THE FOREIGN EXCHANGE MARKET

1. The Structure of the Market

The foreign exchange market is an example of a speculative auction market that has the same "commodity" traded virtually continuously around the world. There is no physical location of the market; instead trading takes place by telex, telephone, email, fax, etc. Most of the trading is performed through an interbank market where the major banks trade with each other. The largest trading centers in the world are in London, New York and in Tokyo; and these centers account for approximately 70% of the total trading. The foreign exchange market is operating 24-hours around the world. See the time zones of the trading centers in *Handout 1*: The New York market opens about 5 hours after the opening of the London market, the Tokyo market opens about 2 hours after the close of the New York market. However, activity in Auckland, Wellington, and Sydney occurs between the North American market and the Asian markets.

Intraday Activity

The intraday activity shows the trading activity of the foreign exchange markets around the world during a day or 24 hours. This intraday activity of foreign exchange markets are closely related to the business hours of each foreign exchange market around the world. Since the activity in the foreign exchange market follows the opening and closing of business hours around the world, the intraday activity of every weekday has the same pattern.

Handout 2 shows the intraday activity of the worldwide foreign exchange markets during 24 hours. It shows the hourly average number of quotes over the business week. Weekends are excluded since the trading activities are relatively small.

New Type of High Frequency Data

Financial data have been the subject of many studies, and most of the work has analyzed daily or lower frequency data. In the last few years, however, the financial studies have dealt with higher frequency intraday prices since gathering financial data has become easier due to the fast developing computer technology.

In particular, foreign exchange markets, which have no one geographical location and no business hour limitation provide a set of complete intraday time series data covering a worldwide 24 hour market.

This new type of high frequency intraday prices is important for the empirical analysis of the foreign exchange markets. First, the large number of observations enhances the significance of the statistical study. Second, it cam increase the ability to analyze finer details of the behavior of different market participants.

Market traders in any bank are located in a trading room, where they have access to a telex, telephones and monitors that display a wide a set of information, including economic news as it is released. Most trades are made over the telephone and are subsequently confirmed in writing. If a mistake occurs, traders customarily split the difference. A trader relies heavily on her credibility and a trader who gained a reputation for reneging on deals would soon end up isolated and be unable to trade.

The volume of the market has grown substantially since 1973 and is easily the largest financial market in the world. The estimated volume of trading in 2000 is approximately $2,000bn per day, which is approximately equivalent to the value of annual US GNP being transacted every eight days. It has been estimated that as much as 95% of the trading of currencies is due to speculation and arbitrage. Despite the growth of international trade, the exchange of currencies for the transactions of goods and services has become a distinctly secondary activity in the foreign exchange market.

Generally, the foreign exchange market can be divided into five basic currency markets: the spot market, the forward market, the futures market, the options markets and Eurocurrency market

2. Benefits of foreign exchange markets for trading currencies

The foreign exchange rate market enables domestic people to exchange the local currency for foreign currencies and in turn, allow them to purchase foreign goods and services. (a medium of exchange for international trade)

The existence of the foreign exchange market and exchange rates allows people to compare the value of goods produced in different countries. (an international unit of account)

The foreign exchange market provides some effective method to avoid the risks on domestic currency such as making an account in foreign banks. (the role of store of value)

The foreign exchange market lets firms and individuals settle the foreign currency denominated payments or accept the receipts. (a mean to settle international payment)

3. Participants in the foreign exchange markets

The most active players in the foreign exchange market are central banks, commercial banks, multinational firms and individuals

Central banks are the dominant player in the foreign exchange market because of the policy of intervention in the market: they can trade foreign currency reserves to manage the exchange rates or finance the trade deficits. And, Central banks can issue or restrict the supply of currencies and change the exchange rates.

Commercial banks are also very active in the foreign exchange market for their own profits and the interests of customers. Actually, the foreign exchange dealing is a considerable source of profits for a commercial bank.

Multinational firms participate in the foreign exchange market to settle foreign currency transactions, or to get profits from foreign exchange.

Individuals partake in the foreign exchange market as customers, traders or brokers. A trader buys or sells foreign currencies to purchase foreign goods or to get profits. A broker execute orders in the foreign exchange market for customers on the trading floor and receive a service fee.

4. Spot Rates

The price of contemporaneously transacting one currency for another. The spot market is a continuous market and is generally recorded at a particular point of time.

The Wall Street Journal reports spot price information at 4:00pm the previous day from the Bankers Trust Company. Unlike many other financial markets, e.g. the stock market, the actual transactions prices are generally unobserved. Instead, quotation prices in terms of bid and ask rates are observed. These quotations are based on large trades of $1m or more in a basically wholesale market for money. There are two possible types of quotations:

American terms, where the spot rate is quoted in terms of the number of US dollars per unit of foreign currency. Practically, the exchange rate between the US and UK, which is always quoted in terms of $/£, i.e. the number of $ for one £.

European terms, where the spot rate is quoted in terms of the number of foreign currency units per US dollar. The standard convention is to quote all rates involving dollars in European terms

Wall Street Journal expresses the rates as "Currency per US $", which is in European terms and also as "US dollar equivalents", which is clearly in American terms. For example, on Wednesday, September 9, 1998, US$1 = HK$ 7.7495, or the HK$/US$ = 7.7495. But, the US $ Equivalent would be HK$1 = US$0.1290, or the US$/HK$ = 0.1290.

One rate is **the reciprocal** of the other, i.e. 1/(7.7495) = 0.1290.

Spreads

There are two forms of exchange rates quoted in the market:

Bid Rate: is the price at which banks are willing to buy currency.
Ask Rate: (or Offer Rate), is the price at which banks are willing to sell currency.

Clearly, the bid rate is always lower than the ask rate.

Spread = Ask - Bid

Percent spread = 100[(ask - bid)/ask]

When the spot price is quoted as S_t = 7.4373/90, the interpretation is that the bid price is 7.4373 and the ask price is 7.4390, i.e. a spread of .0017.

The magnitude of the spread depends on the particular currency, the particular trader, the banks assessment of market conditions, etc. However, the major determinant of the size of the spread is the currency being traded. For the major currencies, a typical spread would be about 0.1% to 0.4%. For a currency in a thin market, the spread would be expected to increase, so that the spread is closely associated with **risk**.

Cross Rates are the exchange rates between two currencies neither of which are being used as the numeraire by a market.

For example the **implied cross rate** between the French Franc FF and the HK $ on September, 9 1998 can be found from the calculation,

US$1 = HK$ 7.7495 = FF 5.7715

Hence HK$1 = FF[5.7715/7.7495] = FF0.7448

The actual cross rate in the market trading FF for pounds would be virtually identical to this rate; the only difference would represent transactions costs.

When the value of one currency rises in terms of the other currency, it is said that the currency is **appreciated** while the other currency is **depreciated**. For example, when we compare the value of the HK$/US$ on January 15, 1995 to that on January 15, 2002, almost 5 years before, US$1 = HK$ 7.5 in January 1995 and US$1 = HK$ 7.8 in January 2002. Hence compared to 5 years previously, the $ is worth more, i.e. it will buy more HK$, so the US$ has **appreciated** against the HK$. Analogously, the HK$ has **depreciated** against the US$ and so the HK$ will buy less $ in 2002 compared to 1995.

Nominal Exchange Rates: is the usual method for quoting the spot exchange rate, i.e. the current price of one currency versus another.

Real Exchange Rate

The regular nominal exchange rate is adjusted by the relative price levels in two countries,

$S_t [P^*_t/P_t]$,

where P^* measures the foreign countries price level and P is the US price level. The calculation is often based on the CPI (Consumer Price Indexes) for the two countries. The concept of the real exchange rate is closely linked to the theory of purchasing power parity and will be discussed in more detail when we consider the determinants of freely floating exchange rates.

Effective Exchange Rate (Exchange rate index)

The nominal spot exchange rate is <u>bilateral</u> in the sense it defines the value of one currency against one other. The effective exchange rate is a weighted average of a currency ($) against a basket of other currencies. The weights are usually chosen on the basis of the shares of trade. It provides a broader measure of the currency's value against many other currencies. The examples are SDRs (Special Drawing Rights) in IMF and ECU (European Currency Unit) in EMS (European Monetary System).

5. Arbitrage in the spot markets

Arbitrage is a "riskless profit" and eliminates any possible market imperfections.

A**rbitrageur** is a person who engages the arbitrage activity in the foreign exchange market.

Two-way arbitrage

Two-way arbitrage refers to profiting from the difference in spot quotations between two currencies.

If the $/DM is $0.55 in New York and for $0.65 in London, a profit seeking arbitrageur would buy marks in New York where they are relatively cheap and sell them in London. He will get a profit of $0.1 if there is no transaction costs. But, if the transaction cost exceeded $0.1 then no arbitrage activity would occur.

Triangular arbitrage

Triangular arbitrage refers to the immediate repurchasing of a currency previously sold in a different currency. To identify the triangular arbitrage opportunities, the arbitragers should compute the reciprocal rates and the cross rates.

In NY market, the buying spot rate for US$/DM = 0.55, and US$/HK$ = 0.13. But, in HK, the selling spot rate DM/HK$ = 0.28. Then, in NY, the bid cross rate for DM/HK$ = 0.24 [(1/0.55)*(0.13)]. So, there exists a difference in the two markets. The arbitrager can get profits from the following transactions;
i) selling HK$1 at DM0.28 in HK, ii) buying US$ 0.154 with DM0.28 and iii) buying back HK$1.18with US$0.154 Thus, he will get a profit of HK$ 0.18 if there is no transaction cost.

It is very unlikely that any significant arbitrage opportunities would be available for a small investor; however large institutions such as commercial banks may possibly be able to arbitrage.

In the arbitrage transactions, there is no risk involved because the transactions are operated simultaneously on the two markets and the relevant prices are known.

6. Statistical Analysis of Exchange Rates

The spot rate at time period t is denoted by S_t and can be measured or observed on a high frequency (minutes or hourly) basis or a low frequency (daily, weekly, monthly or annually) basis.

The change in the spot exchange rate from period t to period t+1 is:

$$\Delta S_{t+1} = S_{t+1} - S_t,$$

The **percentage rate of change** is, $100\{[S_{t+1} - S_t]/S_t\}$

The annual rate of growth. If the exchange rate in period t+n is S_{t+n}, then the annual rate of growth is,

$$[S_{t+n}/S_t]^{1/n} - 1,$$

which is the n'th root of the ratio of the beginning and end period prices minus one. This gives the annual rate of growth.

Over a three year period the dollar appreciated from DM1.4960 to DM1.7494; this implies an annual rate of appreciation of:

$$[1.7494/1.4960]^{1/3} - 1$$

$$= .0535436,$$

which implies an annual rate of appreciation of 5.35% for the dollar versus the DM. We can think of this calculation as,

$$(1.0535436)(1.0535436)(1.0535436)(1.4960)$$

$$= 1.7494.$$

Of course in reality the dollar will probably not have appreciated by exactly 5.35% each year; but this is the implied average rate of appreciation each year.

Natural Logarithms in Financial Research: ln (a) = c

Natural logarithms imply the continuous compounding of interest. Financial researchers utilize the logarithms due to the following two reasons; first, since many relationships in financial research are products or ratios, by using the logarithms, the complex relationships can be presented by simple linear, and additive relationships. Second, the change in the logarithm of some variable is commonly used to measure the percentage change in the variable. So, the percentage change of exchange rate is, $[S_{t+1} - S_t]/S_t$. But, by using the logarithm, it can be calculated, $\ln (S_{t+1}) - \ln (S_t)$. This is very convenient feature of logarithm.

7. Risks in Foreign Exchange Transactions

Since exchange rates change on a minute by minute basis, there is a large degree of risk associated with planning future foreign currency transactions. Suppose, for example, that you are a wine merchant and have just agreed with a wine producer in Bordeaux, France to import two million French Francs, (FF2 million) worth of wine. The wine will not be bottled and ready for shipment until six months time and the French wine maker wants paying FF2,000,000 in six months time. The current exchange rate is S = FF/$ = 5, so that at today's rate, the cost of buying the wine will be:

$$FF2{,}000{,}000 = \$(2{,}000{,}000/5) = \$400{,}000.$$

However, you do not have to pay the French wine producer until six months time when the wine is delivered. Suppose the exchange rate in six months time is FF/$ = 6; so that the $ has appreciated against the French franc. The cost is then

$$FF2{,}000{,}000 = \$(2{,}000{,}000/6) = \$333{,}333,$$

so that the strategy of waiting to pay in six months time will be beneficial for you. However, it is also quite possible that the US $ may depreciate against the French franc over the next six months, so that the exchange rate may be FF/$ = 4 in six months time. The cost is then

FF2,000,000 = $(2,000,000/4) = $500,000.

This simple example illustrates the uncertainty associated with future foreign currency transactions and its impact on planning your business finances. The variability of the possible future costs is a form of risk, since it is potentially costly for you. You can eliminate the risk by **hedging (covering the risks)** in the forward market.

8. Forward Rates

Similarly, to the market for spot rates, there is also a detailed market for participants who want to trade currencies for a certain number of days time in the future. The time before the contract is fulfilled is known as the **maturity time** of the forward rate and 30, 90 and 180-day contracts exist for the major currencies. In a forward contract, a bank and a customer call for delivery at a fixed future date a specified amount of foreign currency against the dollar. Some currencies that are in thin markets, or which are from an emerging market, e.g. Indonesia, do not have forward markets. In this case any forward transaction would have to be through a private negotiation with a bank.

In a typical forward market transaction, an importer buys machinery from Germany with a payment of DM1m due in 90 days time. The importer is then short in DM, i.e. she owes DM for future delivery. If the present price of the DM is $0.57; however over the next 90 days the DM may appreciate against the dollar raising the dollar cost of the imports. The American importer can safeguard this by immediately taking out a 90 day forward contract with a bank at a price of say, DM1 = $0.56. According to the forward contract the bank will give the importer DM1m now and the importer will give the bank $0.56 which is the dollar equivalent of the DM1m at the forward rate. Technically, the importer is going long in the forward market, i.e. is buying DM for future delivery.

Forward Premium

Sometimes dealers quote forward rates as the actual price, which is known as being in Outright terms. In the interbank market traders quote the forward rate in discount or premium form. The forward differential is also known as the Swap rate.

A foreign currency is at a forward premium, when $F_{t,T} > S_t$.

A foreign currency is at a forward discount, when $F_{t,T} < S_t$.

Suppose S_t = DM/$ = 2.4500 and the $F_{t,1}$ = 2.4400, then the market expects the DM to appreciate vis a vis the dollar and hence the dollar to depreciate against the DM. The DM is said to be at a **premium** and the dollar at a **discount**.

A currency at a premium has a forward contract that it more valuable.

A currency at a discount has a forward contract that is less valuable.

Differential is (S_t - $F_{t,T}$); note that both the spot and forward rate are contemporaneous.

Forward premium is $(F_{t,T} - S_t)/S_t$

If F_t is the forward rate for delivery in T days time, then

Annualized Forward premium = $100(360/T)[(F_{t,T} - S_t)/S_t]$

is the expected annual rate of appreciation (or depreciation) of the spot rate implied by the forward market. Behind this concept is the implicit assumption that the forward rate is a good prediction of the future spot rate.

Representations of Forward Rates

If the forward rate is said to be 30/20, then since the first number (30), is larger than the second number (20), the forward rate is <u>at a discount</u> and the two numbers must be subtracted from the respective spot bid and ask rates to find the forward rate. Hence the bid forward rate is 2.4343 and the ask forward rate is 2.4370, i.e. a spread of .0027.

In the above example the forward premium was subtracted. If the forward premium had been added the corresponding forward rates would have been 2.4303 and 2.4310, which has a spread of only .0007. However, the forward rate always has a larger spread than the spot rate, so the first interpretation must be correct.

Suppose the forward rate had been expressed as 20/30. Then, the forward rate is <u>at a premium</u>. Since the first number is smaller than the second, the premium must be added to the spot bid and ask rates. Hence the forward bid rate is 2.4393 and the forward ask rate is 2.4420.

In most financial markets the forward rates are quoted in terms of the premium or discount to be added or subtracted to the spot rate.

Forward rate and Arbitrage

The easiest way of understanding the use of forward rates is to consider the following example of how forward rates could be used for arbitrage in the spot market and domestic and foreign bond markets.

Suppose there is the following situation; the interest rate for HK one-year maturity bond in HK$ is 12%, the interest rate for US one-year maturity bond in US$ is 7%, the spot exchange rate (HK$/US$), S_t is 7.8 and the one-year forward rate (HK$/US$), $F_{t,1}$ is 7.5. So, there is an interest rate differential in favor of HK so that funds will flow to HK from US.

Then, the expected rate of depreciation of HK$ can be calculated from the formula,

$100*(360/T)[(F-S)/S] = 100*(7.5 – 7.8)/7.8 = 3.8\%$ where T = 360 since the forward rate maturity time is one year or 360 days.

The arbitrageur will then implement the following five steps to make a riskless profit.

1) Borrow US$ 1M from a bank in NY at the interest rate of 7%. So, at then end of the year the arbitrageur will have to pay US$1.07M (1M*0.07).
2) Convert the US$1M into HK$ at the spot rate of $S_t = 7.8$ to yield HK$ 7.8M.(1M*7.8)
3) Invest the HK$7.8M to a bank in HK at the interest rate of 12% for one year. Then, at the end of the year, his investment will be worth HK$(7.8M)*(1.12) = HK$ 8.7M
4) And, simultaneously with another forward transaction, he sells the HK$ 8.7M forward at the rate of F = 7.5 for delivery in one year. This will yield US$ 1.16M (HK$ 8.7M/7.5) after one year.
5) At the end of one year, he will collect the HK$ 8.7M from HK bank and pay it for US$ 1.16M from the forward transaction. Then, he will use US$1.07M to repay the loan from NY bank. Thus, the arbitrageur will earn US$ 0.09M.

This example shows how the arbitrageur makes a profit without undertaking any risk. The profit of US$ 0.09M is completely free of any uncertainty or risk. But, in practice, the profits are so small that only large arbitrageurs can get the arbitrage opportunity. Mostly, the forward transactions are used to hedge (to avoid the risk of the loss) in the foreign exchange transactions.

****New Type of High Frequency Data**

Financial data have been the subject of many studies, and most of the work has analyzed daily or lower frequency data. In the last few years, however, the empirical studies have dealt with higher frequency intraday prices since gathering financial data has become easier due to the fast developing computer technology.

In particular, foreign exchange markets, which have no one geographical location and no business hour limitation provide a set of complete intraday time series data covering a worldwide 24 hour market. The exchange rates used for most studies are the quotes from large data suppliers such as Reuters. Since the actual transaction prices and trading volume are not known to the public, quotes are intended to be used by market participants as a general indication of the markets and these indicative prices appear to closely match the true prices in the markets. This new type of high frequency intraday prices is important for the empirical analysis of the foreign exchange markets. First, the large number of observations enhances the significance of the statistical study. Second, it cam increase the ability to analyze finer details of the behavior of different market participants.

The properties of this new type of high frequency data differ from those of the daily or the lower frequency data. The new data shows daily and weekly seasonal heteroskedasticity, so that there is a seasonal behavior of volatility rather than the prices themselves. The daily seasonality appears to be particularly significant. The pattern is clearly correlated to volume of trading in the main financial markets around the world.

When the new type of high frequency data is used, there can arise "database holes" due to human and technical errors in the communication. So, in order to obtain the prices at a time *t* within a hole, it appears to be more appropriate to use the linear interpolation method for interpolating in a series with independent random increments.

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