Park FC ($FC_t$ to $FC_T$) | * Direct: 1.0195 ♥♥<br>* Synthetic: $99.95 \times 1.0095 \times \frac{1}{99.16} = 1.017\,542\,60$ |

required investment by rescaling the whole operation, in rule-of-three style:

(1) time-$t$ input JPY

$$1 \quad \text{produces time-}T\text{ output of USD } 0.001\,018\,9905;$$

(2) time-$t$ input JPY

$$\frac{1}{0.001\,018\,9905} \quad \text{produces time-}T\text{ output of USD } 1;$$

(3) time-$t$ input JPY

$$\frac{785{,}235}{0.001\,018\,9905} \quad \text{produces time-}T\text{ output of USD } 785{,}235;$$

$$\Longrightarrow \quad \text{(short version)} \quad \text{JPY}_t = \frac{785{,}235}{0.010\,189\,905} = 77{,}060{,}090. \tag{5.8}$$

This seems easy enough. What can (and often does) go wrong is that you mix up computational inputs and outputs with financial inputs and outputs. In computations or math, the term input refers to the data and the term output to the result of the exercise. Financially, however, we have defined input as what you feed into the financial system and output as what you get out of it. Sometimes the mathematical and the financial definitions coincide, but not always. In application 3, we exchange spot yen for future dollars, so the financial input is $\text{JPY}_t$ and the output $\text{USD}_T$. But for the computations, the data is $\text{USD}_T = 785.235$ and the result is $\text{JPY}_t = 776{,}841.15$. If you are hasty, you risk thinking that the trip you need to make is from data (the mathematical input, future dollar) to result (the mathematical output, spot yen), while the actual money flow is in the other direction. Because of the mistake, you go through the graph the wrong way, using borrowing not lending rates of return and bid exchange rates instead of ask. In short, it is tempting to work back from the end point ($\text{USD}_T$) to the starting point: how much $HC_t$ is needed for this? If you are really good, you will remember that going from financial output to financial input means going "against" the arrows, and choosing on the basis of a "less is better" rule (less input for a given output is better). But if you are new to this, it may be safer to start by provisionally setting $HC_t = 1$, then identifying the route that delivers most output ($FC_T$), and finally rescaling the winning trip such that the end output reaches the desired level.

A second comment is that, in the second and fourth problems, the direct deposits yield more than the synthetic ones. This is what one would expect, at least if the rates are close to interbank rates. But if the problem is retail, a small FC deposit may earn substantially less than the wholesale rate (which starts at USD 1m or thereabouts), and under these circumstances the direct solution may be dominated by the indirect alternative.

**Example 5.19.** Suppose that the HG&CC holds a lot of JPY so that it gets interbank rates for these; but its USD deposits are small. If the rate she gets on USD were less than 3.58% p.a., Ms. Takeshita would be better off moving her USD into the JPY market for six months.

On the basis of the above, one would expect that, in the wholesale market, swapping of deposits or loans should be very rare: a three-transaction trip should not be cheaper than the direct solution. But this conjecture looks at bid–ask costs only. In practice, we see that swaps are often used, despite their relatively high transaction cost, if there is another advantage: fiscal, legal, or in terms of credit-risk spreads. We start with the tax issue.

### 5.5.2 Swapping for Tax Reasons

In the previous chapter we saw that swapped FC deposits and loans should yield substantially the same rate before tax, and therefore also after tax if the system is neutral. But in many countries, under personal taxation, capital gains are tax exempt and capital losses are not deductible while interest income is taxed. A swapped FC deposit in a strong currency then offers an extra tax advantage: part of the income is paid out as a capital gain and is, therefore, not taxed. In table 5.2, we go back to an example from the previous chapter and add the computations for the case where capital gains/losses are not part of taxable income. The swapped NOK deposit now offers a CLP 3.33 extra because of the tax saved on the CLP 10 capital gain.

If this is the tax rule, the implications for a deposit are as follows:

1. if the FC risk-free rate is above the domestic rate, the HC deposit does best;
2. when there are many candidate foreign currencies, the lower the FC interest rate, the higher the forward premium, so the bigger the capital gain and therefore the larger the tax advantage.

**DIY Problem 5.2.** What are the rules for a loan instead of a deposit?

**Table 5.2.** HC and swapped FC investments if only interest is taxed.

| | Invest CLP 100 | Invest NOK 1 and hedge |
|---|---|---|
| Initial investment | 100.00 | $1 \times 100 = 100.00$ |
| Final value | $100 \times 1.21 = 121.00$ | $[1 \times 1.10] \times 110 = 121.00$ |
| Income | 21.00 | 21.00 |
| Interest | 21.00 | $[1 \times 0.10] \times 110 = 11.00$ |
| Capgain | 0 | $110 - 100 = 10.00$ |
| | Neutral taxes, 33.33% | |
| Taxable | 21.00 | 21.00 |
| Tax (33.33%) | 7.00 | 7.00 |
| After-tax income | 14.00 | 14.00 |
| | Only interest is taxed, 33.33% | |
| Taxable | 21.00 | 11.00 |
| Tax (33.33%) | 7.00 | 3.67 |
| After-tax income | 14.00 | 17.33 |

You should have found that if the tax rule also holds for loans, then one would like to borrow in a weak currency, one that delivers an untaxed capital gain that is paid for, in risk-adjusted expectations terms, by a matching but tax-deductible interest fee.

Note, finally, that there could be other tax asymmetries—for instance, capital losses being treated differently from capital gains. In that case the optimal investment rules are very different. Connoisseurs will see that in that case the tax asymmetry works like a currency option—a financial instrument whose payoff depends on the future spot rate in different ways depending on whether $S_T$ is above or below some critical number. To analyze this we need a different way of thinking to that we have used previously.

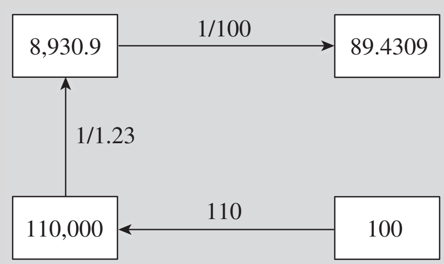
**DIY Problem 5.3.** (For this do-it-yourself assignment you do need to know the basics of option pricing.) Suppose there is a tax rule that says that corporations can deduct capital losses on long-term loans from their taxable income but they need not add capital gains to taxable income. Explain why this is different from the case above. Then show that, in this case, there is always an incentive to borrow *unhedged* FC regardless of the interest rates. (*Hint.* Reexpress the effect of this tax rule in terms of the payoff from an option.) Finally, show that, when choosing among many FCs, you would go for the highest-volatility one, holding constant the interest rates.

### 5.5.3 Swapping for Information-Cost Reasons

Until now we have ignored credit risk. In reality even AAA borrowers pay a credit-risk spread on top of the risk-free rate. If a firm compares HC and FC borrowing, it is quite conceivable that the credit-risk spread on the FC loan is incompatible with the one on the HC alternative. For instance, if both loans are offered by the same bank, the credit analyst may have been sloppy, or may simply not have read this section of the textbook on how to translate risk spreads. Or, more seriously, the FC loan offer may originate from a foreign bank which has little information, knows it has little information, and therefore asks a stiff spread just in case.[11] The rule is then that a spot-forward swap allows the company to switch the currency of borrowing while preserving the nice spread available in another currency.

**Example 5.20.** Don Diego Cortes can borrow CLP for four years at 23% effective, 2% above the risk-free rate; and he can borrow NOK at 12%, also 2% above the risk-free rate. Being an avid reader of this textbook, he knows that the difference between the two risk-free rates reflect the market's opinion on the two currencies; no value is created or destroyed, everything else being the same, if one switches one risk-free loan for another, both at the risk-free rates. But the risk spreads are different: one *can* pay too much, here, and Don Diego especially feels that 2% in a strong currency (NOK) is not attractive relative to 2% extra on the peso.

If, for some exogenous reason, Don Diego prefers NOK over CLP, the solution is to borrow CLP and swap into NOK:




If $FC_T$ is set at 100,000, then a direct loan at 12% produces $FC_t = 100{,}000/1.12 = 89{,}285.71$; but the swapped peso loan ($FC_T \to HC_T \to HC_t \to FC_t$) yields $(100{,}000 \times 110/1.23)/100 = 89{,}430.90$. Stated differently, Don Diego can borrow synthetic NOK @ $(100{,}000 - 89{,}430.90)/89{,}430.90 = 11.81\%$ instead of 12%.

One message is that, when comparing corporate loans in different currencies, one should look at risk spreads, not total interest rates. Second, when comparing spreads we should also take into account the strength of the currency. For example, 2% in a strong currency is worse than 2% in a weak one. We show, below, that the strength of the currency is adequately taken care of by comparing the PVs of the risk spreads, each computed at the currency's own risk-free rate: a 2% risk spread in a low-interest-rate currency then has a higher PV than a 2% spread in a high-rate currency. A related point, relevant for credit managers who need to translate a risk spread from HC to FC, is that

[11] Banks hate uncertainty. When they face an unfamiliar customer, they particularly fear *adverse selection*. That is, if the bank adds too stiff a credit-risk premium, the customer will refuse, leaving the bank no worse off; but if the bank asks too little, the borrower will jump at it, leaving the bank with a bad deal. In short, unfamiliar customers too often mean bad deals.

two spreads are equivalent if their PVs are identical. Note that these results hold for zero-coupon loans; the version for bullet loans with annual interest follows in chapter 7.

**Example 5.21.**

- Don Diego can immediately note that, for the CLP alternative, the discounted spread is 0.02/1.21 = 1.652 89%, better than the NOK PV of 0.02/1.10 = 1.818 18%.
- Don Diego's banker can compute that, when quoting an NOK spread that is compatible with the 2% asked on CLP loans, he can ask only 1.81%:

$$\frac{0.02}{1.21} = \frac{0.0181}{1.10} = 0.016\,528\,9. \tag{5.9}$$

This, as we saw before, is exactly the rate that Don Diego got when borrowing CLP and swapping.

**DIY Problem 5.4.** Here is a proof without words. Add the words, i.e., explain the proof to a friend who is obviously not as bright as you are. We denote the risk spreads by $\rho$ and $\rho^*$, respectively:

$$\text{Swapped HC loan yields } \begin{matrix}\text{more}\\ \text{the same}\\ \text{less}\end{matrix} \text{ if } \quad \frac{F_{t,T}}{1+r+\rho} \times \frac{1}{S_t} \gtreqless \frac{1}{1+r^*+\rho^*}$$

$$\Updownarrow$$

$$\frac{1+r}{1+r^*}\,\frac{1}{1+r+\rho} \gtreqless \frac{1}{1+r^*+\rho^*}$$

$$\Updownarrow$$

$$\frac{1+r}{1+r+\rho} \gtreqless \frac{1+r^*}{1+r^*+\rho^*}$$

$$\Updownarrow$$

$$\frac{1+r+\rho}{1+r} \gtreqless \frac{1+r^*+\rho^*}{1+r^*}$$

$$\Updownarrow$$

$$\frac{\rho}{1+r} \gtreqless \frac{\rho^*}{1+r^*}. \tag{5.10}$$

### 5.5.4 Swapping for Legal Reasons: Replicating Back-to-Back Loans

In the examples thus far, we have used the swap to change the effective denomination of a deposit or a loan. We now discuss reasons for working with a stand-alone swap. The main use of this contract is that it offers all the features of back-to-back loans (that is, two mutual loans that serve as security for each other), but without mentioning the words loan, interest, or security. We proceed in three steps. First, we explain when and why back-to-back loans may make sense. We then establish, via an example, the economic equivalence of a swap and two back-to-back loans. Lastly, we list the legal advantages from choosing the swap representation of the contract over the direct back-to-back loan.

#### *5.5.4.1 Why Back-to-Back Loans May Make Sense*

The most obvious reason for a back-to-back-like structure is providing security to the lender.

**Example 5.22.** During the Bretton Woods period (1945–72), central banks often extended loans to each other. For example, to support the GBP exchange rate, the Bank of England (BoE) would buy GBP and sell USD. On occasion it would run out of USD. Hoping that the pressure on the GBP (and the corresponding scarcity of USD reserves) was temporary, the BoE would borrow USD from, say, the Bundesbank (Buba), the central bank of Germany. The Buba would ask for some form of security for such a loan. In a classical short-term swap deal, the guarantee was in the form of an equivalent amount of GBP to be deposited with the Buba by the BoE. Barring default, on the expiration day the USD and the GBP would each be returned, with interest, to the respective owners. If either party defaulted, the other was automatically exonerated of its own obligations and could sue the defaulting party for any remaining losses.

**Example 5.23.** The central bank of the former Soviet Union often used gold as security for hard-currency loans obtained from Western banks, but repeatedly failed to pay back the loans. For the Western counterparty, the risk was limited to the face value of the loan minus the market value of the gold. The Soviet Union always made good this loss.

**Example 5.24.** Companies often post bonds or T-bills or other tradable securities as guarantee to a loan. One way to view this is that the borrower lends the bonds to the bank, which in return then lends money to the company. The bank can confiscate the bonds and sell them off if the company fails to pay back the loan.

Other applications are of the pure back-to-back loan type: a customer lends money to the bank, which in turn lends money back to the customer and uses the deposit as security for the loan. One motivation may be money laundering.

**Example 5.25.** After a long and successful career in the speakeasy business, Al-C wants to retire and spend his hard-won wealth at leisure. Fearing questions from the tax authorities, he deposits his money in the Jamaica office of a big bank, and then borrows back the same amount from the New York office of that bank. The deposit serves as security for the loan: if Al is unexpectedly taken out, the bank confiscates the deposit in lieu of repayment of the loan. And when questioned by the tax inspectors as to the source of the money he spends so freely, Al can prove it is all borrowed money.[12]

Another motivation is avoidance of exchange restrictions or other costs of moving money across borders. Back-to-back loans (or parallel loans) were often

[12] The example lacks credibility because the tax man's next question would be *why* the bank lent so much to Al. So this can only be done on a small scale, by persons or companies that could have borrowed such amounts without the guaranteeing deposit.

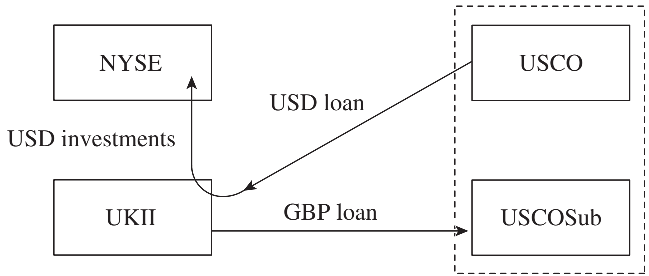



**Figure 5.8.** The parallel loan: example 1.

inspired by the investment dollar premium that existed in the United Kingdom from the late sixties to the mid seventies and made it expensive for companies to buy dollars for foreign investments.[13] Back-to-back loans, promoted and arranged by U.K. merchant banks, were a way to avoid this investment dollar premium.

**Example 5.26.** Suppose a U.K. institutional investor (UKII) wants to invest in the NYSE. The trick is to find a foreign company (say, USCO) that wants to extend a loan to its U.K. subsidiary. The USCO, rather than lending to its U.K. subsidiary, lends USD to UKII. Thus, the UKII borrows USD and pays them back later, which means that it does not have to buy USD initially and that there is no subsequent sale of USD. In short, the investment dollar premium is avoided. The second leg of the contract is that UKII lends GBP to USCO's subsidiary, so that USCO's objectives are also satisfied. The expected gains from avoiding the implicit tax can then be divided among the parties. The flow of the principal amounts of the reciprocal loans is shown in figure 5.8.

As it stands, the design of the back-to-back loan would be perfect if there were no default risk. Suppose, however, that USCO's subsidiary defaults on its GBP loan from the UKII. If no precautions had been taken, UKII would still have to service the USD loan from USCO, even though USCO's subsidiary did not pay back its own loans. Writing a right-of-offset clause into each of the separate loan contracts solves this problem. If USCO's subsidiary defaults, then UKII can suspend its payments to USCO, and sue for its remaining losses (if any)—and vice versa, of course. Thus, the right of offset in the back-to-back loan is one element that makes this contract similar to mutually secured loans. The similarity becomes even stronger if you consolidate USCO with its subsidiary and view them as economically a single entity—see the dashed-line box in the

[13] In those years, the United Kingdom had a two-tier exchange rate. Commercial USD (for payments on current account, like international trade and insurance fees) were available without constraints, but financial USD (for investment) were rationed and auctioned off at premia above the commercial rate. These premia, of course, varied over time and thus were an additional source of risk to investors. In addition, the law said that when repatriating USD investments, a U.K. investor had to sell 25% of his financial USD in the commercial market; the premium lost was an additional tax on foreign investment. In summary, there was quite a cost attached to foreign investment by U.K. investors.

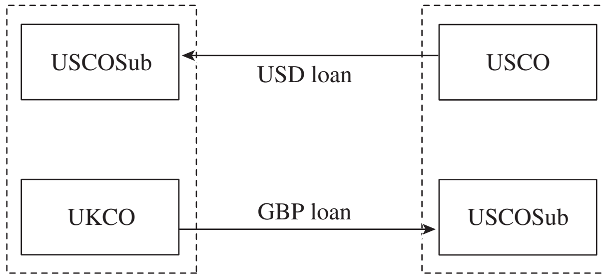



**Figure 5.9.** The parallel loan: example 2.

figure. Then, there is clearly a reciprocal loan between USCO and UKII, with a right of offset.

**Example 5.27.** If USCO also faced capital export controls (for example, Nixon's "voluntary" and, later, mandatory controls on foreign direct investment), there would be no way to export USD to the U.K. counterpart. Suppose that there was also a U.K. multinational that wanted to lend money to its U.S. subsidiary, if it were not for the cost of the investment dollar premium. The parallel loan solves these companies' joint problem, as shown in figure 5.9. (The diagram shows the direction of the initial principal amounts.) USCO lends UKCO dollars in the United States, without exporting a dime, while UKCO lends pounds to USCO's subsidiary in the United Kingdom (and, therefore, is making no foreign investment either).

Thus, no money crosses borders, but each firm has achieved its goal. UKCO's subsidiary has obtained USD, and USCO's subsidiary has obtained GBP, and the parents have financed the capital injections. This parallel loan replicates the reciprocal loan inherent in the short-term swap when we consolidate the parents with their subsidiaries (see the dashed boxes). In addition, the parallel loan typically has a right-of-offset clause that limits the potential losses if one of the parties defaults on its obligations.

**Example 5.28.** Suppose you have left Zimbabwe, where you lived most of your life, but you are not allowed to take out the Zimbabwe dollars you accumulated during your career. What you can do is try to find someone who, puzzlingly, wants to invest money in Zimbabwe, and to convince that party to lend his pounds to you in London, while you undertake to finance his Zimbabwe investment. (One occasionally sees such proposals in the small-ad sections of the *Times* or the *Economist*.) Both parties would feel far safer if there is also a right-of-offset clause in the loans.

Now that we understand why people might want mutually secured loans, we turn to the link between these contracts and swaps.

#### *5.5.4.2 The Economic Equivalence between Back-to-Back Loans and Spot-Forward Swaps*

Let us go back to the USD loan from Buba to BoE, and add some specific figures. We then summarize the contract in a table.

**Example 5.29.** The little table below shows this deal from BoE's point of view: the USD loan in the second column, the GBP deposit in the third. (Ignore the fourth column for the time being.) The rows show for each contract the promised payments at $t$ and $T$, assuming a dollar loan of 100m, a spot rate of USD/GBP 2.5, and an effective six-month rate of 3% on dollars and 5% on pounds. Outflows, from BoE's point of view, are indicated by the "⟨" and "⟩" signs around the amounts.

| | USD 100m borrowed at 3% | GBP 40m lent at 5% | |
|---|---|---|---|
| $t$ | USD 100.0m | ⟨GBP 40.0m⟩ | = spot purchase of USD 100m @ 2.5 |
| $T$ | ⟨USD 103.0m⟩ | GBP 42.0m | = forward sale of USD 103m @ 2.4523 |

The funny thing is that if one looks at the table by date (i.e., row by row) rather than by contract (i.e., column by column), one sees for date $t$ a spot conversion of USD 100m into GBP, at the spot rate of 2.5. For the end date, there is a promised exchange of USD 103m for GBP 42m, which sounds very much like a forward deal. Even the implied forward rate is the normal forward rate, as one can see by tracing back the numbers behind that rate:

$$2.4523 = \frac{103}{42} = \frac{100}{40}\frac{1.03}{1.05} = S_t\frac{1 + r_{\text{USD}}}{1 + r_{\text{GBP}}} = F. \tag{5.11}$$

Thus, depending on one's preferences, the promised cash flows can be laid down either in two loan contracts that serve as security for each other or in a spot contract plus an inverse forward deal—a spot-forward swap. But the similarity goes beyond the promised cash flows: even in the event of default the two stories still have the same implication. If, say, BoE defaults, then under the two-loans legal structure Buba will invoke the security clause, sell the promised GBP 42m in the market rather than give them to BoE, and sue if there is any remaining loss. Under the swap contract, if BoE defaults, Buba will invoke the right-of-offset clause, sell the promised GBP 42m in the market rather than give them to BoE, and sue if there is any remaining loss. Thus, the two contract structures are, economically, perfect substitutes. But lawyers see lots of legal differences, and many of these make the swap version more attractive than the mutual-loan version.

#### 5.5.4.3 *Legal Advantages of the Swap Contract*

*Simplicity.* Legally speaking, structuring the contract as a spot-forward transaction is simpler than the double-loan contract described earlier.

**Example 5.30.** In a repurchase order (repo) or repurchase agreement, an investor in need of short-term financing sells low-risk assets (like T-bills) to a lender, and buys them back under a short-term forward contract. This is another example of a swap contract (a spot sale reversed in the forward market). In terms of cash flows, this is equivalent to taking out a secured loan. Because of the virtual absence of risk, the interest rate implicit between the spot and forward prices is lower than an


**Figure 5.10.** A bank betraying its pawnshop roots. (Author's picture.)

ordinary offer rate and differs from the lending rate by a very small spread, called the bank's "haircut." In the case of default, the bank's situation is quite comfortable because it is already legally the owner of the T-bills.

Repo lending is a fancy name for what is done in pawnshops. In fact, banking and pawning used to be one and the same. In Germany, a repo is called a *Lombard* (and the repo rate is called the Lombard rate), after the north Italian bankers who introduced such lending during the Renaissance; in Dutch, *lommerd* just means pawnshop. The Catholic Church, incensed at the high rates charged, then started its own Lombard houses with more reasonable rates. These institutions were often called *Mons Pietatis*, Mount(ain) of Mercy; some still exist nowadays and a few have grown into big modern banks. The oldest surviving bank, Monte dei Paschi de Siena (1472), is one of these. Figure 5.10 shows a Spanish example.

We know, from chapter 2, that central banks can steer the money supply upward by lending money to commercial banks or downward by refusing to roll over old loans to banks. Nowadays these loans typically take the form of repos. In many countries the repo rate has become the main beacon for short-term interest rates.

In short, simplicity and efficiency is one advantage of a swap contract over a secured or back-to-back loan. To lawyers, who do not necessarily view simplicity as a plus, the main attractions are that the words security, interest, and loan/deposit are not mentioned at all.

**The term *security* is not used.** If the contract involves private firms rather than two central banks, the firm's shareholders need not be explicitly informed about the implicit right-of-offset clause in a swap because a forward contract is not even in the balance sheet (see below). In contrast, if there had been two loans, the financial statements would have had to contain explicit warnings about the mutual-security clause.[14] In some countries, the clause must

[14] Anybody involved with the firm has the right to know what assets have been pledged as security: this would mean that the firm's assets are of no use to the ordinary claimant if and when the firm defaults on its obligations.

even be officially registered with the commercial court or some similar institution. Providing security may also be contractually forbidden if the company has already issued bonds or taken up loans with the status of *senior* bonds or loans: giving new security would then weaken the position of the existing senior claimants. Bond covenants may also restrict the firm's ability to provide new security. All these problems are avoided by choosing the swap version of the contract.

**The term *interest* is not used.** Similarly, the word interest is also never mentioned in a swap contract; there is only an implied capital gain. This can be useful for tax purposes, as we saw earlier. In the example below, the reason is religious objections against interest.

**Example 5.31.** In the Middle Ages, the Catholic Church prohibited the payment of interest; swap-like contracts were used to disguise loans. Eldridge and Maltby (1991) describe a three-year forward sale for wool, signed in 1276 between the Cistercian abbey of St. Mary of the Fountains (in the north of England) and a Florentine merchant. The big "margin" deposited by the merchant was, in fact, a disguised loan to the abbey, serviced by deliveries of wool later on. The forward prices were not stated explicitly, because the implied interest would have been made too easy to spot.

**The term *loan* or *deposit* is not used.** A parallel loan would have shown up on both the asset and liability sides of the balance sheet. In contrast, a forward deal is off-balance-sheet.[15] This has several advantages: (i) it does not inflate debt, so it leaves unaffected the debt/equity ratio or other measures of leverage; (ii) it does not inflate total assets, so it leaves unaffected the profit/total-assets ratio. Under the old BIS rules ("Basel I"), capital requirements on swaps were less exacting than those on separate loans and deposits (see panel 5.1).

A more shady application of disguising one's lending and borrowing arose when a finance minister decided to speculate with taxpayers' money, and used swaps for the purpose.

**Example 5.32.** At one EC Council meeting in the mid 1980s, even Margaret Thatcher, caught off guard, was provoked into saying that she could not entirely exclude the possibility that the United Kingdom might ever think of discussing the option of joining a common European currency. Belgium's then finance minister, Mr. Maystadt, concluded that the advent of the common currency was a matter of a few years and that it would be introduced at the official parities, without any interim realignments. From these views—which, it later turned out, were both wrong—it

[15] This accounting rule is not unreasonable. There is indeed a difference between a swap and two separate contracts (one asset and one liability). In the case of the swap, default on the liability wipes out the asset. For that reason, accountants think it would be misleading to show the swap contract as if it consisted of a standard separate asset and liability. The inconsistency is, however, that once an asset has been pledged as security, it remains on the balance sheet *except* for forwards, futures, swaps, etc.

followed that the huge interest differential between lira and marks had become virtually an arbitrage opportunity. Thus, speculation was justified: one should borrow in a low-interest currency, like DEM, and invest the proceeds in a high-interest one, like ITL (the "carry trade"). Still, the country's rule books stated that the finance ministry could borrow only to finance the state's budget deficit. The minister therefore signed a huge long-term swap contract instead, arguing that, since the law did not mention swaps, their use was unrestricted.

The whole deal blew up in his face when the ERM collapsed in 1992 and the ITL lost one third of its value.

This has brought us to the end of our list of possible uses of forward contracts. We close the chapter with a related management application, where we are not strictly using the forward contract but rather the forward rate as a useful piece of information, notably in the case of valuation for management accounting purposes. This is discussed in the next section.[16]

## 5.6 Using the Forward Rate in Commercial, Financial, and Accounting Decisions

### 5.6.1 The Forward Rate as the Intelligent Accountant's Guide

Suppose a Canadian exporter sells goods in New Zealand, on an NZD 2.5m invoice. This transaction has to be entered into the accounts,[17] and as the exporter's books are CAD-based, the accountants need to translate the amount into CAD. In this context, many accountants fall for the following fallacy: "if we sell NZD 2.5m worth of goods, and 1 NZD is worth CAD 0.9, then we sell CAD 2.25m worth of goods." So these accountants would naturally use the spot rate to convert FC A/R or A/P into HC.

Why is this a fallacy? What is wrong with the argument is that it is glossing over timing issues. True, if we sell our wares today *and* get paid second working day *and* we convert the NZD spot into CAD right now, we will get CAD 2.25m in our bank account on day $t + 2$. But almost all real-world deals involve a credit period. So the above story should be modified: today we sell, and we will receive NZD 2.5m in, say, 45 days. At what rate we will convert this amount into CAD depends on whether we sell forward or not. This is how a finance person worth her salt would think:

- If we do sell forward, then it would look natural to book the invoice at the forward-based value. After all, if we sell NZD 2.5m worth of goods

[16] Of course there are more exchange-rate related issues in accounting than those we discuss here, but they are not directly related to the forward rate; we relegate those to chapter 13.

[17] In traditional accounting this is done as soon as the invoice has been sent or received. Under IFRS, this can be done as soon as there is a firm commitment. More precisely, the firm commitment is then entered initially at a zero value but can and must be updated when the invoice arrives or leaves and at any intervening reporting date. See chapter 13 for more.

The Bank for International Settlements of Basel, Switzerland, has no power to impose rules on banks anywhere. However, the BIS deserves credit for bringing together the regulatory bodies from most OECD countries in a committee called the BIS Committee, or the Basel Committee, or the Cooke Committee (after the committee's chairman), to create a common set of rules. The objective of establishing a common set of rules was to level the field for fair competition.

Under the original agreement the general capital requirement was 8%, meaning that the bank's long-term funding had to be at least 8% of its assets. For some assets and for off-balance-sheet positions with a right of offset, the risk was deemed to be less than the risk of a standard loan to a company, and the capital ratio was correspondingly lowered. For instance, a loan to any (!?) government or bank was assumed to have zero credit risk, and did not require any long-term capital. The rule was crude but was deemed to be better than no rule at all.

This is now called Basel I. The more recent Basel II rules have replaced the 8% rule for credit risks by a system of ratings—external whenever possible, internal otherwise—and have added Value-at-Risk (chapter 13) to cover market risks.

**Panel 5.1.** Capital adequacy rules v 1.0 (Basel I).

and we know we will receive CAD 0.88 per NZD, one would logically book this at CAD $2.5 \times 0.88 = 2.2$m.

- If we do not sell forward, we do not yet know what the exact CAD proceeds will be. So we have to settle for some kind of expected value or equivalent value, for the time being. Since we know that hedging does not change the economic value (at the moment of hedging, at least), we should use the same valuation procedure as if we had hedged—the forward rate, that is. So we still book this as a CAD 2.20m sale even if there is no hedging.

Many accountants would howl in protest. For instance, they might say, if one converts the NZD 2.5m at the forward rate, then the CAD accounting entry would depend on whether the credit period is 30 days or 60 or 90, etc. This is true. But there is nothing very wrong with it. The root of this problem is that accountants are *always* booking face values, not corrected in any way for time value. If they had used PVs everywhere, nobody would have a problem with the finding that an invoice's present value depends on how long one has to wait for the money.

This, of course, might be hard to grasp for some of the accountants. If so, at this point you take advantage of his confusion and ask him whether, if valuation for reporting purposes is done at the spot rate, there is a way to actually lock in that accounting value—that is, make sure you actually get the book value of CAD 2.25m. The only truthful answer of course is that there is no way to do this. You can then subtly point out that there *is* a way to lock in the accounting value of 2.20m: hedge forward. Giving no quarter, you then ask whether the spot rate takes into account expected exchange-rate changes and risks. Of course not, the accountant would bristle: in accounting, there surely is no room for subjective terms like "expectations" and "risk adjustments." The spot rate, he would add, is objective, as any valuation standard should be. You can then subtly point out that the forward rate is actually the risk-adjusted expectation, and that it is a market-set number and not a subjective opinion. At this point your scorecard for the competing translation procedures looks as follows:

| Criterion | Convert at $S_t$ | Convert at $F_{t,T}$ |
|---|---|---|
| Can be locked in at no cost? | No | Yes |
| Takes into account expected changes? | No | Yes |
| Takes into account risks? | No | Yes |
| Objective? | Yes | Yes |
| Understandable to accountants? | Yes | Hmm |

The accountant's last stand might be that valuation at 0.88 instead of 0.90 lowers sales and therefore profits; and more profit is good. This is an easy one. First, for other currencies there might be a forward premium rather than a discount; and for A/P a discount would increase operating income rather than decreasing it. So there is no general rule as to which valuation approach would favor sales and lower costs. Second, you point out, total profits are unaffected by the valuation rule: the only thing that is affected is the way profits are split up into operating income and financial items.

**Example 5.33.** Suppose, for instance, that our Canadian firm does not hedge the NZD 2.5m, and at $T$ the spot rate turns out to be 0.92. Suppose also that the cost of goods sold is CAD 1.5m. Then profits amount to $2.5\text{m}\times 0.92 - 1.5\text{m} = 2.3\text{m} - 1.5\text{m} = 0.8\text{m}$ regardless of what you did with the A/R.

True, the operating profit does depend on the initial valuation of the A/R, but there is an offsetting effect in the capital gain/loss when the accounting value is confronted with the amount actually received:[18]

| | Using $S_t = 0.90$ | | Using $F_t = 0.88$ | |
|---|---|---|---|---|
| • At $t$: | | | | |
| A/R | 2,250 | | 2,200 | |
| COGS | | 1,500 | | 1,500 |
| Operating income | | 750 | | 700 |
| • At $T$: | | | | |
| Bank | 2,300 | | 2,300 | |
| A/R | | 2,250 | | 2,200 |
| Capital gain/loss | | 50 | | 100 |

18 Note that while what I show in the table looks like accounting entries to the untrained eye, it violates all kinds of accounting rules and conventions. For instance, one does not immediately calculate and recognize the profit when a sale is made. Still, you can interpret it as a CEO's secret private calculations of profits and losses from this transaction; and it does convey the gist of what accountants ultimately do with this deal.

### 5.6.2 The Forward Rate as the Intelligent Salesperson's Guide

For similar reasons, the forward rate should also be used as the planning equivalent in commercial decisions. Let us use the same data as before, except that the production cost is 2,210. If the "spot" valuation convention is followed, a neophyte sales officer may think that this is a profitable deal. It is not: the equivalent HC amount of NZD 2.5m is $2.5\text{m} \times 0.88 = 2{,}200$, not 2,250 as the spot translation would seem to have implied.

Some cerebrally underendowed employees may think that the valuation difference is the cost of hedging, but you should know better by now. The acid test again is that the value 2,200 can be locked in at no cost, while you would have had to pay about 50 (minus a small PV-ing correction) for a nonstandard forward contract (sell NZD 2,500 at 0.90 instead of at the market forward rate, 0.88). That is, locking in a value of 2,250 would cost you 50 at $T$, implying that the true future value is 2,200.

### 5.6.3 The Forward Rate as the Intelligent CFO's Guide

Lastly, in taking financing decisions we can always use the forward rate to produce certainty equivalents for FC-denominated service payments. The principle has been explained before. The CEQ idea or, equivalently, the zero-initial-value property of a forward deal implies that no value is added or lost by replacing a loan by another one in a different currency.

Two remarks are in order. First, the above statement ignores credit risks, as we have shown: while no value is gained or lost when adding a swap, value *is* gained when an unnecessarily high-risk spread is replaced by a better one. We should also look at various fees and transaction costs, and possible nonneutralities in the tax law. All these issues make the CFO's life far more interesting than it would have been in a perfect world. Second, when stressing the CEQ property, we also assume that the market knows what it is doing. Some CFOs may disagree, or at least disagree some of the time, and turn to speculation. Others may agree that the market rates are fair but still have a preference for an FC loan, for instance because it hedges other FC income. So even if in terms of market values nothing would be gained or lost, there can still be a preference for a particular currency.

But when swaps are possible, the ultimate currency of borrowing can be separated from the currency in which the original bank loan is taken up. Thus, we first choose on the basis of costs. Then we ask the question of whether the currency of the cheapest loan is also the currency we desire to borrow in. If so, then we are already happy. If not, then (i) a cheap HC loan can be swapped into FC if desired, e.g., to hedge other income or to speculate, or (ii) a cheap FC loan can be hedged, if desired. Thus, in the presence of swap and forward markets it is always useful to split the discussion of, say, what currency to borrow from what bank, into two parts: (i) What are the various transaction costs, risk spreads, and tax effects? (ii) Do we want to change the currency of lowest-cost solution by adding a swap or a forward?

How would we sum up costs and spreads and so on? Here is an example. We calculate all costs in PV terms, using the risk-free rate of the appropriate currency.[19]

**Example 5.34.** Suppose you have three offers for a loan, one year. You need EUR 1m or, at $S_t = 1.333$, USD 1.333m if you borrow USD. Below, I list the interest rate asked, stated as swap plus spread, and the up-front fee on the loan—a fixed amount and a percentage cost. How would you chose?

- Bank A: EUR at 3% (Libor) + 1.0%; up-front EUR 1,000 + 0.50%.
- Bank B: EUR at 3% (Libor) + 0.5%; up-front EUR 2,000 + 0.75%.
- Bank C: USD at 4% (Libor) + 0.9%; up-front USD 1,000 + 0.50%.

The computations are straightforward:

| | Amount | PV risk spread | Up-front | Total |
|---|---|---|---|---|
| A | EUR 1m | $\frac{1\text{m} \times 0.010}{1.03} = 9{,}708.7$ | 1,000 + 5,000.0 = 6,000 | 15,708.7 |
| B | EUR 1m | $\frac{1\text{m} \times 0.005}{1.03} = 4{,}854.4$ | 2,000 + 7,500.0 = 9,500 | 14,354.4 |
| C | USD 1.333m | $\frac{1.333\text{m} \times 0.009}{1.04 \times 1.333} = 8{,}653.8$ | $\frac{1{,}000 + 1.333\text{m} \times 0.005}{1.333} = 5{,}750.2$ | 14,404.0 |

So the second loan is best. The issue of whether or not to speculate then boils down to whether you are keen on selling a large amount of USD 360 days, for instance to speculate on a falling USD or to hedge other USD income.

## 5.7 CFO's Summary

This concluding section has two distinct parts. First I want to simply review the main ideas you should remember from this chapter. The second item is a bird's-eye view of the currency markets and their players.

### 5.7.1 Key Ideas for Arbitrageurs, Hedgers, and Speculators

We opened this chapter with a discussion of bid–ask spreads. Any transaction or sequence of transactions ("trip") that is not a round-trip (not a pure arbitrage transaction) can still be made through two different routes. In imperfect

[19] Discounting at the risk-free rate is not 100% correct: when we want to find the PV, to the borrower or lender, of a series of payments, we should take a rate that includes default risk. (The procedure with discounting at the risk-free rate, above, was derived to find equivalent payment streams from the swap dealer's point of view, who has a much safer position than the lender.) But in the presence of up-front fees it is no longer very obvious what the rate on the loan is, and the error from using the swap rate instead is small. A more in-depth discussion follows in chapter 16.

markets—and, notably, with positive spreads—it is a near certainty that one route will be cheaper than the other, and, therefore, it generally pays to compare the two ways of implementing a "trip." The route chosen matters because, with spreads, it is mathematically impossible that for every single trip the two routes end up with exactly the same result. Equality of outcomes may hold, by a fluke, for at most one trip. And even if the difference between the outcomes of the two routes is small in the wholesale market, that difference can be more important in the retail market, where costs are invariably higher.

But there is more to be taken into consideration than spreads. Differential taxation of capital gains/losses and interest income/cost provides another reason why two routes are likely to produce different outcomes. For most corporate transactions, however, taxes may not matter, since interest and short-term capital gains (like forward premia received or paid) typically receive the same tax treatment. Lastly, information asymmetries can induce incompatibilities between the risk spreads asked by different banks; and, if the loans also differ by currency, one can go for the best spread and then switch to the most attractive currency via a swap. Recall that the attractiveness of a loan is mainly determined by its (PV-ed) risk spread, not the total interest rate.

A second implication of bid–ask spreads relates to the cost of hedging. In chapter 4, we argued that, in perfect markets, hedging has no impact on the value of the firm unless it affects the firm's operating decisions. In the presence of spreads, however, this needs a minor qualification. If a firm keeps a net foreign exchange position open, it will have to pay transaction costs on the spot sale of these funds, when the position expires. If the firm does hedge, in contrast, it will have to pay the cost in the forward market. Since spreads in the forward markets are higher, the extra cost represents the cost of the hedging operation. But we know that the cost of a single transaction can be approximated as half the bid–ask spread, so the cost of hedging is the extra half-spread, which at short maturities remains of the order of a fraction of 1%. Not zero, in short, but surely not prohibitive.

Forward contracts are often used as a hedge. Remember that there may be an alternative hedge, especially if the hedge is combined with a loan or deposit. Also, show some restraint when a single contract is to be used for hedging many exposures pooled over a wide time horizon. An extreme strategy is to hedge all exposures, duly PV-ed, by one hedge. Such a strategy involves interest-rate risk and may also cause severe liquidity problems if the gains are unrealized while the losses are to be settled in immediate cash. It is safer and simpler to stay reasonably close to the matching of cash flows rather than hedging the entire exposed present value via a single contract.

Speculation is a third possible application. Recall that, as an underdiversified speculator, you implicitly pretend to be cleverer than the market as a whole (which, if true, probably means that reading this book is a waste of time). Speculation can be done on the spot rate, the forward rate, or the difference of the two, the swap rate. One can execute this last strategy by forward-forward and spot-forward swaps, but upon scrutiny this turns out to be just speculation on the forward rate, with the spot-rate component in that forward rate simply hedged away.

Swaps can also offer the same advantages as secured loans or back-to-back loans with, in addition, all the legal advantages of never mentioning the words security, interest, or loan. They have been the fastest-growing section of the exchange market since their emergence from semi-obscurity in the 1980s. We return to the modern currency swap in chapter 7.

Lastly, it is recommended that you use forward rates to value contractual obligations expressed in FC. Standard practice is to use the current spot rate, but there is no way to lock in the current spot rate for a future payment; relatedly, that spot rate is not the risk-adjusted expectation or certainty equivalent of the future spot rate either. But remember that total profits are unaffected: the only impact is on the division of profits into operational versus financial income. So as long as you remember that a premium or discount is not the cost of hedging in any economically meaningful way, little harm is done by using the wrong rate.

This ends the "review" part of this concluding section. At this stage you know enough about spot and forward markets to understand the global picture. Let us consider this, too.

### 5.7.2 The Economic Roles of Arbitrageurs, Hedgers, and Speculators

This is the second of two chapters on forward markets. One thing you should remember from these, it is hoped, is the fact that spot, money, and forward markets are one intertwined cluster. Traditionally, players in these markets are categorized as hedgers, speculators, or arbitrageurs. For current purposes, we shall define speculation widely, including all pure financial deals, whether they are based on perceived mispricing or not. Likewise, let us temporarily broaden arbitrage to include not just strict arbitrage but also shopping around: both help enforcing the law of one price. Let us now see how these markets and these players interact to arrive at an equilibrium.

The role of hedgers is obvious. In agricultural markets, for instance, soy farmers want to have some certainty about the sales value of their next crop, so they sell forward part or all of the expected harvest. Manufacturers that need soy as inputs likewise are interested in some degree of certainty about their costs and could buy forward. Similarly, in currency markets, companies with long positions want to sell forward, and players with short positions want to buy. But if hedgers were the only players, the market might often be pretty thin, implying that the market-clearing price could occasionally be rather weird. That is where speculators and arbitrageurs come in.

The role of arbitrageurs, notably, is to make sure that a shock in one market gets immediately spread over all related markets, thus dampening its impact. For instance, if excess sales by hedgers would require a sharp drop in the forward rate to clear the market, then CIP means that the spot rate will feel the pressure too; and if the spot rate moves, all other forward rates start adjusting too. What happens, in principle, is that arbitrageurs rush in and buy, thus making up for the (by assumption) "missing" demand from hedge-buyers; these arbitrageurs then close out synthetically, via spot and money markets or via other forward currency and forward money markets. So instead of a sharp price drop in one segment, we might see a tiny drop in all related markets, or even no drop at all. In fact, the hedgers themselves probably do some of the "arbitrage" work (in the wider sense), since their shopping-around calculations would normally already divert part of the selling toward spot markets if forward rates drop too deep relative to spot prices.

This role of spreading the pressure works for any shock, of course, not just the forward disequilibrium we just used as an example. Suppose, for instance, that a central bank starts selling dollars for euros in a massive way. This would in a first instance affect the spot value: market makers see a constant flow of sell orders coming, which clogs up their books—so they lower their quotes to discourage the seller(s?) and attract new buyers. But, at constant interest rates, all forward rates would also start moving, thus also similarly influencing players in forward markets: there is less supply, and more demand, for these slightly cheaper forward dollars. The pressure can even be borne by other currencies too. For instance, suppose the market sees the change in the USD/EUR rate as a dollar problem; that is, they see no good reason why the EUR/JPY rate would change, for instance, or the EUR/GBP rate, etc. Part of the pressure is diverted to yen and pound spot markets and thence to all yen and pound forward markets too, and so on. Spreading pressure helps to dampen the impact the initial spot sales wave would have had if there had been an isolated market.

The above looks at the markets as a self-centered system where hedgers place orders for exogenous reasons and where market makers just react to order flow. The role of speculators, then, is to link prices to the rest of the world. Notably, the forward price is also a risk-adjusted expected future value. So when the forward dollar depreciates while investors see no good arguments why it should, they would start buying forward, thus limiting the deviation between the forward value and the expected future value.[20] Again, this "speculative" function is a role that can also be assumed by a "hedger"; for instance, if the forward is already pretty low relative to expectations, potential hedgers of long positions may have second thoughts and decide not to sell forward after all, while players with short positions would see the extra expected gain as a nice boon that might tilt the balance in favor of hedging.

If hedgers also function as arbitrageurs (when shopping around) or as speculators (when judging the expected cost of closing out), does that mean that

[20] If they take big positions, then they also assume more risk, so the risk correction may go up, too. This explains why, even at constant expectations, the forward rate may move. The point is that the discrepancy should be limited, though.

the usual trichotomy of players is misleading? Well, hedgers *are* special, or distinct: they start from a long or short position that has been dictated by others, like the sales or procurement departments, and they have to deal with this optimally. Speculators do not have such an exogenous motivation. But both will look at expected deviations between forward prices and expected future spot rates—“speculation”—and both will do their trades in the most economical way, thus spreading shocks into related markets—“arbitrage.” So speculation and arbitrage are roles, or functions, that should be assumed by all sapient humans, including hedgers.

We are now ready to move to two related instruments—younger cousins, in fact, to forward contracts: futures and swaps.

## TEST YOUR UNDERSTANDING

### 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.
   (d) Spot rate risk: the risk that the spot rate has changed once you have signed a forward contract.

2. Which of the following statements are true?
   (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.

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.

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

| | Spot | 1 month | | 3 months | | 6 months | | 12 months | |
|---|---|---|---|---|---|---|---|---|---|
| 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) 18.279–18.391

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

| | Spot bid–ask | 3-month forward bid–ask | P.a. 3-month euro interest | 6-month forward bid–ask | P.a. 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?

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.

## 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 small 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, p.a.) | USD | 5–5.25% | JPY | 3–3.25% |
| 180 days | NZD | 8–8.25% | GBP | 7–7.25% |

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

2. U.S.-based Polyglot Industries will send its employee Jack Pundit to study Danish on 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?

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

Applications 4–6 use the following time-0 data for two fictitious currencies, the Walloon franc (WAF) and the Flemish yen (FLY), on January 1, 2000. The initial spot rate is 1 WAF/FLY, and the interest rates (p.a., simple) are as follows:

| | 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 January 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 rollover date, by a factor $1 + r^*_{T_1,T_2}$, that is, from FLY 500,000 to FLY 512,500.
5. Repeat the previous exercise, except that after six months the exchange rate is at WAF/FLY 1, not 0.9.
6. Compare the analyses in applications 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?