

## CHAPTER I

### FOREIGN EXCHANGE MARKETS

The international business context requires trading and investing in assets denominated in different currencies. Foreign assets and liabilities add a new dimension to the risk profile of a firm or an investor's portfolio: foreign exchange risk. This chapter has two goals. First, this chapter introduces the terminology used in foreign exchange markets. Second, this chapter presents the instruments used in currency markets.

#### I. Introduction to the Foreign Exchange Market

##### 1.A An Exchange Rate is Just a Price

The foreign exchange (FX or FOREX) market is the market where exchange rates are determined. Exchange rates are the mechanisms by which world currencies are tied together in the global marketplace, providing the price of one currency in terms of another.

An exchange rate is a price, specifically the relative price of two currencies.

For example, the U.S. dollar/Mexican peso exchange rate is the price of a peso expressed in U.S. dollars. On March 23, 2015, this exchange rate was USD 1.0945 per EUR, or, in market notation, 1.0945 USD/EUR.

##### ♦ **The Price of Milk and the Price of Foreign Currency**

An exchange rate is another price in the economy. Let's compare an exchange rate to the price of milk. Suppose that the price of a gallon of milk is USD 2.50, or 2.50 USD/milk, using the above exchange rate market notation.

When we price milk, the denominator refers to one unit of the good that it is being bought—a gallon of milk. When we price exchange rates, the denominator refers specifically to one unit of a currency. Therefore, think of the currency in the denominator as the currency you are buying. ♦

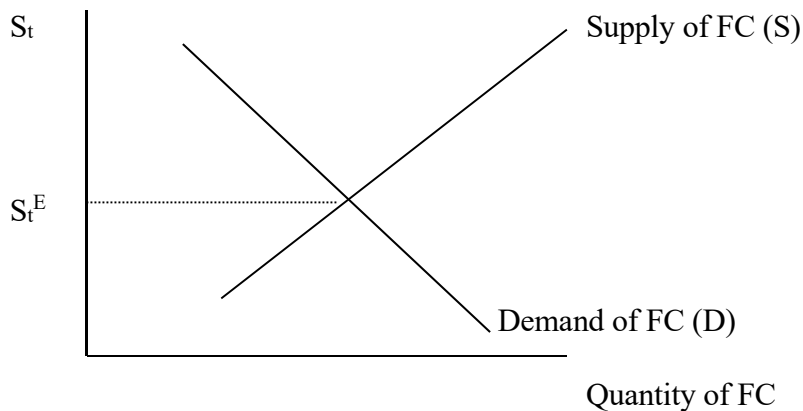
The exchange rate is just a price, but it is an important one:  $S_t$  plays a very important role in the economy since it directly influences imports, exports, & cross-border investments. It has an indirect effect on other economic variables, such as the domestic price level,  $P_d$ , and real wages.

For example: when  $S_t$  increases, foreign imports become more expensive in USD. Then, the domestic price level  $P_d$  increases and, thus, real wages decrease (through a reduction in purchasing power). Also, when  $S_t$  increases, USD-denominated goods and assets are more affordable to foreigners. Foreigners buy more goods and assets in the U.S. (exports, real estate, bonds, companies, etc.). These factors drive aggregate demand up and, thus, GDP increases.

##### 1.A.1 Equilibrium Exchange Rates and Foreign Exchange Risk

Like in any other market, demand and supply determine the price of a currency. At any point in time, in a given country, the exchange rate is determined by the interaction of the demand for foreign currency and the corresponding supply of foreign currency. Thus, the exchange rate is an equilibrium price ( $S_t^E$ ) determined by supply and demand considerations, as shown by Exhibit I.1.

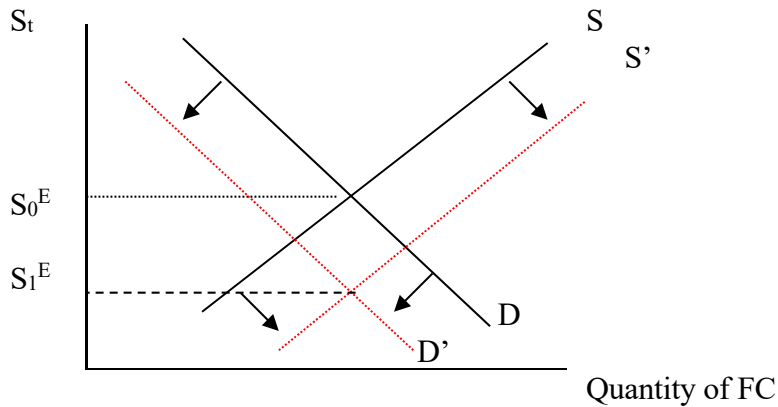
**Exhibit I.1**  
Demand and Supply determine the price of foreign currency ( $S_t^E$ ).



What are the determinants of currency supply and demand in the foreign exchange market? The supply of foreign currency derives from foreign residents purchasing domestic goods and services – i.e. domestic export--, foreign investors purchasing domestic assets, and foreign tourists traveling to the domestic country. These foreign residents need domestic currency to pay for their domestic purchases. Thus, the foreign residents buy the domestic currency with foreign currency in the foreign exchange market. Similarly, the demand for foreign currency derives from domestic residents purchasing foreign goods and services –i.e. domestic imports--, domestic investors purchasing foreign assets, and domestic tourists traveling abroad.

Over time, the many variables that affect foreign trade, international investments and international tourism will change, forcing exchange rates to adjust to new equilibrium levels. For example, suppose interest rates in the domestic country increase, *ceteris paribus*, relative to interest rates in the foreign country. The domestic demand for foreign bonds will decrease, reducing the demand for foreign currency in the foreign exchange rate. The foreign demand for domestic bonds will increase, increasing the supply of foreign currency in the foreign exchange rate. As a result of these movements of the supply and the demand curves in the foreign exchange market, the price of the foreign currency in terms of domestic currency will decrease. Exhibit I.2 shows the effect of these changes in the equilibrium exchange rate.

**Exhibit I.2**  
The Effect of an Increase in Domestic Interest Rates relative to Foreign Interest Rates.



Changes in exchange rates are usually measured by percentage changes or returns. The currency return from time  $t$  to  $T$ ,  $s_{t,T}$ , is given by:

$$s_{t,T} = (S_T/S_t) - 1,$$

where  $S_t$  represents the exchange rate in terms of number of units of domestic currency for one unit of the foreign currency (the spot rate).

Risk arises every time actual outcomes can differ from expected outcomes. Assets and liabilities are exposed to *financial price risk* when their actual values may differ from expected values. In foreign exchange markets, we are in the presence of *foreign exchange risk (currency risk)* when the actual exchange rate is different from the expected exchange rate. That is, if there is foreign exchange risk,  $s_{t,T}$  cannot be predicted perfectly at time  $t$ . In statistical terms, we can think of  $s_{t,T}$  as a random variable.

## II. Currency Markets

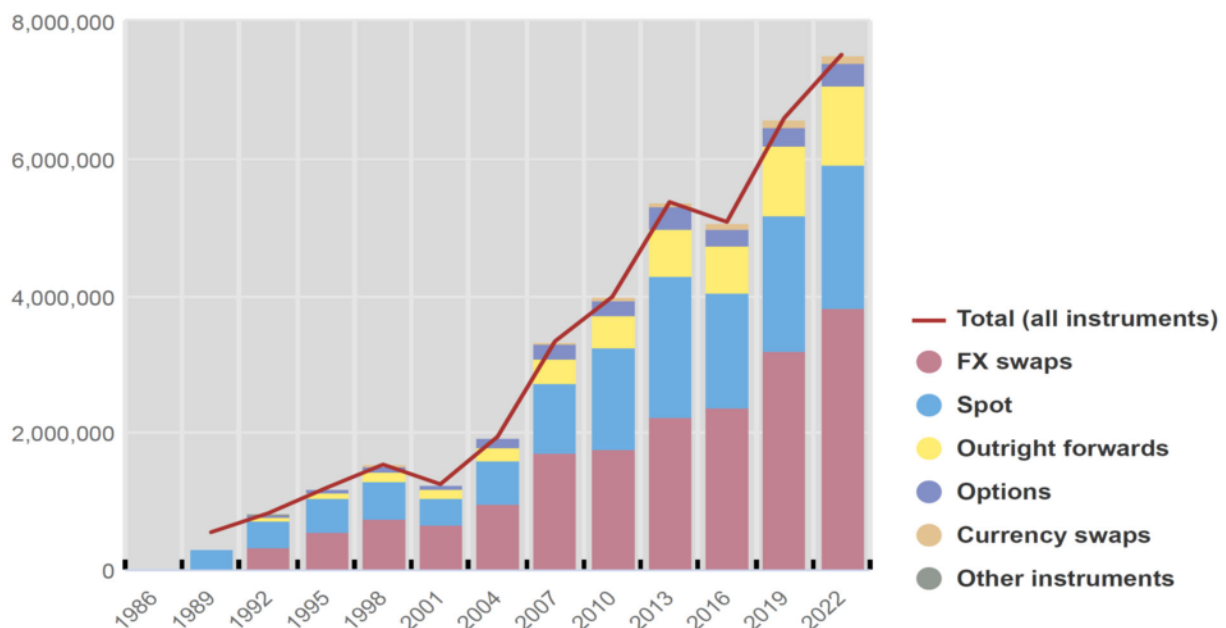
### 2.A Organization

The foreign exchange market is the generic term for the worldwide institutions that exist to exchange or trade the currencies of different countries. It is loosely organized in two tiers: the *retail tier* and the *wholesale tier*. The retail tier is where the small agents buy and sell foreign exchange. The wholesale tier is an informal, geographically dispersed, network of about 2,000 banks and currency brokerage firms that deal with each other and with large corporations. The foreign exchange market is open 24 hours a day, split over three time zones. Foreign exchange trading begins each day in Sydney, and moves around the world as the business day begins in each financial center, first to Tokyo, London and New York. Computer screens, around the world, continuously show exchange rate prices. A trader enters a price for the USD/CHF exchange rate on her machine, and can then receive messages from anywhere in the world from people willing to meet that price. It does not

matter to her whether the counterparties are sitting in London, Singapore, or, in theory, Buenos Aires. The foreign exchange market has no physical venue where traders meet to deal in currencies. When the financial press and economic textbooks talk about the foreign exchange market, they refer to the wholesale tier. In this chapter, we will follow this convention.

Currency markets are the largest of all financial markets in the world. A typical transaction in USD is about 10 million ("ten dollars," in dealer slang). In the last triennial survey conducted by the Bank of International Settlements (BIS) in April 2022, it was estimated that the average daily volume of trading on the foreign exchange market -spot, forward, and swap- was close to **USD 7.5 trillion** –a 13% increase, compared to April 2019, see Figure I.1 below. The daily average volume is about ten times the daily volume of all the world's equity markets and sixty times the U.S. daily GDP. The exchange market's daily turnover is also equal to 40% of the combined reserves of all central banks of IMF member states.

**Figure I.1**  
Growth of FX Market (1989-2022)



In April 2022, the major markets were London, with 38% of the daily volume, New York (19%), Singapore (9%), Hong Kong (7%), and Tokyo (4%). Zurich, Frankfurt, Paris, and Amsterdam are small players. The top traded currency was the USD, which was involved in 88% of transactions. It was followed by the EUR (31%), and the JPY (17%). The USD/EUR was by far the most traded currency pair in 2019 and captured 23% of global turnover, followed by USD/JPY with 18% and USD/GBP with 9%. Trading in local currencies in emerging markets captured about 18% of foreign exchange activity in 2022.

Given the international nature of the market, the majority (62%) of all foreign exchange transactions involves cross-border counterparties. This highlights one of the main concerns in the foreign exchange market: counterparty risk. A good settlement and clearing system is clearly needed.

### 2.A.1 Settlement of transactions

At the wholesale tier, no real money changes hands. There are no messengers flying around the world with bags full of cash. All transactions are done electronically using an international clearing system. SWIFT (Society for Worldwide Interbank Financial Telecommunication). operates the primary clearing system for international transactions. The headquarters of SWIFT is located in Brussels, Belgium. SWIFT has global routing computers located in Brussels, Amsterdam, and Culpeper, Virginia, USA. The electronic transfer system works in a very simple way. Two banks involved in a foreign currency transaction will simply transfer bank deposits through SWIFT to settle a transaction.

**Example I.1:** Suppose Banco del Suquía, one of the largest Argentine private banks, sells Swiss francs (CHF) to Malayan Banking Berhard, the biggest Malayan private bank, for Japanese yens (JPY). A transfer of bank deposits will settle this transaction. Banco del Suquía will turn over to Malayan Banking Berhard a CHF deposit at a bank in Switzerland, while Malayan Banking Berhard will turn over to Banco del Suquía a JPY deposit at a bank in Japan. The SWIFT messaging system will handle confirmation of trade details and payment instructions to the banks in Switzerland and Japan. Banco del Suquía will have a bank account in Japan, in which it holds JPY, and Malayan Banking Berhard will have a bank account in Switzerland, in which it holds CHF. ¶

The foreign accounts used to settle international payments can be held by foreign branches of the same bank, or in an account with a *correspondent bank*. A correspondent bank relationship is established when two banks maintain a correspondent bank account with one another. The majority of the large banks in the world have a correspondent relationship with other banks in all the major financial centers in which they do not have their own banking operation. For example, a large bank in Tokyo will have a correspondent bank account in a Malayan bank, and the Malayan bank will maintain one with the Tokyo bank. The correspondent accounts are also called *nostro accounts*, or *due from accounts*. They work like current (checking) accounts.

The foreign exchange market is largely an unregulated market. Only exchange-traded derivative contracts are subject to formal regulation. The U.S. banks participating in the spot market are supervised by the Federal Reserve System and must report their foreign exchange position on a periodic basis.

### 2.A.2 Activities

*Speculation* is the activity that leaves a currency position open to the risks of currency movements. Speculators take a position to "speculate" the direction of exchange rates. A speculator takes on a foreign exchange position on the expectation of a favorable currency rate change. That is, a speculator does not take any other position to reduce or cover the risk of this open position.

*Hedging* is a way to transfer part of the foreign exchange risk inherent in all transactions, such as an export or an import, which involves two currencies. That is, by contrast to speculation, hedging is

the activity of covering an open position. A hedger makes a transaction in the foreign exchange market to cover the currency risk of another position.

*Arbitrage* refers to the process by which banks, firms or individuals attempt to make a risk-profit by taking advantage of discrepancies among prices prevailing simultaneously in different markets. The simplest form of arbitrage in the foreign exchange market is *spatial arbitrage*, which takes advantage of the geographically dispersed nature of the market. For example, a spatial arbitrageur will attempt to buy GBP at 1.61 USD/GBP in London and sell GBP at 1.615 USD/GBP in New York. *Triangular arbitrage* takes advantage of pricing mistakes between three currencies. As we will see below, *cross-rates* are determined by triangular arbitrage. *Covered interest arbitrage* takes advantage of a misalignment of spot and forward rates, and domestic and foreign interest rates.

### 2.A.3 Players and Dealing in Foreign Exchange Markets

The players in the foreign exchange markets are speculators, corporations, commercial banks, currency brokers, and central banks. Corporations enter into the market primarily as hedgers; however, corporations might also speculate. Central banks tend to be speculators, that is, they enter into the market without covering their positions. Commercial banks and currency brokers primarily act as intermediaries, however, at different times, they might be also speculators, arbitrageurs, and hedgers. All the parties in the foreign exchange market communicate through traders or dealers.

Commercial banks account for the largest proportion of total trading volume. In 2019, the BIS reported that over 90% of all foreign exchange trading was either interbank (39%) or with other financial institutions including hedge funds, mutual funds, investment houses and securities firms (53%). Only 9% of the trading was done between banks and non-financial customers, for example big corporations. The high volume of interbank trading is partially explained by the geographically dispersed nature of the market and the price discovering process.

#### 2.A.3.i Dealers, Market Makers and Brokers

A dealer's main responsibility is to make money without compromising the reputation of his or her employer. To this end, they take positions, that is, buy and sell securities using their employer's capital. At the end of the day, a dealer should have the book squared –i.e., all positions closed.

Many dealers act as *market makers*. Therefore, they are obliged to provide bids and offers to both competitors and clients upon request. That is, any interested parties can ask market makers for a two-way quote, a *bid* and an *ask* quote. Once given, the quote is binding, that is, the market maker will buy foreign exchange at the bid quote and sell at the ask quote. The difference between the bid and the ask is the *spread*. Market makers make a profit from the bid-ask spread. Bid-ask spreads are close to .03%, which are significantly lower than spreads in any other financial market with the exception of the Treasury bill market. The arithmetic average of the bid rate and the ask rate is called the *mid rate*. Market makers profit from the high volume in the foreign exchange market.

Another channel for dealing is through a *broker*. For example, a Bertoni Bank dealer contacts a broker offering to buy, say, JPY 500 million. The broker provides two prices: a bid and an ask, without revealing the name of the counterparty. If Bertoni Bank accepts the ask, then the broker will reveal the name of the counterparty so the electronic settlement of the transaction can be performed. If the broker cannot provide immediately a price, the broker will shop around and see if there are any sellers for this volume. Brokers make a profit from a fixed commission paid by both parties. Instead of going to a broker, Bertoni Bank can contact another bank and try to purchase directly from the other bank. This transaction is an interbank or *direct dealing* transaction. Direct dealing saves the commission charged by the broker. Direct dealing also reveals information about the position of other parties. Discovering other dealers' prices help dealers to determine the position of the market and then establish their prices.

A study by Richard Lyons, published in the Journal of Financial Economics, in 1995, analyzes the transactions of an interbank spot trader over a five-day period. This trader completed 267 transactions per day, that is, one transaction every 67 seconds. The average daily volume traded by this trader was USD 1.2 billion. The majority of the transactions were direct deals; however, this trader tended to use brokers for larger than average transactions. In this study, Richard Lyons reports that the median spread between the bid and ask prices was DEM .0003, which represented less than 0.02 percent of the spot rate.

#### 2.A.3.ii      Electronic Trading

In 1992 Reuters introduced an automated, electronic brokerage system, Reuters Dealing 2000-2. The Reuters system allows dealers to enter their live prices. Prices appear on a screen as anonymous live quotations. Traders from around the world can hit a price from their terminals, then Reuters 2000 checks for mutual credit availability between the two counterparties and completes the transaction with ticket writing and confirmations.

Since the introduction of Reuters 2000, other competing systems were developed. Very quickly, two competitors appeared: MINEX, developed by Japanese banks and Dow Jones Telerate, and Electronic Brokering Service (EBS), developed by Quotron and a consortium of U.S. and European banks.

Electronic trading offers greater transparency compared to the traditional means of dealing described above. Spot foreign exchange markets have been traditionally opaque, given the difficulty of disseminating information in the absence of centralized exchanges. Before the introduction of electronic trading, dealers –like the dealer studied by Lyons- had to enter into a number of transactions just to obtain information on prices available in the market. Traders using an electronic brokerage system are able to know instantly the best price available in the market.

Electronic trading platforms gained market share almost overnight. The share of electronic trading went from 2% in 1993 to almost 20% in 2001. In the last BIS survey, in 2022, the share of electronic trading in the spot foreign exchange market was close to 60%. For certain market segments, such as those involving the major currencies, electronic brokers reportedly covered 90% of the interbank market. The bid-ask spreads for the major currencies have fallen to about two to three hundredths of a US cent.

Today, the electronic FX trading market is very competitive, with many well-established trading venues. The main electronic platforms are EBS, Thompson Reuters and Bloomberg. Other venues are FX Connect, Currenex, and 360T. The big banks (Barclays, Citi, UBS) use their own platforms, *single-bank platforms*, to internalize volume.

## 2.B The Products of the Foreign Exchange Market

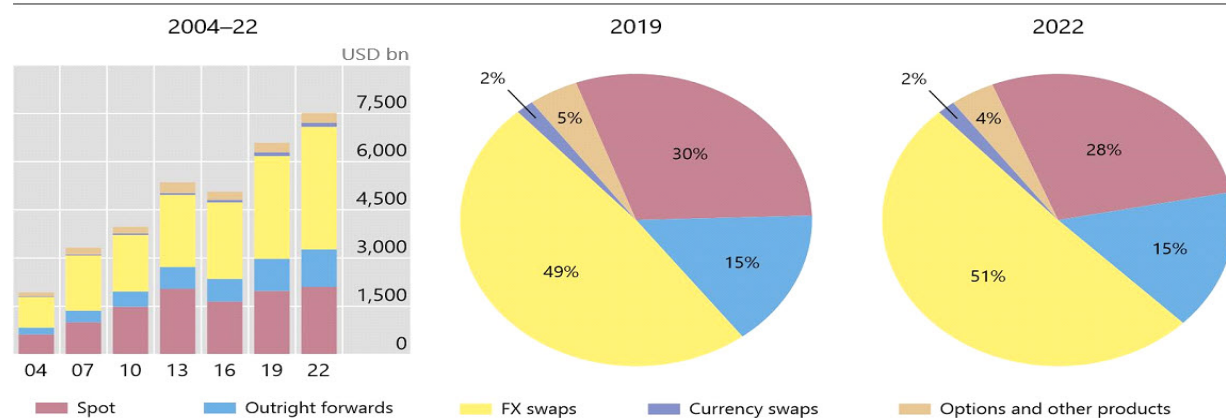
The global FX market is mainly divided in three big segments, which represent different FX instruments: Spot, Forward and FX swap. Figure I.2 below shows the distribution of the segments

**Figure I.2**  
Size of FX Market by Segment (Instruments)

Foreign exchange market turnover by instrument<sup>1</sup>

Net-net basis, daily averages in April

Graph 1



<sup>1</sup> Adjusted for local and cross-border inter-dealer double-counting, ie "net-net" basis.

Source: BIS Triennial Central Bank Survey. For additional data by instrument, see Table 1.

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### 2.B.1 The Spot Market

The spot market is the exchange market for payment and delivery today. In practice, "today" means today only in the retailer tier. Currencies traded in the wholesale tier spot market have customary settlement in two business days. Settlement is done electronically, through transfer of bank deposits.

**Example I.2:** Bank of America (BOFA) buys **GBP 1M** in the spot market at  **$S_t = 1.20$  USD/GBP**.

In 2 business days, BOFA will receive a GBP 1M deposit and will transfer to the counterparty a USD 1.2M deposit. ¶



In the interbank market, dealers quote the *bid* and the *ask*, willing to either buy or sell up to USD 10 million at the quoted prices. These spot quotations are good for a few seconds. If a trade is not done immediately over the phone or the computer, the quotes are likely to change over the next seconds. Traders use a particular system when quoting exchange rates. For example, the EUR/USD bid-ask quotes: 1.2397-1.2398. The "1.23" is called the *big figure*, and it is assumed that all traders know it. The last two digits are referred as the *small figure*. Thus, it is clear for traders the meaning of a telephone quote of "97-98." The difference between the bid and the ask is called the bid-ask spreads. Spreads are very thin in the FX market. For actively traded pairs, usually no more 3 *pips* –i.e., 0.0003.

**Example I.3:** A bid/ask quote of EUR/USD: 1.2397/1.2398 (spread: one *pip*). See screenshot from electronic trading platform EBS below:

The screenshot displays the EBS Spot trading platform interface. At the top, it shows 'EBS Spot', 'BBIL EBS', 'Mar 05 18:05', and 'Page 1'. The main area is divided into several sections:

- Currency Pairs:** A grid of currency pairs with their bid and ask quotes. For example, EUR/USD shows a bid of 1.2397 (small figure 97) and an ask of 1.2398 (small figure 98). The big figure is 1.23. Other pairs include USD/JPY, EUR/JPY, EUR/CHF, EUR/GBP, CHF/JPY, USD/CHF, GBP/USD, and USD/GBP.
- Trader Deals:** A section showing recent trades, including time, direction (BUY/SELL), quantity, and price.
- EBS Deals:** A section showing deals from EBS, including time, direction, quantity, and price.
- Overview:** A section providing a summary of the market, including time, direction, quantity, and price.
- News:** A section at the bottom displaying news headlines, such as '18:05 DJ Guidant Prepared To Launch Heart Failure Devices Outside The United States'.

Take the EUR/USD quote. The first number in black, 1.23, represents the “big figure” –i.e., the first digits of the quote. The big numbers in yellow, within the green/blue squares, represent the last digits of the quote to form 1.2397-1.2398. The number in black by the ask (“offer”) 98 (11) represents an irregular amount (say USD 11 million); if no number is by the bid/ask quote, then the “usual” amount is in play (say, USD 10 million, usually set by the exchange and may differ by currency). These irregular amounts have a better price quote than the regular amounts. The best regular quotes are on the sides 97 & 99. ¶

In 2022, the BIS estimated that the daily volume of spot contracts was USD 2.1 trillion (28% of total turnover). Again, the majority of the spot trading is done between financial institutions. Only 19% of the daily spot transactions involved non-financial customers. The high volume of interbank trading is partially explained by the geographically dispersed nature of the market. Dealers trade with one another to take and lay off risks, and to discover transaction prices. Discovering other dealers' prices help dealers to determine the position of the market and then establish their prices.

## 2.B.1.i Direct and Indirect Quotations

An exchange of currencies involves two currencies, either of which may arbitrarily be thought as the currency being bought. That is, either currency may be placed in the denominator of an exchange rate quotation. When exchange rates are quoted in terms of the number of units of domestic currency per unit of foreign currency, the quote is referred to as *direct quotation*. On the other hand, when exchange rates are quoted in terms of the number of foreign currency units per unit of domestic currency, the quote is referred to as *indirect quotation*. The indirect quotation is the reciprocal of the corresponding direct quotation.

Most currencies are quoted in terms of units of currency that one USD will buy. This quote is called "European" quote. Exceptions are the "Anglo Saxon" currencies (British Pound (GBP), Irish punt (IEP), Australian dollar (AUD), the New Zealand dollar (NZD)), and the EUR. This second type of quote is also called "American quote."

**Example I.4:** Quotations.

(A) Indirect quotation: JPY/USD (European quote).

Suppose a U.S. tourist wishes to buy JPY at Los Angeles International Airport. A quote of JPY 110.34-111.09 means the dealer is willing to buy one USD for JPY 110.34 (*bid*) and sell one USD for JPY 111.09 (*ask*). For each USD that the dealer buys and sells, she makes a profit of JPY .75.

(B) Direct quotation: USD/JPY (American quote).

If the dealer at Los Angeles International Airport uses direct quotations, the bid-ask quote will be USD .009002-.009063 per one JPY. ¶

It is easy to generate indirect quotes from direct quotes. And viceversa. As Example I.4 illustrates:

$$S(\text{direct})_{\text{bid}} = 1/S(\text{indirect})_{\text{ask}},$$

$$S(\text{direct})_{\text{ask}} = 1/S(\text{indirect})_{\text{bid}}.$$

The discussion about exchange rate movements sometimes is confusing because some comments refer to direct quotations while other comments refer to indirect quotations. Direct quotations are the usual way prices are quoted in an economy. For example, a gallon of milk is quoted in terms of units of the domestic currency. Thus, unless stated otherwise, we will use direct quotations. That is, the domestic currency will always be in the numerator while the foreign currency will always be in the denominator.

In the foreign exchange market, banks act as market makers. They realize their profits from the bid-ask spread. Market makers will try to pass the exposure from one transaction to another client. For example, a bank that buys JPY from a client will try to cover its exposure by selling JPY to another client. Sometimes, a bank that expects the JPY to appreciate over the next hours may decide to speculate, that is, wait before selling JPY to another client. During the day, bank dealers manage their exposure in a way that is consistent with their short-term view on each currency. Toward the end of the day, bank dealers will try to *square* the banks' position. A dealer who accumulates too large an inventory of JPY could induce clients to buy them by slightly lowering the price. Thus, because quoted prices reflect inventory positions, it is advisable to check with several banks before deciding to enter into a transaction.

The direct/indirect quote system is related to the domestic currency. The European/American quote system involves the USD. But if a Malayan trader calls a Hong Kong bank and asks for the JPY/CHF quote, the Hong Kong bank will quote a rate that does not fit under either quote system. The Hong Kong bank will quote a *cross rate*. Most currencies are quoted against the USD, so that cross-rates are calculated from USD quotations. For example, the JPY/GBP is calculated using the USD/JPY and USD/GBP rates. This usually implies a larger bid-ask spread on cross exchange rates. The cross-rates are calculated in such a way that arbitrageurs cannot take advantage of the quoted prices. Otherwise, triangular arbitrage strategies would be possible and banks would soon notice imbalances in their buy/sell orders.

**Example I.5:** Suppose Housemann Bank gives the following quotes:  $S_t = .0104-.0108$  USD/JPY, and  $S_t = 1.5670-1.5675$  USD/GBP. Housemann Bank wants to calculate the JPY/GBP cross-rates. The JPY/GBP bid rate is the price at which Housemann Bank is willing to buy GBP against JPY, i.e., the number of JPY units it is willing to pay for one GBP. This transaction (buy GBP-sell JPY) is equivalent to selling JPY to buy one USD -at Housemann's bid rate of  $(1/.0108)$  JPY/USD- and then reselling that USD to buy GBP -at Housemann's bid rate of  $1.5670$  USD/GBP. Formally, the transaction is as follows:

$$S_{bid,JPY/GBP} = S_{bid,JPY/USD} * S_{bid,USD/GBP} = [(1/.0108) \text{ JPY/USD}] * [1.5670 \text{ USD/GBP}] = 145.0926 \text{ JPY/GBP}.$$

That is, Housemann Bank will never set the JPY/GBP bid rate below 145.0926 JPY/GBP.

Using a similar argument, Housemann Bank will set the ask JPY/GBP rate (sell GBP-buy JPY) using the following formula:

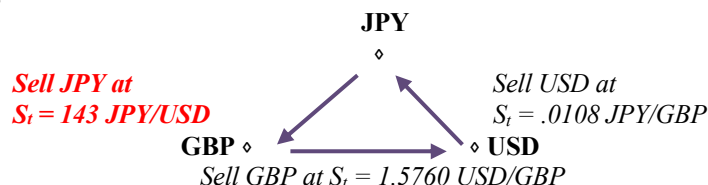
$$S_{ask,JPY/GBP} = S_{ask,JPY/USD} * S_{ask,USD/GBP} = [(1/.0104) \text{ JPY/USD}] * [1.5675 \text{ USD/GBP}] = 150.7211 \text{ JPY/GBP}.$$

**Example I.6: A Triangular Arbitrage Opportunity**

Consider, again, Example I.5. Suppose, now, that a Housemann Bank trader observes the following exchange rate quote:  $S_{ask,JPY/GBP} = 143.00$  JPY/GBP. We can see that the JPY is overvalued in terms of GBP, since it is below the arbitrage-free bid rate of 145.0926 JPY/GBP. The trader automatically starts a triangular arbitrage strategy:

- (1) Borrow USD 1 M
- (2) Sell USD 1,000,000 at the rate .0108 USD/JPY. Then, the trader buys JPY 92,592,592.59.
- (3) Sell JPY 92,592,592.59 at the rate of 143.00 JPY/GBP. The trader buys GBP 647,500.65.**
- (4) Sell GBP 647,500.65 at the rate 1.5670 USD/GBP. The trader buys USD 1,014,633.51.
- (5) Return USD loan, keep profits.

The triangle:



This operation makes a profit of USD 14,633.51 (or 1.46% per USD borrowed). The Housemann trader will try to repeat this operation as many times as possible. After several operations, banks will adjust the quotes to eliminate arbitrage.

Note: For the strategy (1)-(5) to be considered arbitrage, steps (1)-(5) should be done simultaneously. ¶

## 2.B.2 The Forward Market

The (outright) forward currency markets has a very old history. In the medieval European fairs, traders routinely wrote forward currency contracts. An outright forward transaction is simple. It is similar to a spot transaction, but the settlement date is deferred much further into the future. No cash moves on either side until that settlement date. That is, the forward currency market involves contracting today for the future purchase or sale of foreign currency.

**Example I.7:** Outright forward.

BOFA **sells GBP 1M forward** using a 7-day GBP forward contract at

$F_{t,7\text{-day}} = 1.205 \text{ USD/GBP}$ .

In 7 days, BOFA will receive a **USD 1,205,000** deposit and will transfer to the counterparty a **GBP 1M** deposit. ¶

Forward currency transactions are indicated on dealing room screens for intervals of one, two, three and twelve month settlements. Most bankers today quote rates up to ten years forward for the most traded currencies. Forward contracts are tailor-made to meet the needs of bank customers. Therefore, if one customer wants a 63-day forward contract a bank will offer it. Nonstandard contracts, however, can be more expensive.

Forward quotes are given by "forward points." The points corresponding to a 180-day forward GBP might be quoted as .0100-.0108. These points can also be quoted as 8-100. The first number represents the points to be added to the second number to form the ask small figure, while the second number represents the small figure to be added to the bid's big figure. These points are added from the spot bid-ask spread to obtain the forward price if the first number in the forward point "pair" is smaller than the second number. The forward points are subtracted from the spot bid-ask spread to obtain the forward price, if the first number is higher than the second number. The combination of the forward points and the spot bid-ask rate is called the "outright price."

**Example I.8:** Suppose  $S_t = 1.2070\text{--}1.2077 \text{ USD/GBP}$ . We want to calculate the outright price.

(A) Addition

The 180-days forward points are .0100-.0108 (8-100), then  $F_{t,180} = 1.2170\text{--}1.2185 \text{ USD/GBP}$ .

(B) Subtraction

The 180-days forward points are .0072-.0068 (68-4), then  $F_{t,180} = 1.2002\text{--}1.2005 \text{ USD/GBP}$ . ¶

Forward contracts allow firms and investors to transfer the risk inherent in every international transaction. Suppose a U.S. investor holds British bonds worth GBP 1,000,000. This investor believes the GBP will depreciate against the USD, in the next 90 days. This U.S. investor can buy a 90-day GBP forward contract to transfer the currency risk of her British bond position.

A forward transaction can be classified into two classes: *outright* and *swap*. An outright forward transaction is an uncovered speculative position in a currency, even though it might be part of a currency hedge to the other side of the transaction. A foreign exchange swap transaction helps to reduce the exposure in a forward trade. A swap transaction is the simultaneous sale (or purchase) of spot foreign exchange against a forward purchase (or sale) of approximately an equal amount of the foreign currency.

In 2022, the daily volume of outright forward contracts amounted to USD 1.16 trillion, or 15% of the total volume of the foreign exchange market. Unlike the spot market, 35% of transactions involved a non-financial customer. These non-financial customers typically use forward contracts to manage currency risk. Forward contracts tend to have very short maturities: 40% of the contracts had a maturity of up to 7 days. Less than 5% of the forward contracts had a maturity of over one year.

### 2.B.2.i Forward Premium and Forward Discount

A foreign currency is said to be a premium currency if its interest rate is lower than the domestic currency. On the other hand, a foreign currency is said to be a discount currency if its interest rate is higher than the domestic currency. Forwards will exceed the spot for a premium currency and will be less than the spot for a discount currency. For example, on November 9, 1994 (see Example I.10 below), the (forward) British pound was a discount currency. That is, the British pound is cheaper in the forward market.

It is common to express the premium and discount of a forward rate as an annualized percentage deviation from the spot rate. When annualized, the forward premium is compared to the interest rate differential between two currencies. The forward premium,  $p$ , is calculated as follows:

$$p = \frac{F_{t,T} - S_t}{S_t} * \frac{360}{T}$$

Note that  $p$  could be a premium (if  $p > 0$ ), or a discount (if  $p < 0$ ).

**Example I.9:** Using the information from Example I.11 below, we obtain the 180-day USD/GBP forward rate and the spot rate. The 180-day forward rate is 1.6167 USD/GBP, while the spot rate is 1.62 USD/GBP. The forward premium is:

$$p = \frac{1.6167 - 1.62}{1.62} * \frac{360}{7} = \textcolor{red}{-0.0041}.$$

The 180-day forward premium is **-0.41%**. That is, the GBP is trading at a .41% discount for delivery in 180 days. ¶

Remark: Think of  $p$  as the annualized return of:

- Selling forward the FC for T days
- Buying the FC spot today.

### 2.B.3 The Foreign Exchange Swap Market

As mentioned above, in a foreign exchange swap transaction, a trader can simultaneously sell currency for spot delivery and buy that currency for forward delivery. A foreign exchange swap involves two transactions. For example, a sale of GBP is a purchase of USD and a purchase of GBP is a sale of USD. A foreign exchange swap can be described as a simultaneous borrowing of one currency and lending of another currency.

Swaps are typically used to reduce exposure to the short-term risk of currency rate changes. For example, a U.S. trader wants to invest in 7-day GBP certificates of deposit (CDs). Then, the U.S. trader buys GBP spot, uses the funds to purchase the short-term GBP CDs, and sells GBP forward. The sale of GBP forward protects the U.S. trader from an appreciation of the USD against the GBP, during the life of the GBP CD. Traders also use foreign exchange swaps to change the maturity structure of their overall currency position.

The foreign exchange swap market is the segment of the foreign exchange rate market with the highest daily volume. In 2022, the BIS reported that FX swap transactions accounted for USD 3.81 billion out of the USD 7.5 trillion daily foreign exchange market turnover (51%). Foreign exchange swaps are usually very short-term contracts. The majority of them (70%) have a maturity of less than one week.

**Example I.10:** A U.S. trader wants to invest in a **GBP 1M** bond position for a 7-day period. Simultaneously, the U.S. trader

- (1) Buys **GBP 1M** spot at  $S_t = 1.20 \text{ USD/GBP}$
- (2) Buys the short-term **GBP 1M** bond position, and
- (3) Sells **GBP 1M** forward at  $F_{t,7\text{-day}} = 1.205 \text{ USD/GBP}$ .

Selling **GBP 1M** forward protects (“covers”) against an appreciation of the USD.

$$\begin{aligned}\text{Return of FX Swap} &= (1.205 - 1.20)/1.20 = 0.004167 \approx 0.42\% \text{ in 7 days} \\ \Rightarrow \text{Annualized} &\approx 0.004167 * 360/7 = 0.2143 (= p). \P\end{aligned}$$

#### ♦ **FX Swaps and Currency Swaps: Not the Same Thing**

The foreign exchange swaps should not be confused with the currency swaps to be discussed in Chapter XIV. ♦

### 2.B.4 Newspaper quotes

**Example I.11:** The *Wall Street Journal* publishes daily exchange rate quotes in the Money & Investments section (i.e., the third section). The first two columns provide the direct quotation and the last two columns provide the indirect quotation. On November 9, 1994, the *Wall Street Journal* published the following currency (spot and forward) quotes:

## EXCHANGE RATES

Tuesday, November 8, 1994

Country	U.S. \$ equiv		Currency per U.S. \$	
	Tues.	Mon.	Tues.	Mon.
<b>Argentina</b> (Peso).....	1.01	1.01	.99	.99
<b>Australia</b> (Dollar)....	.7532	.7535	1.3277	1.3271
<b>Austria</b> (Schilling)...	.09415	.09364	10.62	10.68
<b>Bahrain</b> (Dinar).....	2.6529	2.6529	.3770	.3770
<b>Belgium</b> (Franc) .....	.03219	.03203	31.07	31.22
<b>Brazil</b> (Real).....	1.1848	1.1848	.8440	.8440
<b>Britain</b> (Pound).....	1.6200	1.6137	.6173	.6197
30-Day Forward..	1.6193	1.6130	.6173	.6197
90-Day Forward..	1.6188	1.6125	.6177	.6202
180-Day Forward..	1.6167	1.6104	.6185	.6210
<b>Canada</b> (Dollar).....	.7375	.7369	1.3560	1.3570
30-Day Forward..	.7375	.7369	1.3560	1.3570
90-Day Forward..	.7378	.7273	1.3553	1.3563
180-Day Forward..	.7372	.7366	1.3565	1.3575

### 2.C Other Instruments to Manage Currency Risk

#### 2.C.1 Currency Futures

Currency futures are contracts traded in organized exchanges. They are standardized contracts that work like commodity futures. The International Monetary Market (IMM), a division of the Chicago Mercantile Exchange, lists contracts on major currencies with respect to the USD. The Philadelphia Board of Trade, the MidAmerica Commodity Exchange, and the Singapore International Monetary Exchange (SIMEX) also list currency futures contracts. Take the IMM's yen contract as an example. It settles in the months of March, June, September and December and calls for delivery of JPY 12.5 million at expiration. Margins are required.

#### 2.C.2 Currency Options

Currency options are both exchange-listed and over-the-counter (OTC). Call options are contracts giving the owner ("buyer") the right, but not the obligation, to purchase a quantity of foreign currency at a fixed price (strike price) for a limited interval of time. Put options give the buyer the right to sell. The seller of the option is called the writer. The buyer pays an amount called a "premium" to the seller for the put or call option. The Philadelphia Stock Exchange lists calls and puts on foreign currency. Calls and puts on currency futures contracts are listed on the IMM and SIMEX.



### III. Looking Ahead

Foreign exchange rate risk refers to the possibility that a domestic investor's holding of foreign currency will change in purchasing power when converted back to the domestic currency.

How can we measure the effect that changes in exchange rates have on the price of foreign assets and liabilities? A simple mathematical relation links the rates of returns measured in the local currency of the foreign asset with those in the home country, or domestic, currency:

$$(1+r_d) = (1+r_f)(1+s_{t,T}) \quad (I.1)$$

$r_d$ : return in the domestic currency from  $t$  to  $t+T$ .

$r_f$ : return on the foreign asset from  $t$  to  $t+T$ .

$s_{t,T}$ : change of the foreign currency in terms of the domestic currency from  $t$  to  $t+T$ .

**Example I.12:** During 1980-1999, the return on Japanese equities averaged an annual 10.92%. The Japanese Yen (JPY) appreciated against the USD, on average, an annual 4.03%. The return on Japanese equities for a U.S. investor can be found as:

$$r_{d-US \text{ investor}} = (1.1092)(1.0403) - 1 = .1539 \quad (15.39\%).$$

On the other hand, for a Japanese investor, investing in the U.S., the picture is different. During 1980-1999, the return on U.S. equities averaged an annual 12.60%. The USD depreciated against the JPY -3.87% annually. The return on U.S. equities for a Japanese investor was:

$$r_{d-Japanese \text{ investor}} = (1.1260)(.9613) - 1 = .0824 \quad (8.24\%).$$

That is, both U.S. and Japanese investors would have been better off by investing in the Japanese stock market during the period 1980 and 1999. ¶

As Example I.12 points out, currency fluctuations have a very important role in the determination of  $r_d$ . We want to study what are the determinants that influence  $s_t$ . We also want to study how to minimize the impact of unexpected changes in  $s_{t,T}$  on  $r_d$ . That is, we want to study how to hedge currency risk.

#### 4.A Introduction to Currency Risk Management: Hedging and Insuring

Hedging programs attempt to lessen or eliminate the risk of having a position denominated in foreign currency. For instance, a U.S. investor who buys an Argentine peso (ARS) bond could hedge the risk of a depreciation of the ARS by selling it forward. If the ARS were to fall (rise), there would be a decline (increase) in the U.S. dollar value of the bond. But this would be matched by a profit (loss) from the forward sale of the Argentine peso. Hedges are symmetric with respect to exchange rate movements.

Insurance programs reduce the risks associated with having a position denominated in foreign currency. When combined with the currency exposure of the underlying position, downside losses



are possible, but only to some maximum loss floor, and, of course, there is the chance of some upside profit. For instance, the same U.S. investor who buys an ARS bond could reduce the risk of a depreciation of the ARS by buying a call option on the USD. The call option gives the U.S. investor the right to buy USD at a set price. The investor will exercise the call option, only if it is convenient. If the ARS appreciates, the investor will let not exercise the call option. That is, insurance programs are asymmetric with respect to exchange rate movements.

### Example I.13: Hedging and Insurance

Situation:

It is January 2001. A U.S. investor is considering buying an ARS 100 bond. In January 2001, the exchange rate is 1 ARS/USD ( $S_{01}=1.00$ ). The ARS 100 bond has a return of 10% in ARS. That is, if she buys the ARS bond, investing USD 100, in January 2002 she will receive ARS 110. The U.S. investor, however, does not care about ARS returns, but USD returns. She is facing currency risk: the USD value of her ARS investment in January 2002 is uncertain, since  $S_{02}$  is not known. She is considering using currency forwards and currency options to reduce currency risk.

#### A. Hedging with Forward Contracts.

Suppose the U.S. investor decides to buy the ARS bond and at the same time she sells 110 ARS (buys USD) forward to an Argentine bank. The one-year forward contract trades at 1.02 ARS/USD.

The hedged USD return on this investment is:  $(110/1.02) - 100 = \text{USD } 7.84$ . (This return is known in January 2001, regardless of the spot rate in January 2002.)

Now, suppose the investor does not hedge and there is a devaluation of the ARS of 10%, that is,  $S_{02} = 1.10$  ARS/USD. The unhedged USD return is:  $(110/1.10) - 100 = 0$ .

#### B. Hedging with Option Contracts. (Insurance.)

Suppose that in January 2001, the same investor decides to buy the ARS 100 bond, but she prefers not to use a forward contract. Instead, she buys an ARS-put/USD-call option to sell ARS 110, with a strike price of 1.04 ARS/USD. The total premium for this option is ARS 1.

The minimum (exercised) return is:  $(110/1.04) - 100 - 1 = \text{USD } 4.76$ . (This minimum return is known in January 2001, regardless of the spot rate in January 2002.)

If  $S_{02} = 1.10$  ARS/USD, the investor will exercise the option and will obtain a return of USD 4.76.

If  $S_{02} = 1.00$  ARS/USD (no devaluation), the investor will not exercise the option and will obtain a return of  $(110/1.00) - 100 - 1 = \text{USD } 9$ . ¶

### ◆ Positions Limits and Currency Risk

Example I.13 illustrates the risk caused by an open (unhedged) position denominated in foreign currency. If the ARS appreciates, the investor will do very well. If the ARS depreciates, however, the investor could face significant losses. Because of currency risk, most banks set *position limits*, which are the maximum net foreign exposure a trader can have at any point in time. ◆

**Related readings:**

For a journalist perspective on the problems associated with fixed-exchange rates, see the first chapter of **Lost Prophets: An Insider's History of the Modern Economists**, by Alfred J. Malabre, Jr.

Part II of **The New Market Wizards** (interview with currency trader Bill Lipschutz), by Jack D. Schwager.

Parts of Chapter I were based on the following books:

**International Financial Markets**, by J. Orlin Grabbe, published by McGraw-Hill.

**International Financial Markets and The Firm**, by Piet Sercu and Raman Uppal, published by South Western.

**International Investments**, by Bruno Solnik, published by Addison Wesley.

### Exercises:

1. Using supply and demand graphs, show the effect on the USD/EUR exchange rate of the following events (*ceteris paribus*):
  - (a) The European inflation rate, relative to the U.S. inflation rate, increases.
  - (b) U.S. interest rates, relative to European interest rates, increase.
  - (c) A shift in tastes for European luxury goods.
2. During the second semester of 2000, many currencies dropped to historic record-lows against the USD. According to observers, these currencies were the victims of a strong demand for U.S. assets? Take the South African rand (ZAR). What is the effect of a strong demand for U.S. assets on the ZAR/USD? (Hint: You are an investor residing in South Africa. Draw a graph.)
3. On September 19, 2000, the *Wall Street Journal* reported that the ECB Vice President Christian Noyer said “the euro is dangerously undervalued.” How can the ECB intervene to increase the value of the euro? Draw a graph. Describe the effect of ECB intervention on European money markets.
4. In Example I.11, the WSJ provides direct and indirect quotes. For example, the USD/BRR direct quote is 1.1848 USD/BRR. Check if the indirect quotes are correct for the ARS and BRR.
- 5.- The Brazilian real is quoted 1.1848 BRR/USD, while the Argentine peso is quoted 1.01 ARS/USD. Provide the BRR/ARS cross-rate.
6. The ZAR is quoted as USD/ZAR=.2210-50, that is, the bid rate is .2210 and the ask rate is .2260. The Egyptian pound (EGP) is quoted as the USD/EGP=.3100-40. What is the implicit ZAR/EGP quotation?
7. A BT-Alex Brown trader observes the following quotes:  
 $S_{JPY/USD} = 123.39-49$  JPY/USD.  
 $S_{CHF/USD} = 1.7445-87$  CHF/USD  
 $S_{JPY/CHF} = 61.5450-107$  JPY/CHF.  
Can the BT-Alex Brown trader profit from these quotes?
8. Assume a Hong Kong dollar (HKD) is worth .15 Swiss francs (CHF), that is, the spot rate is .15 CHF/HKD. Also, assume a CHF is worth 96 Japanese Yen ( $S_t = 96$  JPY/CHF).
  - i. What is the cross rate HKD/JPY?
  - ii. Compute the 90-day forward discount or premium for the JPY/HKD whose 90-day forward rate is 18 JPY/HKD. State whether your answer is a discount or premium.
9. Describe the effects of the following events under the QTM:
  - i. A country is flooded with gold, while income remains constant.
  - ii. Income increases, while the stock of gold remains constant.
  - iii. The velocity of money increases, while income and stock of gold remain constant.
10. The return of a Polish investment in USD was 22.87% during a nine-month period. During the same nine-month period the Polish zloty (PLN) devalued 5.23% against the USD. What was the return for the same period for a Polish investor (i.e., in PLN)?

11. Go back to Example I.13.

Suppose the investor buys a call option to buy USD 100, with a strike price of 1.05 ARS/USD. The premium was ARS .90.

- a) What is the minimum (exercised) return for our investor?
- b) If  $S_{02} = 1.04$  ARS/USD, what is the net return of the operation?
- c) If  $S_{02} = .94$  ARS/USD, what is the net return of the operation?