Appendix

Measuring the Foreign Exchange Basis

In international economics, the principle of covered interest rate parity (CIP) specifies that the interest rate differential between two countries is equal to the differential between the forward exchange rate and the spot exchange rate.

The FX basis is derived from the CIP condition

$$\frac{1+i_D}{1+i_F}=\frac{F}{S},$$

where i_D is the domestic interest rate, i_F is the foreign interest rate, and F and S are, respectively, the forward and spot rates for the domestic currency relative to the foreign currency. We first explain the connection between CIP and FX swaps and then show how to derive the dollar basis rate from the CIP relation.

To see how CIP relates to the FX swap market, consider a European investor (in this case, the domestic investor) who is interested in investing 100 euros at the three-month euro interest rate of 1.25 percent—that is, i_D =0.0125. The investor has two options (see table). First, he can deposit euros in a European bank and, at the end of three months, earn a total of 101.25 euros at the prevailing rate of interest. Alternatively, he can use an FX swap contract to exchange 100 euros for U.S. dollars at the current dollar-euro spot rate, S, while simultaneously agreeing to exchange the dollars back into euros in three months at the current three-month dollar-euro forward rate, F.

Assume that S = a euro-dollar exchange rate of 0.714286 and that the three-month dollar interest rate is 1 percent—that is, $i_F = 0.01$. Using the CIP condition, we determine that F = a euro-dollar exchange rate of 0.716054. Accordingly, the investor receives \$100/S, or \$140, by exchanging euros for dollars. He then deposits the funds in a U.S. bank and, at the end of three months, earns a total of $(100/S)(1+i_F)$ dollars, or \$141.40 (since the U.S. interest rate is assumed to be 1 percent). Converting this back into euros at the forward rate, F, the investor receives $(100/S)(1+i_F)F$, or 101.25 euros.

The payout to the investor from these two investment options is the same: 101.25 euros. More generally, the cash flows from the two options are

$$100\left(1+i_D\right)=\frac{100F\left(1+i_F\right)}{S}.$$

This equation is identical to the CIP relation.

To derive an *implied rate*, we solve for i_D from the CIP condition. Since the interest rates are annualized, we use an adjustment factor of (90/360) to convert into a three-month term rate. Thus, the implied rate is

$$i_D=\frac{360}{90}\left(\left[\frac{F\left(1+i_F\left(\frac{90}{360}\right)\right)}{S}\right]-1\right).$$

We calculate the implied rate on a particular day by matching exchange rate data as of the close of the day with euro Libor (London interbank offered rate) and dollar Libor announced at approximately 7:00 a.m. Eastern U.S. time on the following morning.

To understand how we use this formula, suppose we want to calculate the implied dollar rate using the three-month euro-dollar swap. We substitute three-month euro Libor for the foreign interest rate, i_F, the dollar-euro spot rate for S, and the three-month forward exchange rate for F. The dollar basis is defined as the difference between the implied dollar rate and dollar Libor.

Example of an Arbitrage Trade

In the example, we assume that the CIP relation holds. But suppose we had instead assumed that $F = 0.72$, which is greater than $F = 0.716054$—the level implied by the CIP relation. In this case, the investor can earn 101.81 euros from converting euros to dollars and investing in the U.S. market. This amount is greater than 101.25 euros, which is what he earns from investing in Europe.

To take advantage of this risk-free profit, the investor can borrow euros, exchange them for dollars, and then invest for three months before converting the dollars back into euros. As other investors also rush to take advantage of this profitable opportunity, the excess current demand for dollars will drive S, the spot rate, up, while excess demand for euros three months hence will drive F, the forward rate, down.[a] Both of these changes drive down the payout from investing in the United States until the two rates of return are equalized. If the payout from investing in the United States is less than the payout from investing in Europe, the investor would conduct the opposite transaction to generate a risk-free profit: borrow dollars, exchange for euros, and invest in Europe.

Alternative Investment Strategies of a European Investor

Strategy	Action Now	Cash Flow	Action Three Months from Now	Cash Flow
Option 1: Invest in euro cash market	Invest 100 euros in European bank	-100 euros	Redeem investment	101.25 euros
Option 2: Use foreign exchange (FX) swaps to invest in dollar cash market	Exchange 100 euros for dollars in FX swap market	\$140	Redeem investment	\$141.40
	Invest in U.S. bank	-\$140	Convert dollars to euros	101.25 euros

Note: We assume a three-month euro interest rate of 1.25 percent, a three-month dollar interest rate of 1 percent, and a euro-to-dollar spot rate of 0.714286; following the principle of covered interest rate parity, the euro-to-dollar forward rate is 0.716054.

[a] For simplicity, we assume that the arbitrage works via changes in exchange rates only. In reality, changes in interest rates will also help maintain the CIP relation. If, for example, the basis is negative (say, because Libor is higher than the implied rate), investors should increase dollar funding from the FX swap market until the implied rate rises to the same level as Libor, thus returning the basis to zero.