# *Foreign Exchange (Forex)*

- Forex is not an asset.
- Forex quotes.
- Forex appreciation and depreciation.
- Forex forward contracts, the carry trade and interest rate parity.
- Forex and central bank monetary policy.

# *Foreign Exchange Markets*

Foreign exchange markets are also known as currency, FX and forex markets. They are the biggest markets in the world by turnover.

The FX market is all over-the-counter (OTC). You have to deal with a bank or an FX broker to actually buy and sell currencies.

Other markets that are also mostly OTC are the debt markets, land and property markets and many types of derivatives such as swaps and forwards.

In contrast, exchange traded financial assets include shares and futures. Exchange-traded assets are more standardised.

# *FX is not an Asset*

Foreign exchange rates are not an asset, they're a ratio of the price of one currency against another, usually the United States of America's Dollar (USD).

If someone says that they're 'investing in foreign exchange', it usually means that they're actually investing in short term debt denominated in another country's currency.

If an Australian buys US dollars, they're probably buying short term debt denominated in USD and selling short term debt denominated in AUD.

To ‘buy US dollars’ an Australian could:

- Borrow AUD from an Australian bank. This is the Australian person selling a **new** AUD short term debt contract to the bank, so the person will have a debt liability. Alternatively, the Australian could withdraw AUD deposits from their Australian bank which is reduced lending to that bank. Here the person is selling their **existing** AUD short term debt asset to the bank; After this, the Australian person can:
- Lend USD to a US bank. This is the same as buying the bank’s USD-denominated short term debt, also known as depositing USD into a US bank. It’s normally done electronically, there’s no need to transport notes and coins.

However, instead of buying US banks' short term debt, the investor could also attain exposure to fluctuations in the USD by buying stocks or long term debt or land or any other asset in the US where assets are denominated in USD.

Another way to gain exposure to foreign currencies is to use derivatives such as FX forward agreements or options. Their valued is determined by the underlying exchange rate.

# *Investable Assets in Finance*

It can be useful to think about finance in terms of three broad categories of investable assets, differentiated by their payoffs, liquidity and the type of market they trade in:

- Equity
  - Common stock, also known as ordinary stock.
- Debt
  - Short term money market debt such as bank accepted bills (BAB's), certificates of deposit (CD's) and promissory notes (PN's or commercial paper) which usually have an original maturity of less than one year. This market is also known as the 'cash market' since it's very liquid and short-term.

- Long term bond market debt such as bonds and debentures which have an original maturity of more than one year.

- Property
  - Land, buildings, apartments, equipment.

Hybrids such as preference stock and convertible bonds can be thought of as another category of investable asset.

Derivatives such as options, futures, forwards and swaps are another important category but since they are usually used for hedging and speculating they are not thought of as investable assets.

Some other investable assets which are not included are things like human capital which is too difficult to measure.

# *Foreign Currency Quotes*

Confusingly, FX rates are quoted in different ways.

A quote of "USD/JPY **100**" means 1 United States Dollar (USD) equals 100 Japanese Yen (JPY), or 100 JPY = 1 USD.

Often, the slash (/) character is removed, so the same quote could be expressed as "**USDJPY 100** "

Here, the USD is the **base** currency, also called the:

- primary, transaction, price or currency 1 (CCY1).

The JPY is the **term** currency, also called the :

- quote, counter or currency 2 (CCY2).

Beware, because many of the methods of quoting currencies are not consistent with how scientific units are normally quoted.

# *Scientific Units*

Mathematical manipulations of foreign currency are best done by listing the units **after** the number, similar to how engineers and scientists do with, say, a car that travels at a speed of 10 m/s, which means it covers 10 metres per second. So if the car travelled for 3 seconds it would cover:

$$3s \times \frac{10m}{s} = 30m$$

Notice how the seconds units can be cancelled to get the result which is clearly a distance with units of metres (m). Using this convention we can easily do mathematical manipulations of foreign exchange.

# *Mathematical Manipulations of FX*

If a quote of "**USDJPY 100**" is given, this means that 1 USD equals 100 JPY.

The exchange rate as a mathematical quantity would be:

100 JPY/USD.

To avoid confusion, some economists write this as:

100 JPY per USD, where per means divide.

To convert 50 USD to JPY:

$$50\ USD = 50\ USD \times 100 \frac{JPY}{USD}$$

$$= 50 \times 100\ JPY = 5{,}000\ JPY$$

To convert 50 JPY to USD:

$$50\ JPY = 50\ JPY \div 100 \frac{JPY}{USD}$$

$$= 50\ JPY\ /\ \left(\frac{100\ JPY}{1\ USD}\right)$$

$$= 50\ JPY \times \left(\frac{1\ USD}{100\ JPY}\right)$$

$$= \frac{50}{100}\ USD$$

$$= 0.5\ USD$$

# *Currency Quotes: European Terms and American Terms*

Traders in the inter-bank FX market often quote currencies against the USD and these quotes may be given in 'European terms' or 'American terms'.

By convention, most currencies are quoted in 'European terms', such as 100JPY = 1USD and 0.9630CAD = 1USD. Confusingly, FX quotes in 'European terms' have nothing to do with the EUR currency or Europe at all. It only means that the FX quote is given as the amount of currency that can be traded for one USD. Other examples are or 6.8RMB = 1USD and 47INR = 1USD.

Conversely, currencies quoted in 'American terms' are expressed as the number of USD per one unit of the currency. By convention, the 'Queen's currencies' (GBP, AUD, NZD) and the euro (EUR) are normally quoted in American terms. Examples are:

- 1.5 USD per GBP;
- 0.73 USD per AUD;
- 0.67 USD per NZD; and
- 1.1 USD per EUR.

# *Currency Quotes: Direct and Indirect*

Direct quote: domestic currency per one unit of foreign currency.

Indirect quote: foreign currency per one unit of domestic currency.

The following are all given in 'European terms' (or 'per USD'), which are **direct** quotes of the JPY currency from a Japanese person's perspective, and **indirect** quotes from an American's perspective:

| | |
|---|---|
| 100JPY/USD | 100 JPY per USD |
| 100 JPY = 1 USD | USDJPY100 |

The following are all given in 'American terms' (or 'in USD') which are **indirect** quotes of the JPY currency from a Japanese person's perspective, and a **direct** quote from an American's perspective:

| | |
|---|---|
| 0.01USD/JPY | 0.01 USD per JPY |
| 0.01 USD = 1 JPY | JPYUSD 0.01 |

The Australian Dollar (AUD) is usually given in American terms (0.9686USD/AUD or 0.9686USD = 1AUD) which is an indirect quote from the perspective of an Australian. It is a direct quote from an American's perspective.

Since the same numerical quote can be 'direct' to one person and 'indirect' to another, it's best to avoid these labels.

Instead, many banks and FX dealers prefer to state a currency quote as either:

- 'per USD' which is European terms, like 100JPY = 1USD, or
- 'in USD' which is American terms, like 0.8USD = 1AUD.

| Currency Quote Types | | | | |
|---|---|---|---|---|
| American terms: USD in numerator<br>Indirect quote from local's perspective. Direct quote from American's perspective | | | | |
| Currency | Algebraic ratio form | Per or ratio form | Equality form | Trader form |
| JPY | 0.01USD/JPY | 0.01 USD per JPY | 0.01 USD = 1 JPY | JPYUSD0.01 |
| AUD* | 0.8USD/AUD | 0.8 USD per AUD | 0.8 USD = 1 AUD | AUDUSD0.8 |
| GBP* | 2USD/GBP | 2 USD per GBP | 2 USD = 1 GBP | GBPUSD2 |
| RMB | 0.1666USD/RMB | 0.1666 USD per RMB | 0.1666 USD = 1 RMB | RMBUSD0.1666 |
| European terms: USD in denominator<br>Direct quote from local's perspective. Indirect quote from American's perspective | | | | |
| Currency | Algebraic ratio form | Per or ratio form | Equality form | Trader form |
| JPY* | 100JPY/USD | 100 JPY per USD | 100 JPY = 1 USD | USDJPY100 |
| AUD | 1.25AUD/USD | 1.25 AUD per USD | 1.25 AUD = 1 USD | USDAUD1.25 |
| GBP | 0.5GBP/USD | 0.5 GBP per USD | 0.5 GBP = 1 USD | USDGBP0.5 |
| RMB* | 6RMB/USD | 6 RMB per USD | 6 RMB = 1 USD | USDRMB6 |
| * Normal methods of quotation. | | | | |

# *Appreciations and Depreciations*

The rise in value of a currency against another is called an appreciation. Vice versa for a depreciation.

Note that not all currencies can appreciate at once since they are measured relative to one another, at least one must fall if all the others appreciate.

It is easier to understand appreciations and depreciations of currencies by focusing on the denominator currency in an FX quote. If the number increases, it's because the denominator currency is appreciating.

# *If the currency quote number rises, the denominator currency has appreciated*

- If the Japanese exchange rate moves from 100 to 101 JPY per USD, then the USD has appreciated against the JPY since the USD is in the denominator:

  $$100\,\frac{JPY\ (numerator)}{USD\ (denominator)}\ \text{to}\ 101\,\frac{JPY\ (numerator)}{USD\ (denominator)}$$

- If the exchange rate moves from 0.8 to 0.9 USD per AUD, then the AUD has appreciated against the USD since the AUD is in the denominator:

  $$0.8\,\frac{USD\ (numerator)}{AUD\ (denominator)}\ \text{to}\ 0.9\,\frac{USD\ (numerator)}{AUD\ (denominator)}$$

# *Mathematics of Appreciations and Depreciations*

So if the USD appreciates against the JPY, then:

- **100 JPY/USD** will **increase** since the USD is in the denominator of the fraction.
- **0.01 USD/JPY** will **decrease** since the JPY is in the denominator of the fraction and the JPY is depreciating against the USD.

# *FX Forward Agreements*

Buying foreign currency right now is called a spot transaction because it happens immediately (t=0).

But it is also possible to buy foreign currency in the future at an agreed exchange rate that is fixed right now. This is called a foreign exchange forward agreement.

For example, you might be able lock in to sell USD1 million at an exchange rate of JPY102 million in one year. The counter-party to your FX forward rate agreement, usually a bank, will give you USD1 million in exchange for JPY102 million in one year. In this example the FX dealer would say that you are "selling USD 1million forward one year at 102 JPY per USD".

The forward FX rate agreed to by the long and short FX forward traders will be the expected future spot exchange rate. This is why the value of an FX forward is zero when it is first entered into, for both the long and short FX forward traders.

After it's first agreed to, the expected future spot rate may, for example, increase, making the FX forward agreement worth a positive amount to the long trader and a negative amount to the short trader.

# *FX, Interest Rates and the 'Carry Trade'*

Because interest rates on debt vary from country to country, some investors think that borrowing in a country where interest rates are low and investing (lending) in a country where interest rates are high is a good idea to make money. This is called a 'carry-trade'.

The classic carry-trade is to borrow in Japan where short-term interest rate have been close to zero for some decades, and to invest in Australia or New Zealand where interest rates are historically much higher. This investing strategy is not likely to be successful in the future in the long run due to the theory of cross currency interest rate parity.

# *Cross-Currency Interest Rate Parity*

Cross currency interest rate parity (sometimes referred to as IRP) is a theory based on a risk-free arbitrage which goes as follows:

Lending JPY1 million in Japan at the Japanese interest rate ($r_{JPY}$) for one year must provide a cash flow equivalent to:

- Converting JPY1m to USD at the spot FX rate (divide by $S_{0,JPY/USD}$),
- Lending at the US interest rate ($r_{USD}$) for one year, and
- Locking in a forward FX agreement now to convert USD to JPY in one year at the forward FX rate (multiply by $F_{1,JPY/USD}$).

Mathematically, this is:

$$JPY1m.\left(1+r_{JPY}\right)^{1} = JPY1m.\frac{1}{S_{0,JPY/USD}}.(1+r_{USD})^{1}.F_{1,JPY/USD}$$

$$\underbrace{\overbrace{V_{0,JPY}}}_{V_{1,JPY}} \qquad \underbrace{\underbrace{\overbrace{V_{0,JPY}}}_{V_{0,USD}}}_{V_{1,USD}} \Bigg\}_{V_{1,JPY}}$$

Cancelling the JPY1 million on both sides and re-arranging,

$$F_{1,JPY/USD} = S_{0,JPY/USD} \cdot \frac{(1 + r_{JPY})}{(1 + r_{USD})}$$

Where the forward FX rate is for one year and the interest rates are effective annual rates and risk-free.

The multi-period version of the cross-currency interest rate parity theorem is:

$$F_{T,JPY/USD} = S_{0,JPY/USD} \cdot \frac{(1 + r_{JPY})^{T}}{(1 + r_{USD})^{T}}$$

Common sense-wise, cross currency interest rate parity (IRP) says that expected gains on interest rates by borrowing in a low-interest rate country and lending in a high interest rate

country are likely to be lost when you 're-patriate' your profits, which is when you convert them back to your domestic currency.

So if interest rates in Japan are less than in the US, then the JPY should appreciate against the USD, so the forward FX rate $F_{T,JPY/USD}$ is likely to be lower, so in the future USD1 is likely to buy less JPY.

# *Calculation Example: Cross-Currency Interest Rate Parity*

**Question:** The current exchange rate is at parity, so:

**1 USD = 1 AUD**.

The money market rate in:

- Australia in AUD is **4**% pa;
- US in USD it's **3**% pa.

Assume a flat yield curve, that the rates are effective (not simple) annual interest rates and that you can borrow and lend at either rate.

What is the implied **3 year** forward foreign exchange rate?

**Answer:** Since Australian interest rates are more than in the US, we expect the AUD to depreciate against the USD, so the 3-year forward FX rate $F_{3,USD/AUD}$ should decrease. Remember that the AUD is in the denominator in this forward quote of the AUD, so a decrease in the number will be a depreciation of the denominator currency, the AUD.

To find the exact 3 year forward FX rate:

$$F_{T,USD/AUD} = S_{0,USD/AUD} \cdot \frac{(1 + r_{USD})^T}{(1 + r_{AUD})^T}$$

$$F_{3,USD/AUD} = 1 \text{ USD/AUD} \cdot \frac{(1 + 0.03)^3}{(1 + 0.04)^3}$$

$$= 0.971430324 \text{ USD/AUD}$$

Note that this is an 'American terms' AUD quote, it’s “in USD” not “per USD”. This is how it’s normally quoted in Australia.

In 'European terms' which is “per USD” it would be 1.029409908 AUD/USD, just the inverse of the above.

# *Central Bank Monetary Policy and FX*

The interest rates given in the cross currency interest rate parity equation are often thought to be short-term risk free rates which are set by a country's central bank.

These short term risk free rates are called 'policy rates' since they’re used to set monetary policy. The policy rate in:

- Australia is the interbank overnight cash rate (OCR), which is the rate that banks lend AUD to each other for one day, unsecured. The RBA targets this rate, hence it's often also called the 'target rate'.
- US is the federal funds rate, the overnight unsecured USD lending rate between banks.

Central banks determine a country's monetary policy which is adjusted to speed up or slow down the economy and thereby help control inflation. Since the 1990's most central banks have a policy of 'inflation targeting' to try to keep inflation in a narrow, predictable band because they believe that this helps promote long-term economic growth.

Different countries' central banks:

- The United States has the Federal Reserve (the Fed).
- The Euro-area's is the European Central Bank (ECB).
- Japan's is the Bank of Japan (BoJ).
- China's is the Peoples' Bank of China (PBoC).
- England's is the Bank of England (the BoE or 'Old Lady').
- Australia's is the Reserve Bank of Australia (RBA).

Monetary policy is conducted using 'open market operations' to adjust the very short term interest rate, also called the cash rate, overnight rate or policy rate.

# *Surprise Central Bank Policy Rate Changes*

Unexpected changes in a central bank's monetary policy have an instant effect on exchange rates. If short-term interest rates are unexpectedly raised, the exchange rate will instantly appreciate.

# *Theory Example: Short and Long Term Effects*

**Question:** If the US Federal Reserve unexpectedly decides to increase its federal funds rate, what will happen to the AUD per USD exchange rate immediately *and* in the next year?

Assume that the:

- US federal funds rate and the Australian interbank overnight cash rate are equal, so: $r_{USD} = r_{AUD}$
- Australian dollar and US Dollar (USD) are at parity, so 1 AUD = 1 USD or there's 1 USD per AUD.
- Markets are efficient.

**Answer:** Due to the surprise US federal funds rate **hike**, the USD will instantly **appreciate** against the AUD, all things remaining equal. Therefore the AUD will instantly **depreciate** against the USD.

But due to cross-currency interest rate parity (IRP), since the US fed funds rate is now greater than the Australian overnight cash rate ($r_{USD} > r_{AUD}$), the USD per AUD forward exchange rate will be higher than the new spot exchange rate ($F_{T,USD/AUD} > S_{0,USD/AUD}$). Therefore, all things remaining equal, as time goes by the AUD will slowly **appreciate** against the USD.

# *Theory Examples: Short Term Effects Only*

- If the BoJ unexpectedly decides to increase its policy rate, the Japanese Yen will appreciate against other currencies.
- If the Fed unexpectedly decide to decrease their policy rate, then the US Dollar will depreciate against other currencies.
- If the market expects the RBA to decrease rates and the RBA does decrease its policy rate then the Australian Dollar will not rise or fall since the decrease in policy rates would already be reflected in the price. In other words, the Australian Dollar would have fallen at an earlier time when the market first found out that the Australian policy rate was likely to fall.