Lecture Notes for Chapter 4

International Financial Markets and Institutions

Chapter 4

The forward market for foreign exchange

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Road Map

12 Summary of international finance

13 Revision classes

4.1 Main Issues

- Conventions for quoting forward exchange rates
- Relation between spot and forward exchange rates
- Valuation of forward contracts
- Application of forward exchange rates to
  - hedging;
  - speculation;
  - arbitrage.

4.2 Motivating problems

Motivating Problem 4.1 (Hedging)
Suppose you work for Sony (Japan) in the division that exports computer games to Britain. You receive GBP 100 M for these exports at the end of each quarter. You are worried about the possibility of a decrease in the JPY value of the GBP.

How can you hedge your position against such a decrease?

Motivating Problem 4.2 (Speculation)
You are a trader in New York with a friend who works for the German central bank. Your friend calls you and says that while he is not sure about the direction of exchange rates, he is sure that the difference in the USD and DEM interest rates is going to increase.

How can you design a trading strategy to take advantage of this information?

Motivating Problem 4.3 (Synthetic replication)

You work at Citibank Tokyo. A client calls you and says that she is expecting to receive USD 1 M in 3 months time and would like to hedge her position by selling forward contracts; however, she is restricted from trading forward contracts.

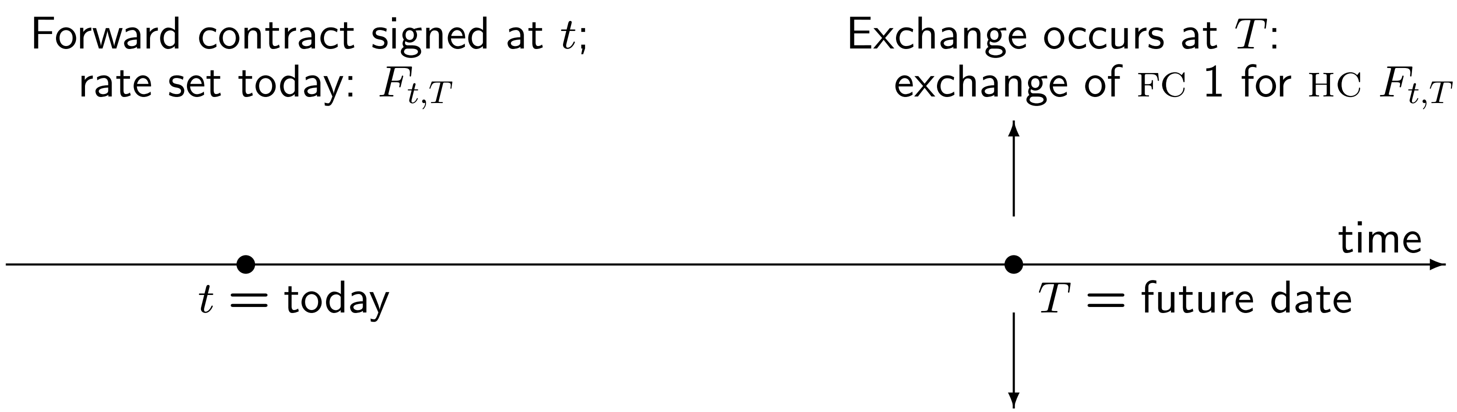
How would you design a strategy for her that allows her to hedge her position without trading in the forward market.

Motivating Problem 4.4 (Financing)

You work in the treasury office of BC Gas in Vancouver, Canada. It is 6 AM, and you have yet to see your first cup of coffee. The Chief Financial Officer has told you, Marie, that there is a cash shortfall, and that to buy gas you need to borrow USD 10 M, for 1 month. How do you decide where to finance this loan—in the US or the Canadian money market.

4.3 Definition of forward exchange rate

Definition 4.1 (Forward exchange rate)
The forward exchange rate between two currencies, $F_{t,T}$, is the price agreed upon today (t) at which one currency can be exchanged for the other currency at a certain future date (T).



Observe that with forward contracts:

- The rate at which the transaction will take place is determined $today$; thus, there is no uncertainty about the price (it is not random).
- The actual transaction (settlement) takes place at a future date, T, in contrast to a spot transaction, which is settled on the same date (t).
- There is no exchange of cashflows today.

The forward exchange rates for major currencies, along with spot rates, are given in Table 4.1.

Table 4.1: Foreign exchange spot and forward rates

For selected currencies, as reported by *The Wall Street Journal* on July 29, 1999

Country column 1	US$ equiv. column 2	Currency per US$ column 3
Britain (Pound)	1.6173	0.61831
1-month forward	1.6174	0.61827
3-months forward	1.6180	0.61805
6-months forward	1.6196	0.61744
Canada (Dollar)	0.6640	1.5060
1-month forward	0.6643	1.5054
3-months forward	0.6647	1.5045
6-months forward	0.6652	1.5033
Japan (Yen)	0.008662	115.45
1-month forward	0.008700	114.94
3-months forward	0.008778	113.92
6-months forward	0.008908	112.26
Switzerland (Franc)	0.6721	1.4878
1-month forward	0.6746	1.4824
3-months forward	0.6794	1.4719
6-months forward	0.6866	1.4565

Example 4.1 (Forward rate for goods)

- You agree today to sell your house after 3 months for USD 1 M. Thus, the 3-month forward exchange rate for your house is USD/house 1 M. This implies that:
  - No exchange takes place today;
  - After 3 months you will receive USD 1 M and will transfer ownership of your house.

Example 4.2 (Forward rate for currencies)

Suppose you are a resident of the U.S.

- You are planning a vacation to Japan in 6 months time. Your budget for the holiday is JPY 10 M. To buy this amount forward, the amount of USD you need in 6 months time is given by the current USD/JPY 6-month forward rate in Table 4.1:

$$[\text{JPY } 10\text{M}] \times [\text{USD/JPY } 0.008908] = \text{USD } 0.08908 \text{ M}.$$

4.4 Conventions for quoting forward rates

- Forward exchange rates can be quoted in two ways.

Outright rate — as given in Table 4.1.
This is the convention used in the retail banking sector and by much of the financial press (for instance, *The Wall Street Journal*).

Swap rate — difference between forward and spot rate (see Table 4.2).
This is the convention used by traders in interbank trading.

4.4.1 Outright quote for forward exchange

Country	US$ equiv.	Currency per US$
column 1	column 2	column 3
Britain (Pound)	1.6173	0.61831
1-month forward	1.6174	0.61827
3-months forward	1.6180	0.61805
6-months forward	1.6196	0.61744

From Column 2 of the above panel, we see that:

- The USD/GBP forward rates exceed the spot rate for all maturities. This means that it takes more USD to buy 1 Pound in the future; that is, the Pound is trading at a forward *premium* .

- The difference between the spot rate and the forward rate, the premium, is increasing with maturity.

Country	US$ equiv	Currency per US$
column 1	column 2	column 3
Britain (Pound)	1.6173	0.61831
1-month forward	1.6174	0.61827
3-months forward	1.6180	0.61805
6-months forward	1.6196	0.61744

Column 3 of the above panel, gives the indirect quote: GBP/USD. From this, we see the above statements are reversed:

- The GBP/USD forward rate is less than the spot rate for all maturities.

  This means that it takes less GBP to buy 1 USD in the future;

  that is, the USD is trading at a forward *discount*

- The (negative) difference between the spot rate and the forward rate is increasing with maturity; that is, the discount is increasing with maturity.

- Some conclusions:
  - The spot and forward rate will typically not be the same.
  - If the forward rate for the FC (the currency in the denominator) is larger than the spot rate, then the FC is said to be trading at a premium.

    If the forward rate for the FC is less than the spot, then the FC is said to be trading at a discount.
  - If the FC is trading at a forward premium, then the HC is trading at a discount, and vice versa.

4.4.2 Swap quote for forward exchange

- The second way of quoting the forward rate is to give only the *difference* between the outright forward rate and the spot rate, that is, the premium or discount.

- A forward rate quoted this way is called a *swap rate*.

- Swaps, as the word indicates, is an exchange.
  - The origin of the term "swap rate" is the *spot-forward swap contract*, where one exchanges (buys or sells) FC spot for FC forward.
  - This is in contrast to the outright contract, where one either buys or sells just the forward contract.
  - The sign of the swap rate—plus sign (for premium) or minus sign (discount)—indicates whether one should add or subtract the swap rate to the spot rate to get the forward rate.

- The spot-forward swap market is an interbank market, where only banks who are part of the "club" are allowed to trade.

- The transactions costs in this market are very low because
  - transaction sizes are large;
  - the "players" in this market are well known to each other so there is little default risk;

  Thus banks prefer to hedge their positions using the interbank swap market rather than the outright forward market.

Table 4.2: Forward outright and swap exchange rates

Country	US$ equiv	
	Outright rate	Swap rate
column 1	column 2	column 3
Britain (Pound)	1.6173	—
1-month forward	1.6174	$+0.0001$
3-months forward	1.6180	$+0.0007$
6-months forward	1.6196	$+0.0023$

Example 4.3 (Swap quote)

The 3-month forward USD/GBP exchange rate could be quoted:

- Outright: USD/GBP 1.6180
- Swap: $+0.0007$ (along with the spot rate USD/GBP 1.6173).

Example 4.4 (Outright vs. swap transactions)

– The price for an outright purchase of 6-month forward Pounds is USD/GBP 1.6196.

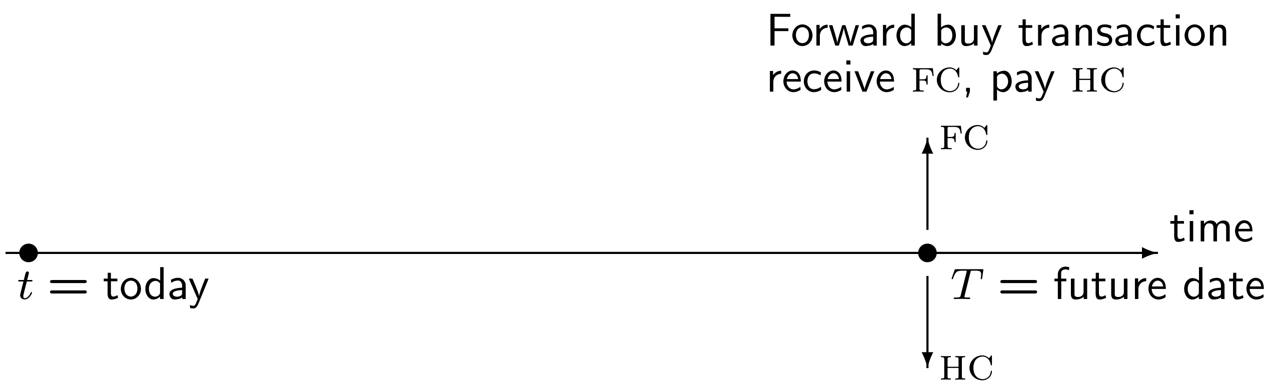
– The price you pay for a swap, where you

  ⋆ buy 6-month forward Pounds (pay USD/GBP 1.6196)
  ⋆ sell spot Pounds (receive USD/GBP 1.6173)

  is USD/GBP 0.0023 (the difference).

▶ The difference between the forward and spot rate is the swap rate, also called the *basis*.

- Outright forward buy transaction



- Spot-forward swap transaction (sell spot, buy forward)

- Because the value of spot FC is not the same as forward FC, the HC legs do not cancel out and difference (premium or discount) must be settled.

4.4.3 Quotes with transactions costs

We now look at quotes with bid-ask spreads.

Table 4.3: Forward outright and swap exchange rates

Country	US$ equiv				Bid-Ask
	Outright rate		Swap rate		spread
	bid	ask	bid	ask	
column 1	column 2	column 3	column 4	column 5	column 6
Britain (Pound)	1.6171	1.6175	—	—	0.0004
1-month forward	1.6172	1.6177	+0.0001	+0.0002	0.0005
3-months forward	1.6176	1.6184	+0.0005	+0.0009	0.0008
6-months forward	1.6190	1.6202	+0.0019	+0.0027	0.0012

- The outright quotes are similar to the ones for spot rates.
- The bid-ask spreads (last column) increase with maturity; this is because the market-maker wants higher compensation for contracts of longer maturity, which have greater default risk and are less liquid.
- To get the outright forward rate from the swap quote:
  - If the FC is at a forward premium (as in the table above) the swap bid-ask quotes are to be *added* to the corresponding spot quotes.
  - If the FC is at a discount, the swap quotes are to be *subtracted* from the spot bid-ask rates

Example 4.5 (Swap quotes in the case of a discount)
In Table 4.4 below, the USD is treated as the FC (the currency in the denominator) and the JPY as the HC. From this table, we see that:

– The USD is trading at a forward discount—it takes fewer JPY to buy USD as the contract maturity increases.

– The bid-ask spread (given in last column) is increasing with maturity.

– The swap rate in the case of discounts is quoted so that in absolute value the bid swap quote is *larger* than the ask swap quote; this is necessary if the bid-ask spread is going to increase with maturity once the swap quote is *subtracted* from spot rate.

Table 4.4: Forward outright and swap exchange rates

Country	JPY				Bid-Ask
	Outright rate		Swap rate		spread
	bid	ask	bid	ask	
column 1	column 2	column 3	column 4	column 5	column 6
US (Dollar)	115.31	115.58	—	—	0.27
1-month forward	114.75	115.13	−0.56	−0.45	0.38
3-months forward	113.65	114.19	−1.66	−1.39	0.54
6-months forward	111.81	112.71	−3.50	−2.87	0.90

4.5 Spot and forward rate relations

4.5.1 Covered Interest Rate Parity (CIP)

- Consider the following strategy:

  – Borrow S_t units of the HC at the rate $r_{t,T}$ so that the amount of HC owed at T is: $S_t \times (1 + r_{t,T})$.

- Use the loan of S_t to buy FC 1 in the spot market.

- Invest (lend) the FC 1 at the riskless interest rate $r^*_{t,T}$; at maturity, this will give FC $1 \times (1 + r^*_{t,T})$.

- Sell this amount forward to get HC: $F_{t,T} \times (1 + r^*_{t,T})$.

- In the absence of an arbitrage opportunity,

$$
\begin{aligned}
\text{payoff from strategy at } T &\leq \text{cost of strategy at } T \\
F_{t,T} \times (1 + r^*_{t,T}) &\leq S_t \times (1 + r_{t,T}) \\
F_{t,T} &\leq S_t \frac{(1 + r_{t,T})}{(1 + r^*_{t,T})}. \qquad (4.1)
\end{aligned}
$$

- Now, undertake the reverse of the strategy described above:
  - borrow FC 1, which implies that the cost at T is HC $1 \times (1 + r^*_{t,T}) \times F_{t,T}$.
  - convert into S_t units of HC,
  - lend this amount at $r_{t,T}$ so that the payoff at T is: $S_t \times (1 + r_{t,T})$.
  - To preclude arbitrage,

$$\begin{aligned} \text{the cost of the strategy at } T &\geq \text{payoff from strategy at } T \\ (1 + r^*_{t,T}) \times F_{t,T} &\geq S_t \times (1 + r_{t,T}) \\ F_{t,T} &\geq S_t \frac{(1 + r_{t,T})}{(1 + r^*_{t,T})}. \qquad (4.2) \end{aligned}$$

- From (4.1) and (4.2), we see that the only way both inequalities can be satisfied is if we have an equality. In frictionless markets and in the absence of arbitrage:

$$\boxed{F_{t,T} = S_t \frac{(1 + r_{t,T})}{(1 + r^*_{t,T})}. \qquad (4.3)}$$

- This is called Covered Interest Rate Parity (CIP); it is a useful result that we will apply in many different contexts.

- The CIP relation in equation (4.3) does not imply that the forward rate is *determined* by the spot rate and interest rates; it says only that all four quantities must be such that this relation is satisfied.

$$F_{t,T} = S_t \frac{(1 + r_{t,T})}{(1 + r^*_{t,T})}. \qquad \ldots \text{CIP}$$

- A currency is said to be *strong* if it is expected to appreciate, that is, if it is trading at a forward premium: $(F_{t,T} > S_t)$. Re-writing the CIP relation as

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

  we see that $F_{t,T} > S_t$ if the domestic interest rate is greater than the foreign interest rate, $r_{t,T} > r^*_{t,T}$.
  Thus, strong currencies can offer a lower interest rate, while weak currencies must compensate by offering a higher interest rate.

- To remember the CIP relation,

$$F_{t,T} = S_t \frac{(1 + r_{t,T})}{(1 + r^*_{t,T})}, \tag{4.4}$$

it is convenient to note that in the ratio

$$\frac{(1 + r_{t,T})}{(1 + r^*_{t,T})}$$

the interest rate in the numerator is the one for the currency in the numerator of the exchange rate, $S_t(\text{HC}/\text{FC})$.

Example 4.6 (Memory tip)
If S_t is being quoted as $\left(\frac{\text{EUR}}{\text{JPY}}\right)$ then

$$F_{t,T} = S_t \frac{(1 + r_{t,T}^{\text{EUR}})}{(1 + r_{t,T}^{\text{JPY}})}.$$

4.5.2 Empirical evidence on CIP

- Empirical evidence for the major currencies indicates that CIP holds very closely in the data.
  - Interest rates and exchange rates from *Financial Times* (Feb. 20, 1998).

Table 4.5: Exchange rate data for February 19, 1998

	LIBOR	Exchange rates	
Currency	$r_{1/4}$(% p.a.)	S_0	$F_{1/4}$
USD	5.5625	—	—
CAD	4.8750	0.7017	0.7029

  - Forward rates implied by Covered Interest Parity
    * For USD/CAD

$$F_{1/4} = 0.7017 \times \frac{1 + .055625/4}{1 + .04875/4} = \text{USD/CAD } 0.7029.$$

4.5.3 Implications of CIP for corporate borrowing decision

The CIP relation,

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

can be re-written as:

$$\begin{aligned} \frac{1}{S_t}(1 + r^*_{t,T})F_{t,T} &= (1 + r_{t,T}) \\ \text{cost at } T \text{ of borrowing HC 1 abroad} &= \text{cost at } T \text{ of borrowing HC 1 at home} \end{aligned}$$

From the above, in frictionless markets (no transactions costs, no taxes etc.) can you save money by borrowing in one currency rather than another?

- No, according to CIP, once you hedge exchange rate risk, borrowing cost will be the same across currencies.
  - Of course, this is true only in frictionless markets.

- Should a CFO borrow where rates are low, and lend where rates are high (without covering with forwards)?
  - Answer: Only if want to speculate on exchange rates ($\tilde{S}_T$).

Observation: After hedging for exchange rate changes with forward contracts, nominal interest rates are the same in all countries with perfect financial markets.

Q. What are expectations of traders in undertaking strategy given below?

Playing Yen Against Dollars Is Again Tempting the Risk Takers

Jonathan Fuerbringer, The Wall Street Journal, June 1, 1999

(This article has been edited for class use.)

One of the main culprits in the global financial crisis of 1997 is sneaking back into the financial markets. The spread between Japanese and higher American interest rates has recently been widening, tempting speculators to borrow yen at bargain-basement prices, convert them to dollars and invest them in U.S. Treasury bills. The idea is to sell the bills later on, pocket most of the interest payments and then repay the low-interest yen debt. If the yen does not turn against the borrower – and most forecasts are saying that it will not – it is an easy, if perhaps esoteric way to make money.

The key to the trade – besides a large enough difference in interest rates – is the performance of the currency that the borrowing is done in. It has to remain stable or weaken against the currency that the bonds are bought in. If the borrowing currency suddenly rallies, the cost of paying off the loan rises. A sharp currency rally can quickly make the carry trade a big loser.

In 1997, Asian investors took low-interest loans in yen or dollars and invested at higher rates at home, for example, in Thailand. But when the yen suddenly rallied against the dollar and other Asian currencies in May 1997, that carry trade blew up in the speculators' faces. The rush to get out involved the selling of local currencies, like the Thai baht, to convert to yen and dollars to pay off the loans. And that selling marked the beginning of the rush that forced the devaluation of the Thai currency in July, which in turn marked the beginning of the Asian, and eventually broader, financial crisis. Last year, speculators began to get out of the yen carry trade as the Russian financial crisis came to a head in August. The flight accelerated after the near-collapse of Long-Term Capital Management, the American hedge fund. The selling of dollars to buy yen and pay off the yen loans helped send the yen soaring 29 percent against the dollar in two months.

4.5.4 Implications of CIP for synthetic replication of payoffs

Replicating a forward contract's payoff

- The CIP relation,

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

  also tells us that a forward contract (on the left-hand-side of the above equation) can be replicated via transactions in the markets appearing on the right-hand-side of the equation:

  - the spot market
  - the domestic money market, and
  - the foreign money market.

- We illustrate below this equivalence between an outright forward transaction and transactions in the spot and money markets:

- Strategy A: Buy FC 1 forward outright for one year.

- Strategy B (synthetic replication of forward purchase):
  - Borrow $S_t/(1+r^*_{t,T})$ units of the HC.
  - Use (all of) this to buy spot $1/(1+r^*_{t,T})$ units of FC.
  - Invest this at $r^*_{t,T}$ to get FC 1 at maturity.

The cash inflows and outflows at $t = 0$ exactly offset each other, leaving only the cashflows at T, which match those from Strategy A.

- Since the two strategies have the same cashflows, they must also have the same cost; otherwise, there would be arbitrage opportunities.

- Instead of using pictures of cashflows, we can show the replication argument using a "payoff table"—a useful tool in analyzing payoffs of securities:

Strategy	Cashflow at t	Cashflow at T
A: Forward purchase	zero cashflows	Pay $F_{t,T}$ units of HC Receive FC 1
B: Replication	• Borrow HC $\frac{S_t}{(1+r^*_{t,T})}$	Pay HC $(1+r_{t,T})\frac{S_t}{(1+r^*_{t,T})}$
	• Buy FC $1/(1+r^*_{t,T})$	—
	• Invest FC $1/(1+r^*_{t,T})$	Receive FC 1
	Net cashflow $= 0$	

- Both strategies generate a payoff of FC 1, with zero cashflows at $t = 0$. Thus, the cost at T must be the same for both strategies:

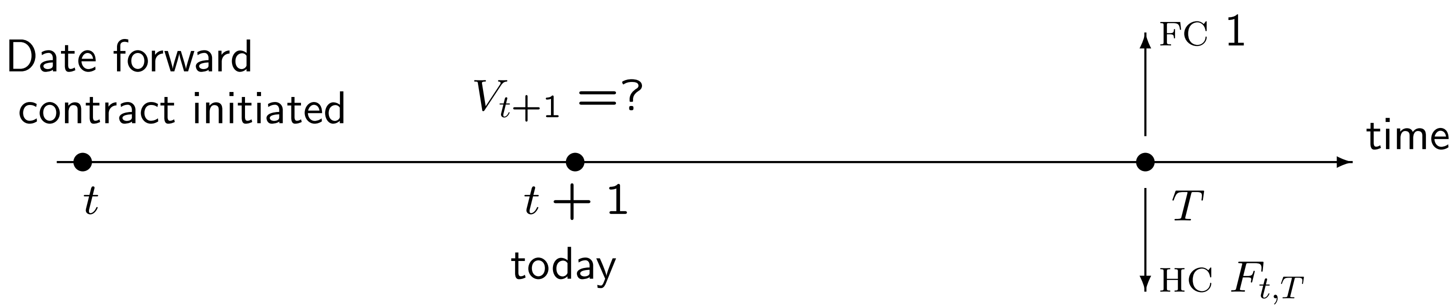
$$F_{t,T} = (1 + r_{t,T})\frac{S_t}{(1 + r^*_{t,T})}, \quad \text{CIP.}$$

- It is possible to replicate the cashflows from one instrument by trading in other instruments;
  - Thus, if you are not permitted to trade forward contracts, you can "trade" them synthetically by using the spot and money markets.
- If the cashflows from the two strategies are the same, then in the absence of arbitrage, the cost must also be the same

4.6 Valuation of new and existing forward contracts

4.6.1 Value of an existing forward contract

- Suppose that you wish to value today (at $t+1$) a forward contract to purchase FC 1 that was initiated at t with maturity date T at the rate $F_{t,T}$.



- The cashflows generated by this contract at T are:
  - ⋆ Receive FC 1 (because this is a contract to buy FC)
  - ⋆ Pay $F_{t,T}$ (the agreed upon forward rate).

- The present value of these cashflows can be summarized as follows:

Cashflows at T	Value today $(t+1)$	Value today $(t+1)$ in HC
Inflow of FC 1	$+\frac{\text{FC}1}{1+r^*_{t+1,T}}$	$+\frac{\text{FC}1}{1+r^*_{t+1,T}} \cdot S_{t+1}$
Outflow of HC $F_{t,T}$	$-\frac{F_{t,T}}{1+r_{t+1,T}}$	$-\frac{F_{t,T}}{1+r_{t+1,T}}$

- Thus, the net present value of this contract at date $t+1$ is:

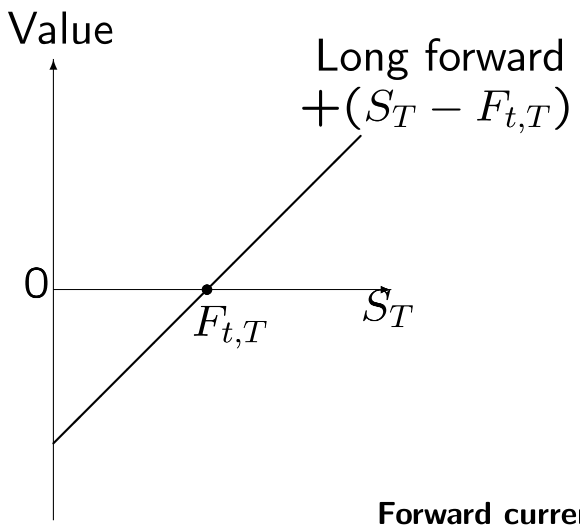
$$\boxed{V_{t+1} = \frac{S_{t+1}}{1+r^*_{t+1,T}} - \frac{F_{t,T}}{1+r_{t+1,T}}. \qquad (4.5)}$$

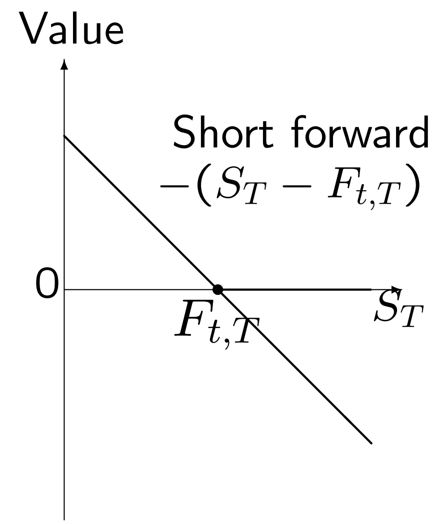
4.6.2 Value of a forward contract at maturity

- From equation (4.5), the value of the forward contract at date T is:

$$\boxed{V_T = \frac{S_T}{1 + r^*_{T,T}} - \frac{F_{t,T}}{1 + r_{T,T}} = S_T - F_{t,T},}$$

where we used the result that $r_{T,T}$ and $r^*_{T,T}$, the returns for zero-maturity loans (from date T to T), are zero.





4.6.3 Value of a forward contract on the initiation date

- The value of the forward contract on the date that it is purchased, t, is

$$V_t = \frac{S_t}{1 + r^*_{t,T}} - \frac{F_{t,T}}{1 + r_{t,T}}.$$

- But according to CIP, $F_{t,T} = S_t \frac{1+r_{t,T}}{1+r^*_{t,T}}$, which implies that

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

- Thus, at the initiation date, the forward rate is picked so that

$$V_t = 0.$$

Example 4.7 (Value of forward contract for currency)
From Table 4.1, we see that the market rate for a 3-month forward contract for Pounds is USD/GBP 1.6180.

– The value of this contract at $t =$ July 29, 1999 would be:

$$V_t = 0.$$

– Suppose after 1 month the spot rate is $S_{t+1} = \text{USD}/\text{GBP}$ 1.62. Then, the value of the forward contract to buy GBP would be:

$$V_{t+1} = \text{USD}/\text{GBP} \left(\frac{1.62}{1 + r^*_{t+1,T}} - \frac{1.6180}{1 + r_{t+1,T}} \right).$$

– If after 3 months, the spot rate is USD/GBP 1.625, the value of the forward contract to buy GBP will be:

$$V_T = \text{USD}/\text{GBP}\ (1.6250 - 1.6180) = \text{USD}/\text{GBP}\ 0.0070.$$

4.6.4 The certainty equivalent value of the future spot rate

- What is market's certainty equivalent value for the future spot rate, $\tilde{S}_T$?
  - That is, if you were offered FC 1 in the future, and asked to determine today an equivalent amount of future HC, what would be that exchange rate?

Example 4.8 (Certainty equivalent value of the future spot rate)

Suppose your HC is the GBP and the exchange rate is quoted as GBP/JPY. If you were offered JPY 1 M at the end of the year (T):

- The future value of this would be
  - ⋆ the random amount: $\tilde{S}_T \times \text{JPY } 1\text{M}$
  - ⋆ or, the certain amount: $F_{t,T} \times \text{JPY } 1\text{M}$.
- The present value can be computed as follows:

$$\text{PV}_t = \underbrace{\frac{E_t[\tilde{S}_T] \times \text{JPY } 1\text{M}}{1 + E_t\tilde{r}_{t,T}}}_{\substack{\text{risky cashflow discounted} \\ \text{at risk-adjusted rate (A)}}} = \underbrace{\frac{F_{t,T} \times \text{JPY } 1\text{M}}{1 + r_{t,T}}}_{\substack{\text{safe cashflow discounted} \\ \text{at riskless rate (B)}}} \tag{4.6}$$

  where
  - ⋆ $E_t\tilde{r}_{t,T}$ is the discount rate adjusted for the risk that $\tilde{S}_T$ is random,
  - ⋆ $r_{t,T}$ is the riskless discount rate because $F_{t,T}$ is a non-random quantity—its value is known at t.

- Comparing expressions (A) and (B) in equation (4.6), we see that:

  the certainty equivalent value of the future spot rate, is the forward rate:

$$F_{t,T} = \mathrm{CEQ}_t(\tilde{S}_T) \tag{4.7}$$

  – This does *not* imply that S_T, the realized spot rate at future date T will equal the current forward rate at t, $F_{t,T}$.

  – While

    ⋆ CIP tells us the relation between the *current* spot rate, the *current* forward rate, and interest rates,

    ⋆ the certainty equivalence concept gives us the relation between the *future* spot rate, $\tilde{S}_T$, and the *current* forward rate.

- It should be clear from equation (4.6) that there are two ways to determine the PV of foreign-currency-denominated cashflows.

$$\mathrm{PV}_t = \underbrace{\frac{E_t[\tilde{S}_T] \times \text{JPY } 1\text{M}}{1 + E_t \tilde{r}_{t,T}}}_{\substack{\text{risky cashflow discounted} \\ \text{at risk-adjusted rate (A)}}} = \underbrace{\frac{F_{t,T} \times \text{JPY } 1\text{M}}{1 + r_{t,T}}}_{\substack{\text{safe cashflow discounted} \\ \text{at riskless rate (B)}}}$$

- It will always be easier to
  - translate the FC into HC using the forward rate with discounting then done at the riskless discount rate,
  - rather than using the random spot rate to do the translation and discounting at a risk-adjusted discount rate.

4.7 Applications

We now apply the theory we have developed to a variety of problems.

- Hedging FC-denominated cashflows
- Speculating on the
  - future spot exchange rate
  - future forward rate
  - future basis (difference between future forward rate and future spot rate)

4.7.1 Using forward contracts for hedging

- FC inflows at a future date can be hedged by selling this FC forward.
- FC outflows at a future date can be hedged by buying FC forward.

▶ Hedging allows us to translate

- a future outflow of FC,
  whose HC value would depend on the future random spot rate $\tilde{S}_T$,
- into an outflow of HC,
  whose value is equal to $F_{t,T}$, which is known today.

Example 4.9 (Hedging FC outflows)

Suppose that you live in the US and intend to vacation in London (UK) three months from today. You expect to spend GBP 1 M on your vacation. You are worried, however, that if there is an increase in the value of the GBP, you will either have to cut back on what you spend, or you will need additional USD to keep the same expenditure in GBP.

How can you use forward contracts to hedge your position?

Answer: Your current position is short forward GBP. You can hedge this by going long forward GBP (buying GBP forward).

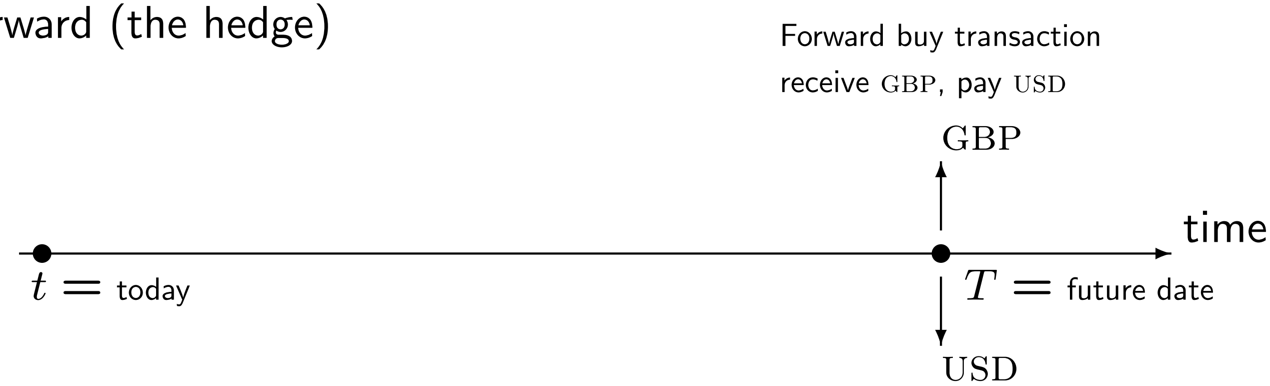
From Table 4.3, reproduced below, we see that the cost of buying 3-month forward GBP would be: USD/GBP 1.6184.

Britain (Pound)	US$ equiv				Bid-Ask
	Outright rate		Swap rate		spread
	bid	ask	bid	ask	
Spot	1.6171	1.6175	—	—	0.0004
3-months forward	1.6176	1.6184	+0.0005	+0.0009	0.0008

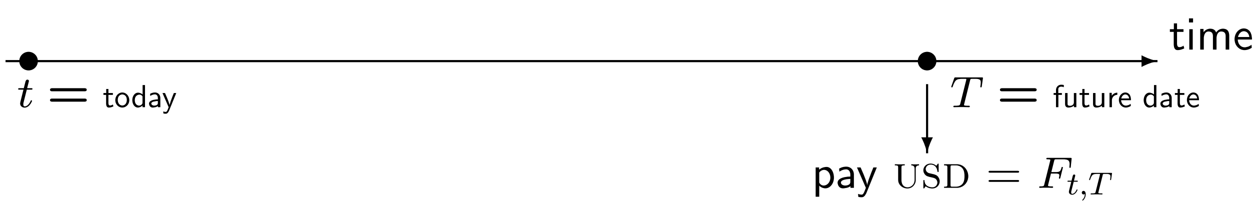
We can see the result of hedging with forwards using pictures:

- Position today: short forward GBP (the expected outflow)

- Buy GBP forward (the hedge)



- Net position: add the two payoff profiles above so that the GBP legs cancel out, leaving only the HC (USD) leg



Example 4.10 (Hedging exports to Japan)

Recall the Motivating Problem 4.1 where the exporter of computer games from Japan to Britain wishes to hedge future GBP-denominated inflows.

To hedge the underlying position, which is long GBP, the trader should short (that is, sell) GBP forward.

Cost of forward hedging

What is the cost of hedging forward in Example 4.9?

- Is it the difference between the spot rate and the forward rate?
- If not,
  - why not?
  - and, what is it?

Britain (Pound)	US$ equiv				Bid-Ask
	Outright rate		Swap rate		spread
	bid	ask	bid	ask	
Spot	1.6171	1.6175	—	—	0.0004
3-months forward	1.6176	1.6184	+0.0005	+0.0009	0.0008

Example 4.11 (Hedging in the swap market)

Suppose you are given the following rates:

Spot rate	USD/GBP 1.50-1.55
Outright 6-month forward rate	USD/GBP 1.70-1.80
Inter-bank swap rate	USD/GBP 0.21-0.23

Question 1: What is the outright forward rate in the *interbank* market?

Answer 1: This synthetic rate, computed by adding the swap rate to the spot rate, is: USD/GBP 1.71-1.78.

Observe that the bid-ask spread $1.78 - 1.71 = .07$ is smaller in the interbank market than that in the *outright* forward market, $1.80 - 1.70 = 0.10$.

Question 2: Suppose that Honda US has to make a GBP 1 M payment in 6 months time. Thus, to hedge this payment, the company makes an outright purchase of 6 month forward GBP 1 M from its bank. After this transaction, Honda is fully hedged.

However, now the bank has a short position of GBP 1 M in forward pounds, at USD/GBP 1.80.

- How should the bank cover its position.

- What is the cost of this hedge to the bank.

<u>Answer 2:</u> To cover its position, the bank will undertake two transactions:

1. Swap out (which consists of two legs)

(a) Buy GBP 1 M 6-month forward
(b) Sell GBP 1 M spot

with the "cost" of the swap being USD/GBP 0.23.

2. Buy spot at USD/GBP 1.55.

After these transactions the banks position is fully hedged, at a cost of swap + spot = USD/GBP 1.78.

The bank's profit is USD/GBP 1.80 − 1.78 = USD/GBP 0.02.

<u>Question 3:</u> What is the bank's profit if it hedges in the *outright* forward market?

Answer 3: In the outright forward market, the cost of buying GBP forward is USD/GBP 1.80. (You must realize that the bank will now have to go to another bank, and it will be treated like another customer, and therefore must pay the ask rate.) Thus, if it used the outright market, its profit would be zero.

Question 4: What is the maximum profit that the bank could make, if it were willing to be exposed to risk for "some" time, while it waited for another client to come and take an opposite position?

Answer 4: If the bank were willing to wait, it could wait until another customer came to sell GBP 6-months forward, at USD/GBP 1.70. But, this would be risky, because it is not clear when another customer will show up.

- It is cheaper for banks to hedge in the interbank market because the bid-ask spread in this market is small than that in the outright forward market.

4.7.2 Using forward contracts for speculation

- Speculation, in contrast to hedging and arbitrage, involves undertaking risk consciously.

- One speculates only if one's belief (expectation) about a market variable is different from those of the market.

- Moreover, one will profit from speculation only if these beliefs are validated, ex post, by the market.

- In plain English, what this means is, that you have a different estimate of what the price of a certain asset should be, and you will make money only if the market view of this price "coincides" with your view when your bet matures.

- Speculation consists of three steps:

1. Make a forecast about future value of a certain variable (you can only speculate on *future* values)
2. Take a position, based on your forecast
3. Close out position, after the forecasted event takes place (or doesn't)

Speculating on the future spot rate

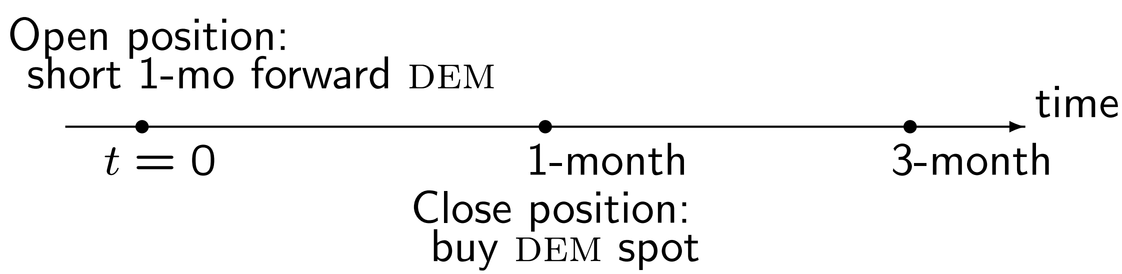
- To speculate on a decrease in the future spot rate,
  - sell forward today, and
  - buy spot at maturity.

Example 4.12 (Speculating on the future spot rate)
The table below summarizes your expectations and market data. What should be your trading strategy given this information.

Your expectation: $E_0 S_1$	USD/DEM	0.3701-0.3702
Market rate: $F_{0,1}$	USD/DEM	0.3703-0.3706
Market rate: $F_{0,3}$	USD/DEM	0.3711-0.3724

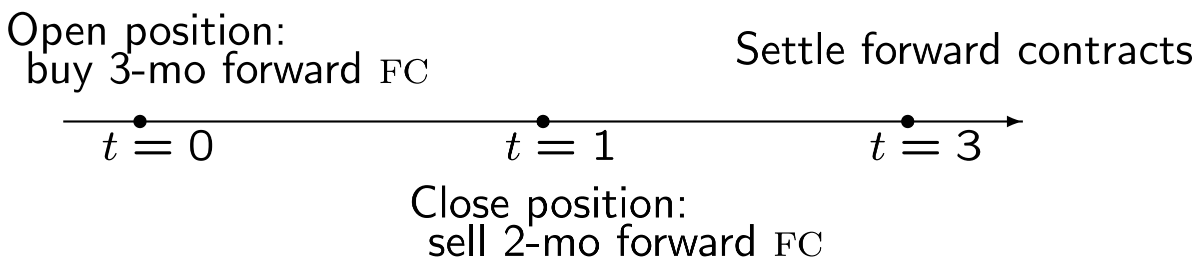
Answer We see that the expected 1-month future spot rate for the DEM is lower than the current view of the market, reflected in the 1-month forward rate. Thus,

- Today: Sell DEM one month forward at USD/DEM 0.3703.
- After 1 month: expect to buy DEM spot for an expected profit of USD/DEM $0.3703 - 0.3702 =$ USD/DEM 0.0001.



Speculating on the future forward rate

- To speculate on an increase in the forward rate after 1 month,
  - Today: buy long maturity (say, $T = $ 3-month) forward contract;
  - After 1 month: sell forward for remaining maturity (2 months);
  - At T: settle both contracts.



Example 4.13 (Speculating on the future forward rate)

Given the following market data and your expectations about the future forward rate, what should be your strategy.

Your expectation: $E_0F_{1,3}$	USD/DEM	0.3730-0.3735
Market rate: $F_{0,1}$	USD/DEM	0.3703-0.3706
Market rate: $F_{0,3}$	USD/DEM	0.3711-0.3724

Answer: Given that 1-month from now $F_{1,3}$, the forward rate for maturity $t = 3$, is expected to be higher than current rate, $F_{0,3}$, the trading strategy should be:

Date	Action	Rate
$t = 0$	Buy DEM 3 month forward at	USD/DEM 0.3724
$t = 1$	Expect to sell DEM 2-mo forward at $F_{1,3}$	USD/DEM 0.3730
$t = 3$	Expect profit of 0.3730 – 0.3724	USD/DEM 0.0006

Speculating on the future basis

- Suppose that you are not sure about
  - the future value of either the forward rate or the spot rate,
  - but you expect that the difference between the two, the $basis$, will change in a particular direction.
- Then, to speculate on the basis, you need a strategy that is a combination of the two strategies described above.

- To speculate on an increase in the basis rate after 1 month,

Date	Action	Rate
$t = 0$	Sell FC 1-month forward	$+F_{0,1}$
	Buy FC 3 month forward	$-F_{0,3}$
$t = 1$	Expect to buy FC spot	$-E_0 S_1$
	Expect to sell FC 2-month forward	$+E_0 F_{1,3}$
$t = 3$	Settle forward contracts	

- Using CIP, one can show that speculating on the future basis is equivalent to speculating on the future difference between the interest rates of the domestic and foreign countries.

- An alternative way for describing the strategy for speculating on the basis is in terms of *forward-forward swaps*.

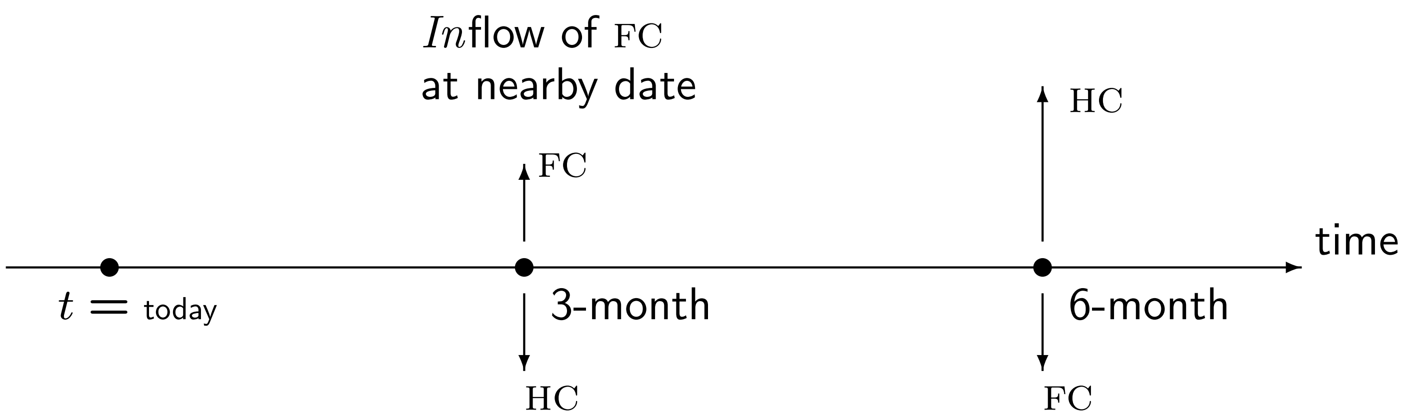
Definition 4.2 (Forward-forward swaps)
In a *forward-forward swap* one trades FC forward (at F_{t,T_1}) for a particular maturity date, and simultaneously trades forward (F_{t,T_2}) for a second maturity date, with $T_1 \neq T_2$.

- The swap takes its name from the direction of the FC flow at the *nearby* date.
  - Swap-*in*: if FC is purchased for the near-maturity, and sold for the distant maturity;
  - Swap-*out*: if FC is sold for the near-maturity, and purchased for the distant maturity.

Example 4.14 (Forward-forward swap-in)

In the case of a 3-month for 6-month forward *swap-in*, one

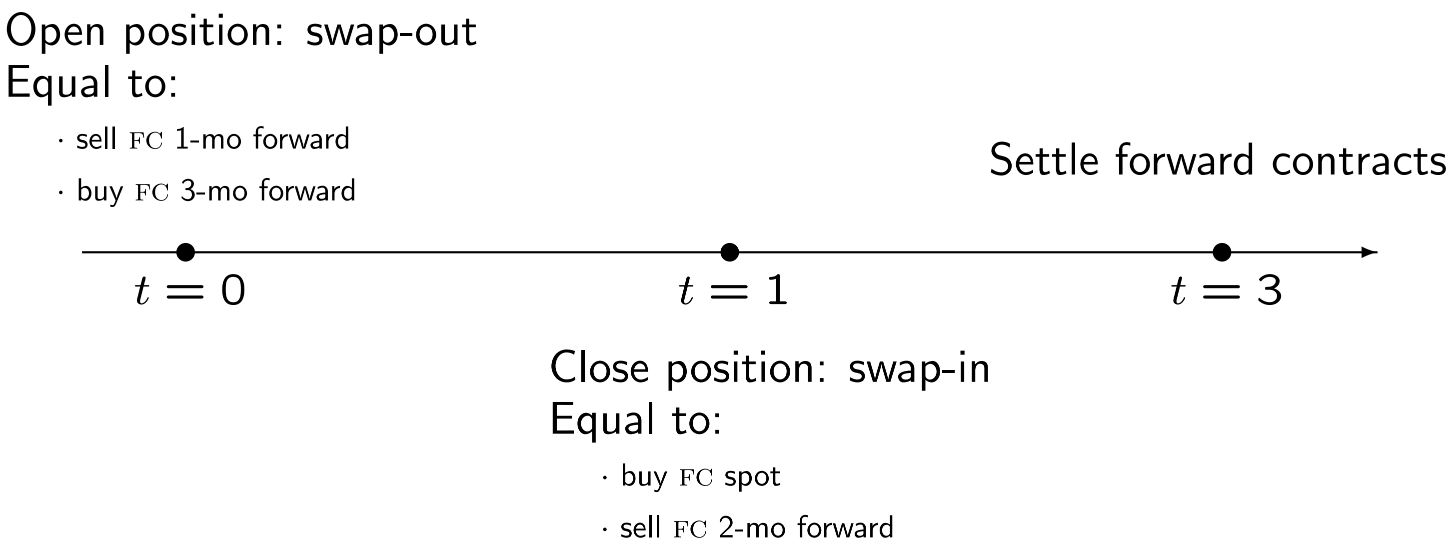
- buys FC 3-month forward: $-F_{t,t+3}$ (outflow, since buying)
- sells FC 6-month forward: $+F_{t,t+6}$ (inflow, since selling)
- The net cashflow, $[F_{t,t+6} - F_{t,t+3}]$, is the basis or the forward-forward swap rate.



- The description of the trading strategy when the basis is expected to increase is given in column 2 below, and it can be restated in terms of swaps as follows (in column 3):

Date column 1	Action column 2	Swap column 3
$t = 0$	Sell FC 1-month forward	
	Buy FC 3-month forward	= Forward-forward swap out
$t = 1$	Expect to buy FC spot	
	Expect to sell FC 2-month forward	= Spot-forward swap in
$t = 3$	Settle forward contracts	

- Using a payoff picture, we can represent both descriptions:



4.8 Summary

- Forward currency is traded just like spot currency—not on an organized exchange but via banks and brokers.

- The forward exchange rate is quoted either outright or relative to the spot rate, in which it is called the swap rate.

- The value of a forward contract is the discounted value of the difference between the current forward rate and the rate at which the forward contract was initiated.
  - The value of a just-issued forward contract is zero.
  - The value of a forward contract at expiration is $S_T - F_{t,T}$.
  - The value of a previously issued contract is $\frac{F_{t-1,T} - F_{t,T}}{1+r_{t,T}}$.

- The absence of arbitrage implies a relation between the spot rate and the forward rate.
  - In frictionless markets, CIP is: $F_{t,T} = S_t \frac{(1+r_{t,T})}{(1+r^*_{t,T})}$.
  - With frictions, the forward bid and ask rates only need to satisfy certain bounds.

- CIP implies that
  - One *cannot* make money by borrowing in one currency and lending in another.
  - With frictions, one can always *save* money: it will always be cheaper to borrow in one currency rather than another, even after hedging against exchange rate risk.

- Forward contracts can be used for
  - hedging FC-denominated cashflows, and also for
  - speculating on the future spot rate, the future forward rate, and the future interest rate differential.

- Limitations of forward contracts:
  - Default risk
  - Illiquid secondary market

  Futures contracts are designed to address these limitations.

4.9 Recommended readings

- Chapters 2, 3, 4 of Sercu and Uppal, "International Financial Markets and the Firm."

Quiz questions

These are optional and not set as homework. We may even do some in class.

- Questions 1–5 on pages 65 of SU Chapter 2.
- Questions 1–2 on page 92 of SU Chapter 3.
- Question 4 on page 122 of SU Chapter 4.

Exercise questions

- Optional: Questions 1–3 on pages 65–66 of SU Chapter 2
- Optional: Questions 1–4 on pages 92–93 of SU Chapter 3.
- Optional: Question 2 on page 124 of SU Chapter 4.