Swapskills Pte Ltd

FX Pricing and Arbitrage

FX

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In this booklet we'll take a look at how to accurately price up the value of one currency in terms of another. Firstly, we'll understand parity relations and how to derive theoretical forward rates. We'll understand how to handle prices and dealer quotes in spot FX, forward FX, non deliverable forwards, swaps and non deliverable swaps. Finally, we'll take a look at a few trade strategies to capitalize on market mispricing.

Understanding a Quote

There's a lot of terminology to be understood in the FX markets and having a sound understanding of them all will help you learn things faster.

Reading a Quote:

AUD/USD spot = 0.60 means that 1 AUD currently buys 0.6 USD

Buy AUD = sell USD?

We could also have phrased the above transaction as 0.6 USD can be sold for 1 AUD. Hence, for each currency pair, buying one currency is the same as selling the other.

Inside this issue:

Points of interest

- **Dealers use the spread to control inventory positions and margins**
- **There are 2 parity relations that explain pricing of FX forwards**
- **Arbitrageurs help correct mispricings in the market by exploiting opportunities that last for short periods of time**

Base Currency: In the quote **AUD**/USD = 0.6000, AUD is the base currency.

Quoted Currency: In the quote AUD/**USD** = 0.6000, USD is the quoted currency.

Bid: Suppose a dealer quotes you, AUD/USD spot = **0.6000**—0.6015. The market maker (dealer) will buy AUD (sell USD) at a rate of 0.6000 against the USD. This is called the *Bid* rate or the *Bid* side of the quote.

Ask / Offer: Suppose a dealer quotes you, AUD/USD spot = 0.6000—**0.6015**. The market maker (dealer) will sell AUD (buy USD) at a rate of 0.6015 against the USD. This is called the *Ask or Offer* rate or the *Ask* side of the quote.

Mid Price: The mean of the market bid and offer quotes, AUD/USD = 0.60075. The market maker (dealer) will generally quote their price around the market mid rate.

Direct Quote: AUD/USD = 0.60. This is a direct quote to an investor based in the USA because it is a quote per unit of foreign currency.

Indirect Quote: AUD/USD = 0.60. This is a indirect quote to an investor based in the Australia because it is a quote per unit of local currency.

Currency Appreciates: If AUD/USD rises to 0.6200, 1 AUD now buys more USD. This mean that the AUD has appreciated against the USD.

Currency Depreciates: If AUD/USD falls to 0.5900, 1 AUD now buys less USD. This mean that the AUD has depreciated against the USD.

Currency Cross Rates

	USD	EUR	JPY
HKD			
AUD			
CAD			
CHF			
GBP	0.6384	0.8347	0.0074
JPY	85.701	112.0455	-
EUR	0.7649	-	0.0089

This is a spot FX monitor that shows the current MID prices, which is the mean of the BID and ASK price on all dealer quotes on the OTC market.

Quote: Only the last 2 digits are quoted. Eg. The quote below shall be quoted as 98/03. These are called "pips" and the remainder of the quote is called the "big figure" or the "handle".

Base Currency	Quoted Currency
USD	JPY

USD / JPY = 85.698—85.703

Understanding a spread

Once an analysis of market fundamentals allows a dealer to arrive at a point estimate of an FX rate or price (a mid rate), he has to quote a bid and an offer price around the estimated price.

The difference between the bid and the offer side of a quote is called a '**Spread**'. A spread is also sometimes quoted as a percentage of the ask price.

EUR/USD = 1.4828—1.4839

In this quote, the spread = 1.4839 -1.4828 = 0.0011 EUR/USD = 11 basis points.

EUR/USD = 1.4828—1.4839

% spread = 0.0011/1.4839 = 0.000741 = 0.0741%

As events occur, and economic and financial information reaches the market place, market prices move and dealers vary the spreads. The spread is a dealer's tool to control his profit margin, hence allowing him to influence market liquidity or manage his inventory in the currencies he trades. Let's take a closer look, with 3 examples—

1 Volatility in the EUR/USD rate increases

The greater the volatility → The harder it becomes to estimate the price → The margins are typically higher for holding the currency risk → The spread increases → The liquidity decreases.

Before: EUR/USD = 1.4828—1.4839 → After: EUR/USD = 1.4826—1.4841

2 Dealer has excess inventory in EUR

Dealer has excess EUR → He seeks to not buy EUR → He buys EUR at a sub-market price (lower bid) → He sells EUR at a sub-market price to offload his EUR to the market (lower offer) → This way he buys less EUR and sells more EUR this expressing his bearish view on the EUR.

Market: EUR/USD = 1.4828—1.4839 → Dealer: EUR/USD = 1.4826—1.4837

3 Dealer has excess inventory in USD

Dealer has excess USD → He seeks to sell USD and hence buy EUR → He buys EUR at an above market price (higher bid) → He (buys his dollars) sells EUR at an above market price to make sure he isn't hit on the wrong side and stuffed with USD (higher offer) → This way he buys less USD and sells more USD thus expressing his bearish view on the USD.

Market	Dealer
EUR/USD = 1.4828—1.4839 →	EUR/USD = 1.4830—1.4841

4 Trading volume in the currency pair increases

Trading volume increases → liquidity increases → Dealers cut their margins to stay competitive → The spread decreases.

Before	After
EUR/USD = 1.4828—1.4839 →	EUR/USD = 1.4826—1.4837

5 Maturity of the contract increases

Forward prices generally have larger spreads than spot prices. This is because as time to maturity increases, greater uncertainty over the effect of interest rates. Further the volumes of longer term forward contracts traded is lower, and hence the liquidity is lower. As a result the spread increases.

From the four examples we've seen, we now know that the spread reflects information about 3 important factors—

1. Market Conditions
2. Bank Dealer Positions
3. Trading Volume

EURUSD 99) Chart Spot & Forward Rates

EURO Pricing Source BGN Bloomberg BGN

Term	Pts Time	Pts Bid	Pts Ask	Spread	Outrt Bid	Outrt Ask	Time
1) SPOT	9:39	1.4615	1.4616	0.0001	1.4615	1.4616	9:39
2) ON*	9:11	-0.540	-0.340	0.200	1.4616	1.4617	9:11
3) TN*	9:39	-0.430	-0.398	0.032	1.4615	1.4616	9:39
4) SN	9:38	-0.435	-0.385	0.050	1.4615	1.4616	9:38
5) 1W	9:39	-2.90	-2.80	0.10	1.4612	1.4613	9:39
6) 2W	9:39	-5.25	-5.06	0.19	1.4610	1.4611	9:39
7) 3W	9:39	-7.97	-7.72	0.25	1.4607	1.4608	9:39
8) 1M	9:38	-12.69	-12.48	0.21	1.4602	1.4604	9:38
9) 2M	9:39	-22.97	-22.67	0.30	1.4592	1.4593	9:39
10) 3M	9:38	-35.57	-35.17	0.40	1.4579	1.4581	9:38
11) 4M	9:38	-49.65	-49.15	0.50	1.4565	1.4567	9:38
12) 5M	9:39	-63.28	-62.47	0.81	1.4552	1.4554	9:39
13) 6M	9:38	-77.69	-76.69	1.00	1.4537	1.4539	9:38
14) 9M	9:38	-125.80	-123.90	1.90	1.4489	1.4492	9:38
15) 12M	9:39	-174.39	-172.11	2.28	1.4441	1.4444	9:39
16) 15M	9:39	-222.75	-218.75	4.00	1.4392	1.4397	9:39
17) 18M	9:38	-266.51	-260.49	6.02	1.4348	1.4356	9:38
18) 2Y	9:38	-332.87	-325.13	7.74	1.4282	1.4291	9:38
19) 3Y	9:38	-411.14	-398.64	12.50	1.4204	1.4217	9:38

Here is a run though of EUR/USD spot and forward rates for different maturities. Note how the spread increases as the term of the contract increases.

Cross Rates

FX rates are typically quoted with the USD being one of the currencies. Quotes where the USD does not feature are called “Cross Rates”. Eg: EUR/JPY, EUR/CHF. Cross rates are required when there is no active market in that currency pair.

How are they calculated ?

Broker 1

Broker 2

USD / JPY = 85.698—85.703 **EUR / USD = 1.3100—1.3104**

Question: Suppose 2 brokers quote you the above prices on USD/JPY and EUR/USD, what will be the EUR/JPY cross rate?

Answer: The key to deriving cross rates is as simple as 3 steps

- Assume the role of the market taker
- Assume u have 1 EUR and convert it into JPY
- Assume u have 1 JPY and convert it into EUR

A) If we had 1 EUR, we would sell EUR to broker 2 at the BID @ 1.3100 for USD, and sell the USD received to broker 2 at the BID @ 85.698 for JPY. The JPY received would be 1.3100 * 85.698 = 112.2644. This would be the bid rate for an equivalent EUR/JPY cross rate as we are selling EUR at this rate.

B) If we had 1 JPY, we would sell JPY at the OFFER side @ 85.703 to broker 1 for USD, and sell the USD received to broker 2 at the OFFER @ 1.3104 for EUR. The EUR received would be (1/85.703) * (1/1.3104) = 1/(112.3052). Hence we'd buy EUR from an equivalent EUR/JPY cross rate quote at OFFER side @ a rate equal to the inverse of this ratio. Since we are buying EUR, this forms the offer side of the quote (the market maker would sell EUR at this price).

EUR / JPY = 112.2644—112.3052

If the market does not price the cross rates as above, there might be a potential for risk free profits by a strategy called triangular arbitrage. This is explained in the final section of this booklet.

Spot FX transactions

What is a Spot FX transaction?

A Spot FX transaction a deal to exchange units of one currency today for units of another (Buy NOW).

What are its uses?

- Individuals use Spot FX to transfer one currency to another for consumption / expenditure in a foreign country
- Investors use Spot FX to obtain access to investments denominated in a foreign currency
- Corporations use Spot FX to pay international trading partners and for investments denominated in foreign currency

Where does the price come from?

Spot rates derive their value from the fundamentals of the FX markets. A detailed picture of FX fundamentals is available in the FX101 booklet.

How does settlement happen?

- Spot FX settles 2 working days after the date of the trade. (This is called T+2 basis.
- Spot trades settle on the USD/CAD currency pair settle however on a T+1 basis.

Examples

1) A T+2 basis trade on USD/JPY takes place on a Monday. When does it settle?

2) A T+1 basis trade on USD/CAD takes place on Friday. The Monday after is a public holiday in Canada. When does it settle?

3) A T+2 basis trade on EUR/USD takes place on a Tuesday. Thursday is a public holiday in Germany. When does it settle?

Answers

1) Wednesday 2) The Tuesday on the week after 3) Thursday itself! (euro settlements can happen from anywhere in the eurozone)

How is it quoted?

Only the last 2 decimal places (called pips or basis points) are quoted. (Eg. 10/14 in the example beside).

The remaining significant digits are assumed from current market prices. (Eg 1.2100) This is called the 'big figure' or 'the handle'.

EUR/USD Spot: 1.2110-14

Trader A: EUR / USD in 10 please

Trader B: 10/14

Trader A: Yours!

Trader B: To confirm, I buy EUR 10 mio at USD 1.2110 value Sep 23rd, standard payment instructions.

Trader A: To confirm, I sell EUR 10 mio at USD 1.2110 value Sep 23rd, standard payment instructions.

Forward FX transactions

What is a Forward FX transaction?

BUY LATER

A Forward FX transaction is an agreement to exchange units of one currency today for units of another at a specific future date at a price agreed today (Buy LATER).

What are its uses?

- Corporations use forward FX to protect their sales margins
- Speculators buy and sell forward contracts for profits (the advantage being that there are no upfront initial costs)
- Governments use forward FX markets to maintain their reserve accounts
- Financial institutions use forward FX markets for capital raising in a foreign currency using cheap funds raised elsewhere.

Where do the prices come from?

The forward price of foreign exchange is determined using 2 very important parity relations—

Interest Rate Parity (IRP)

Purchasing Power Parity

Interest Rate Parity (IRP)

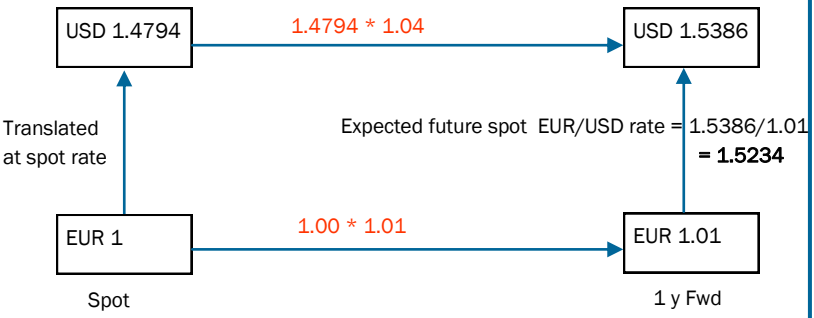
Interest rate parity is a relation that tries to explain the relation between foreign exchange rates between 2 currencies and interest rates in the 2 countries. It comes in 2 forms which are very similar—

(a) Covered Interest Parity: An active forwards market exists in the currency pair and the FX risk may be "covered" by using a forward contract. This helps us derive the forward price from the spot price and the interest rates.

(b) Uncovered Interest Parity: An active forwards market does not exists in the currency pair. In this case we can derive the expected future spot price from the spot price and the interest rates.

Let us understand the postulates of interest rate parity first—

Assume that 1 year USD interest rates are 4% and 1 year EUR interest rates are 1% and that the current EUR/USD spot rate is 1.4794.



- Everyone would like to convert their EUR to dollar to earn 3% more interest if possible.
- This however doesn't happen if it were expected that the value of the USD falls will respect to the EUR by a value equal to the difference in the interest earned ie 3% (approx).
- Owing to this we see that 1 EUR must be worth 1.5234 USD in 1 year's time. This is the expected future spot rate 1 year later.
- This is typically quoted as a 1 y forward rate if there's an active forwards market in the currency.

With this learnt, let us interpret the statement of interest rate parity

Interest rate parity is stated in various ways to the same effect -

Exchange rates must rise or fall so that the return on investments with identical risk are equal in any currency : The 1 year USD loan and the 1 year EUR loan are of identical risk and have the same return when currency rate movements are accounted for.

Difference in interest rate should equal the difference in expected changes in exchange rate: If the USD interest rate exceeds the EUR rate by 3%, the value of the USD must fall with respect to the EUR by 3%.

The forward premium equals the interest rate differentials: The forward premium is the difference between the forward price and the spot price as a percentage of the spot price.

Forward Premium = (1.5234—1.4794)/1.4794 = 2.97%
Interest Rate Differential = 3%
The two are typically very close to each other and this statement is an ***approximation***.

Discounted Interest Rate Differential = 3/1.01 = 2.97%
A better definition is that forward premium equals the discounted interest rate differentials.

Converting the above statements into mathematical formulae we get—

Covered Interest Rate Parity

$$F = \frac{S_0\,(1+Ra)}{(1+Rb)}$$

F = theoretical forward price one period later
S0 = Spot Price
Ra = Per period Interest Rate of Country A
Rb = Per period Interest Rate of Country B

Uncovered Interest Rate Parity

$$S_n = \frac{S_0\,(1+Ra)}{(1+Rb)}$$

Sn = Expected future spot rate one period later
S0 = Spot Price
Ra = Per period Interest Rate of Country A
Rb = Per period Interest Rate of Country B

- The Interest Rate Parity relation doesn't hold in the short term in real life i.e. the forward price may not equal the expected future spot price. The difference between the actual forward price and the theoretical forward price is called the "FX risk premium" and is what investors in FX seek to be compensated for holding the risk in the short term.
- When the covered parity relation doesn't hold, a risk free profit is available using a strategy called covered interest arbitrage (discussed later).

- Banks and arbitragers take on this risk in the short term and exploit these mispricings for profit.
- As a result Forward prices converge to their theoretical levels very quickly and markets attain efficiency.
- This theory does not solely explain movements in exchange rates.
- Other factors limit the use of IRP in practice such as differential tax laws, transaction costs and political risk, making IRP not feasible within a certain range.
- However this can be taken as one of the methods in determining forward rates.

Purchasing Power Parity (PPP)

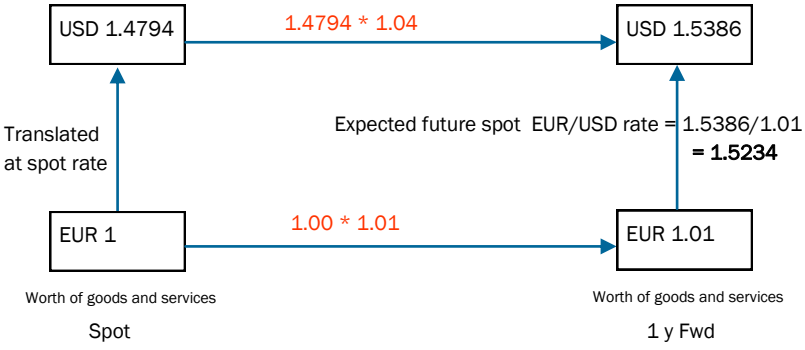
Purchasing power parity is a relation that tries to explain the relation between foreign exchange rates between 2 currencies and purchasing power in the 2 countries. It comes in 2 forms —

(a) Average Purchasing Power Parity: This states that a basket of goods must cost the same in every country after adjusting for exchange rate. It doesn't always hold because of tariffs and transportation costs, and due to different consumption patterns across households in different economies.

(a) Relative Purchasing Power Parity: Exchange rates should move so that effects of different inflation rates in different countries are offset.

Let us understand the postulates of purchasing power parity first—

Assume that annual inflation rates are 4% in the USA and 1% in the eurozone and that the current EUR/USD spot rate is 1.4794.



- Everyone would like to convert their EUR sales to USD denominated sales to earn 3% more margin if possible via exports.
- This however doesn't happen if it were expected that the value of the USD falls will respect to the EUR by a value equal to the difference in the inflation rates ie 3% (approx).
- Owing to this we see that 1 EUR must be worth 1.5234 USD in 1 year's time. This is the expected future spot rate 1 year later.
- This is typically quoted as a 1 y forward rate if there's an active forwards market in the currency.

With this learnt, let us interpret the statement of PPP

Purchasing power parity is stated in various ways to the same effect

Difference in inflation rate should equal the difference in expected changes in exchange rate: If the USD inflation rate exceeds the EUR rate by 3%, the value of the USD must fall with respect to the EUR by 3%.

The forward premium equals the inflation differentials: The forward premium is the difference between the forward price and the spot price as a percentage of the spot price.

Forward Premium = (1.5234—1.4794)/1.4794 = 2.97%
Inflation Differential = 3%
The two are typically very close to each other and this statement is an ***approximation***.

Converting the above statements into mathematical formulae we get—

$$F = \frac{S_0\,(1+Infa)}{(1+Infb)} \qquad S_n = \frac{S_0\,(1+Infa)}{(1+Infb)}$$

F = theoretical forward price one period later
S0 = Spot Price
Infa = Per period Inflation Rate of Country A
Infb = Per period Inflation Rate of Country B
Sn = Expected future spot rate one period later

- This helps partially explain exchange rate movements based on changes in inflation rates.
- This however does not always hold true because exchange rate movements are also governed by changes in income levels, government controls and changes in future expectations.
- There's no true arbitrage that can be immediately be exploited when PPP doesn't hold and hence these mispricings may last in the short term and medium term.
- When the PPP relation doesn't hold, an arbitrage becomes possible by holding an appropriate commodity price index as opposed to a currency
- However this relation gives us another way of deriving forward rates.

International Fischer Relation

We saw that the interest rate parity statement "The forward premium equals the interest rate differentials" was an approximation. We also saw that the purchasing power parity statement ""The forward premium equals the inflation differentials" was an approximation.

The International Fischer relation derives this condition makes assumptions under which this relation holds good.

The Relation between nominal and real interest rates are mathematically given by a precise relation or a linear approximation—

Let 'a' and 'b' denote 2 different countries

Precise Relation

$$1 + R_{nominal\,(a)} = (1 + R_{real\,(a)})(1 + Inf(a))$$

$$1 + R_{nominal\,(b)} = (1 + R_{real\,(b)})(1 + Inf(b))$$

dividing $$\frac{1 + R_{nominal\,(a)}}{1 + R_{nominal\,(b)}} = \frac{(1 + R_{real\,(a)})(1 + Inf(a))}{(1 + R_{real\,(b)})(1 + Inf(b))}$$

If R real (a) = R real (b) $$\frac{1 + R_{nominal\,(a)}}{1 + R_{nominal\,(b)}} = \frac{(1 + Inf(a))}{(1 + Inf(b))}$$

A Linear Approximation

$$R_{nominal\,(a)} = R_{real\,(a)} + Inf\,(a)$$

$$R_{nominal\,(b)} = R_{real\,(b)} + Inf\,(b)$$

Subtracting

$$R_{nominal\,(a)} - R_{nominal\,(b)} = \left(R_{real\,(a)} - R_{real\,(b)}\right) + (Inf(a) - Inf\,(b))$$

If R real (a) = R real (b)

$$R_{nominal\,(a)} - R_{nominal\,(b)} = Inf(a) - Inf\,(b))$$

From the above equations we can state the Fischer equation as—

"The Difference between the nominal interest rates of 2 countries is equal to their inflation differential"

This statement is valid under the assumption that real interest rates are equal in all countries.

Examples for IRP

Assume that the annual interest rates in USA and in Spain are 4% and 6% respectively.

1. What should the forward premium be?
2. Assuming that the Euro's spot rate is 1.40, what should the forward rate of the Euro be?

Answer-1 :

Forward premium = (Ra-Rb)/(1+Rb) = 0.02/1.04 = 1.9230%

Answer -2

F = S (1 + Fwd Premium)
F = 1.40 (1 + 0.0192)
F = $1.4269 / Euro

Examples (PPP)

Assume that over the next year the inflation rate in USA is expected to be 5% and in France it is expected to be 3%. What is the expected change in the value of the foreign currency?

Expected change = Forward premium = (0.05-0.03)/(1.03)
= 0.0194 or **1.94%**

How is it quoted?

Forward rates are quoted in ***Forward Points***. 1 point equals 0.0001 for most currencies, however it equals 0.01 for JPY (a notable exception). This is because yen is only quoted to 2 decimal places. The forward rate is calculated by adding or subtracting the forward points to or from the spot rate.

1 **Forward Points in Ascending Order**

Add the forward points to the spot price.

Eg. 1 month USD/SEK fwd rate
= (6.9538+0.003992)/(6.9563+0.004108)
= (6.957792/6.960408)
The forward price is greater than the spot price.
This happens when the Quoted CCY interest rates are higher than the Base CCY interest rates.

2 **Forward Points in Descending Order**

Subtract the forward points from the spot price.

Eg. 1 month EUR/USD fwd rate
= (1.3127-0.000130)/(1.3128-0.000118)
= (1.312570/1.312682)
The forward price is lower than the spot price.
This happens when the Quoted CCY interest rates are lower than the Base CCY interest rates.

USD/SEK Fwd Quote (1)

	Standard Rates				
	Dates	Pts - Bid	Ask	Fwd - Bid	Ask
1)	ON 09/22/10	1.05	1.40	6.953533	6.956084
2)	TN 09/23/10	1.11	1.27	6.953673	6.956189
3)	SP 09/23/10	6.9538	6.9563	6.953800	6.956300
4)	SN 09/24/10	1.14	1.28	6.953914	6.956428
5)	1W 09/30/10	7.99	8.81	6.954599	6.957181
6)	2W 10/07/10	15.86	17.04	6.955386	6.958004
7)	3W 10/14/10	23.49	25.49	6.956149	6.958849
8)	1M 10/25/10	39.92	41.08	6.957792	6.960408
9)	2M 11/23/10	85.25	87.25	6.962325	6.965025

(2) EUR/USD Fwd Quote

	Standard Rates				
	Dates	Pts - Bid	Ask	Fwd - Bid	Ask
1)	ON 09/22/10	-0.05	-0.03	1.312707	1.312810
2)	TN 09/23/10	-0.05	-0.03	1.312703	1.312805
3)	SP 09/23/10	1.3127	1.3128	1.312700	1.312800
4)	SN 09/24/10	-0.05	-0.03	1.312695	1.312797
5)	1W 09/30/10	-0.32	-0.27	1.312668	1.312773
6)	2W 10/07/10	-0.59	-0.49	1.312641	1.312751
7)	3W 10/14/10	-0.90	-0.80	1.312610	1.312720
8)	1M 10/25/10	-1.30	-1.18	1.312570	1.312682
9)	2M 11/23/10	-2.75	-2.60	1.312425	1.312540

RULE OF THUMB

If the Forward points are in ascending order,
Forward price > Spot price
Forward Premium is positive
Base CCY trades at a premium
Quoted CCY trades at a discount
Quoted CCY interest rates are higher
Base CCY is strong and appreciating

Non Deliverable Forwards

What is a Forward FX transaction?

A new type of forward contract called a non-deliverable forward contract (NDF) is frequently used for currencies in emerging markets. Like a regular forward contract, an NDF represents an agreement regarding a position in a specified amount of a specified currency, a specified exchange rate, and a specified future settlement date.

Why Non Deliverable FX?

When there are ***capital controls*** in place set by the emerging market economy it creates the functioning of two markets for the emerging country currency, i.e. onshore and offshore markets. Capital controls limit the maximum amount of local currency that can be owned by a foreign individual or enterprise or limit holding of local currencies altogether. This is a common means by which developing countries maintain their reserve balances and control the price of their exports in international markets. Due to this regulation, the price of an emerging market currency (such as INR) varies in the onshore and offshore market.

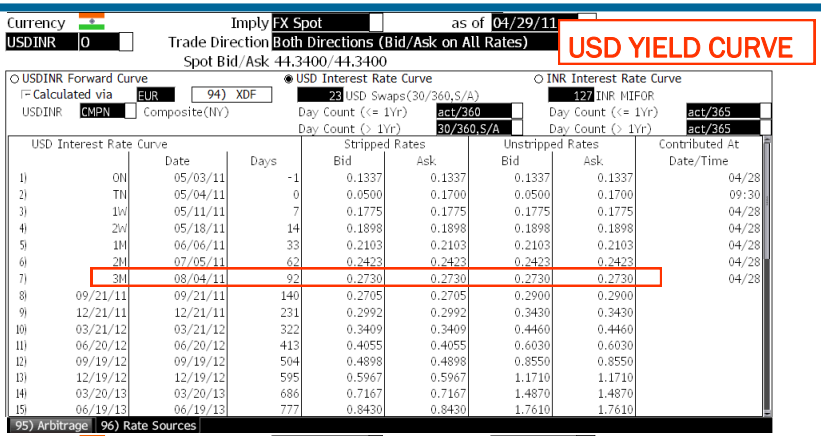
Further, since settlement may not occur in INR, participants in the NDFX market settle their gains / losses in USD.

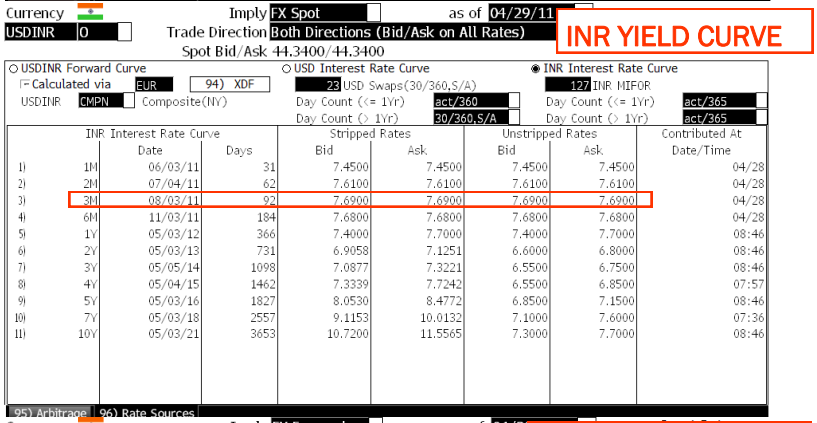
What are its uses?

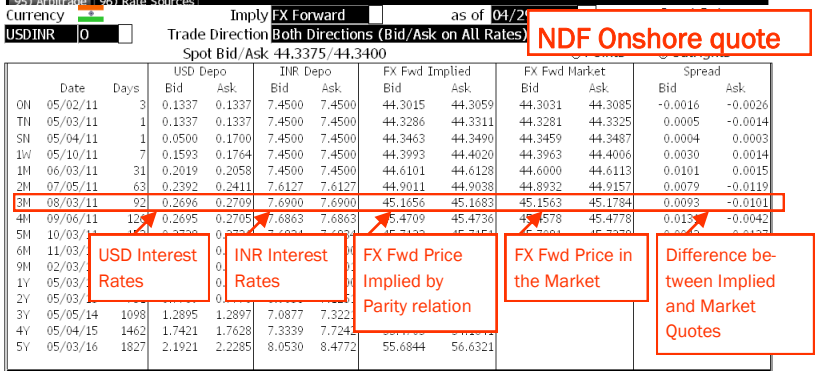
- NDFs allow hedging exposure to FX risk in emerging markets
- NDFs are a key instrument in emerging market strategies and allow speculators adopt the same strategies they otherwise would using forward contracts for G10 currencies.

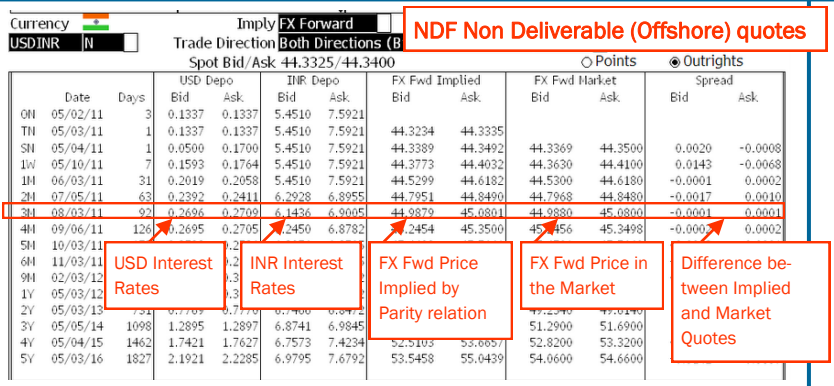
Where do the prices come from?

Similar to forwards NDF prices come from interest rates and inflation rates. Here is an example of USD/INR forward price using the USD yield curve and the INR yield curve—









Note that INR lending rates are lower in the offshore market. This is because banks incur additional regulatory costs and hence offer a lesser rate.

You can see that the implied FX quotes and the Market quotes vary for certain terms. If the spread is wide enough to overcome transaction costs and tax costs, there is potential for Covered Interest Arbitrage using NDFs.

How are they settled?

A party that goes long the 3M USD/INR contract at the market asking price of 45.0800 agrees to buy 1,000,000 USD in 3 months time at the rate of 45.0800 (say).

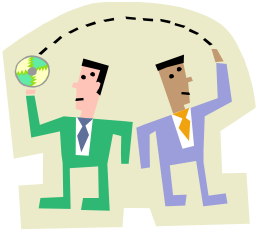
Upon expiry if the spot rate were ***46.0800*** (Say) the Long receives the gains of 1*1,000,000 USD from the short.

If however upon expiry the spot rate were ***44.0800***, the short receives USD 1,000,000 from the party that is long.

FX Swaps

What are FX Swaps?

A Foreign Exchange Swap transaction allows you to utilize the funds you have in one currency to fund obligations denominated in a different currency, without incurring foreign exchange risk. It is an effective and efficient cash management tool for companies that have assets and liabilities denominated in different currencies.



How does it work?

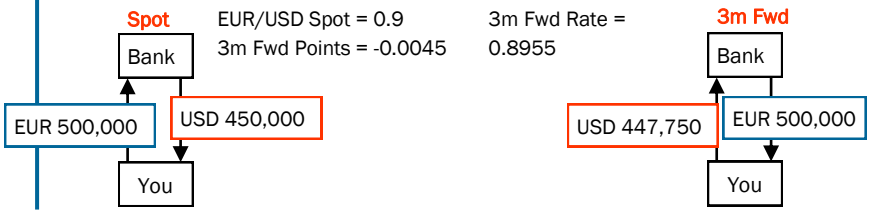
On the ***near date***, you swap one currency for another at an agreed foreign exchange rate and agree to swap the currencies back again on a ***future (far) date*** at a price agreed upon at the inception of the swap.

In most cases, currencies are initially swapped at the spot rate and the future (far) rate is calculated by adjusting the spot price by the forward points for the length of time the swap transaction runs for.

Example

You currently have EUR 500,000 in currency available to your firm, sitting in a bank account in Europe, invested at short-term rates. You have a funding requirement of USD 450,000 for three months in the United States and wish to utilize your EUR funds to meet this funding requirement. You do not wish to take any foreign exchange exchange risk on this transaction.

Use an FX Swap



In the situation outlined above, you would agree to sell the EUR to the bank at the spot rate of 0.90. A full exchange of funds takes place on the near date and you would deliver EUR 500,000 to the bank. In return the bank will deliver USD 450,000 to you on the near date (typically but not always the spot date). At the same time you would agree to buy back the EUR and send back the USD in three months time at a spot price of 0.90, adjusted for forward points of -. 0045, for a forward price of 0.8955. In this case, on the future (far) date the bank would return the EUR 500,000 and you would send the bank USD 447,750.

How is it priced?

As we can see it is priced from the spot rate, the forward rate (corresponding to the tenor) and the notional amount.

Why does it work for the bank?

We note that the EUR / USD forward rate is lower than the spot rate, This means that the quoted currency interest rates are higher. (USD money market deposit rates). As a result the bank earns a greater amount of interest on the USD which it holds over the 3m period.

Benefits and Disadvantages

- Simple, efficient cross-currency cash management product
- Mitigates Foreign Exchange Risk for Financing Transactions
- Accounting and Tax issues must be weighed when considering such a transaction.

FX swaps are most liquid at terms shorter than one year, but transactions with longer maturities have been increasing in recent years.

Non Deliverable Swaps

Non Deliverable Swaps are FX Swaps where one currency is a restricted currency on which capital controls are imposed. (Eg. Philippine Peso, Korean Won)

How does it work?

On the ***near date***, you swap one currency for another at an agreed foreign exchange rate and agree to swap the currencies back again on a ***future (far) date*** at a price agreed upon at the inception of the swap.

In most cases, currencies are initially swapped at the spot rate and the future (far) rate is calculated by adjusting the spot price by the forward points for the length of time the swap transaction runs for.

Instead of physical delivery of the restricted currency the difference is settled in USD.

Example

Assume two companies are entered into a swap, exchanging U.S. bank and South Korean won. The Korean company is due to pay $110,000,000 won, and the U.S. bank is due to pay $125,000 U.S. dollars (notional). (Spot rate = 880 won/dollar)

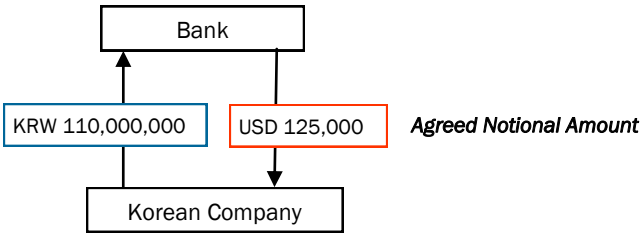
The fixed rate for the contract is taken as the expected spot rate for the day before the payment date. In this example, we will assume the forward rate of 929 won/dollar. The Korean company is then due to pay $118,406.89 ($110,000,000/929) U.S. dollars. A net payment is made on the payment date - for this example, the U.S. bank pays $6,593.11 ($125,000 - $118,406.89) U.S. dollars to the Korean company.

The swap mentioned in this example has only one payment date. This is because NDS are generally popular only for short tenors. However more payment dates may be part of a Non deliverable Swap.

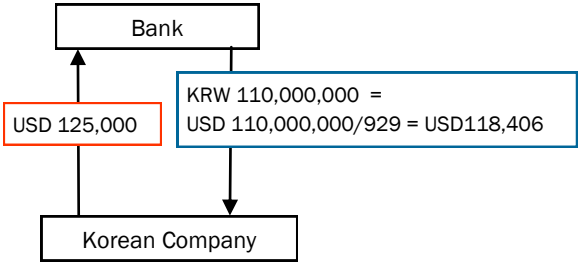
For a routine FX Swap, the cashflows would like this—

Spot

USD/KRW Spot = 880
USD/KRW 3m Forward Rate = 929



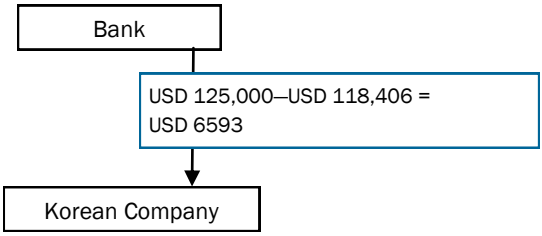
3m Forward Payment Date



For a Non Deliverable Swap However,

Spot No Cashflows exchanged

3m Forward Payment Date



9:37 **ZAR SWAP RATES** PAGE 1 / 1

	ZAR	ASK	BID	TIME		ZAR Basis Swaps	Ask	Bid	Time
1)	1 Year	5.910	5.850	6:00	16)	1 Year		6.00	6:00
2)	2 Year	6.63	6.57	6:00	17)	2 Year		4.00	6:00
3)	3 Year	7.18	7.12	6:00	18)	3 Year		4.00	6:00
4)	4 Year	7.51	7.45	6:00	19)	4 Year		4.00	6:00
5)	5 Year	7.72	7.66	6:00	20)	5 Year		4.00	6:00
6)	6 Year	7.87	7.81	6:00	21)	6 Year	10.00	4.00	6:00
7)	7 Year	7.98	7.92	6:00	22)	7 Year		4.00	6:00
8)	8 Year	8.07	8.01	6:00	23)	8 Year	10.00	4.00	6:00
9)	9 Year	8.13	8.07	6:00	24)	9 Year	10.00	4.00	6:00
10)	10 Year	8.17	8.11	6:00	25)	10 Year		4.000	6:00
11)	12 Year	8.19	8.09	6:00	26)	12 Year	11.000	3.000	6:00
12)	15 Year	8.16	8.06	6:00	27)	15 Year		4.000	6:00
13)	20 Year	8.07	7.95	6:00	28)	20 Year	13.000	5.000	6:00
14)	25 Year	7.95	7.83	6:00	29)	25 Year	13.000	5.000	6:00
15)	30 Year	7.800	7.720	6:00	30)	30 Year	11.000	3.000	6:00

ICAP

Day Count: ACT/365 vs.3 month Jibar as quoted on SAFEY

Day Count: ACT/365
vs. Libor

London: John Fitzgerald 44 207 532 4820
Johannesburg: Giles Friedrich 27 11 276 9050

A Swap quotes monitor for ZAR basis swaps against 3m JIBAR

90) Actions | 91) Swaps & Option | 92) Str. Notes | 93) Mkt Data | 94) Help | Swap Manager

XCCY Fix Fix Swap | Cpty SWAP CNTRPARTY | CCP OTC | Ticker / SWAP | Series | Deal ID | 21) Detail

31) Load | 32) Save | 34) Send | 36) Ticketing | 37) Add to Portfolio

Leg 1	Receive Fixed		Leg 2	Pay Fixed	
Notional	1MM	Leg ID	Notional	44,338,033.16	Leg ID
Currency	USD	Coupon 2.000000 %	Currency	INR	Coupon 8.089081 %
Effective	05/04/2011	Calc Basis Money Mkt	Effective	05/04/2011	Calc Basis Money Mkt
Maturity	05/04/2016	Day Count 30I/360	Maturity	05/04/2016	Day Count ACT/365
Pay Freq	SemiAnnual		Pay Freq	SemiAnnual	
MV	992,607.06	Accrued 0.00	MV	-992,607.06	Accrued 0.00
Premium	99.26	DV01 503.51	Premium	-99.26	DV01 -402.90
Market Dscnt Curve	23 Bid	USD Bloomberg Curve	Dscnt Curve	157 Bid Pay	INR Basis Swaps

Curve Date 04/29/2011 | Valuation 05/04/2011 | Currency USD | FX Rate 0.022554

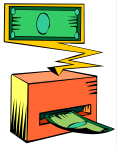
Valuation

Principal	0.00			BR01 INR Basis Swaps	-400.97
Accrued	0.00	Calculate	Leg2: Coupon	DV01	100.61
Market Value	0.00	Premium	0.00000	Gamma (1bp)	0.07

3) Main | 4) Curves | 5) Cashflow | 7) Leg Detail | 11) Risk | 13) Scenario | 14) Charts

A INR, USD Fixed-Fixed Swap Valuation

Arbitrage



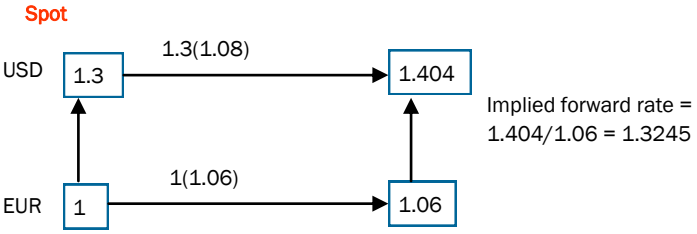
In this section we will look at 2 popular FX arbitrage strategies namely covered interest arbitrage and triangular arbitrage.

Covered Interest Arbitrage

When the forward quotes / futures prices in the markets are not in line with the implied forward rates as implied by covered interest parity, the spot rate and the relevant interest rate curves, there is potential for risk free profits. This kind of arbitrage is called "**Covered Interest Arbitrage**".

Example

Assume that the annual interest rates in USA and in Spain are 8% and 6% respectively. Assuming that the spot EUR/USD is 1.30, what should the 1 year forward rate of the Euro be? If the forward rate is actually 1.35, how would you take advantage of covered interest arbitrage?



Since the market forward rate exceeds the implied forward rate, we will sell our euros forward at this higher rate, and we will buy and hold euros spot. Here's how it works—

TODAY:

A) Borrow $1000 at 8% and purchase 1000/1.30 = 769.23 Euros

B) Invest the Euros at 6%

C) Sell the expected proceeds at the end of 1 year = 769.23(1.06) = 815.38 euros, forward 1 year at $1.35 each

1 YEAR FORWARD:

A) Sell the 815.38 euros under the terms of the forward contract at $1.35 to get $1,100.76

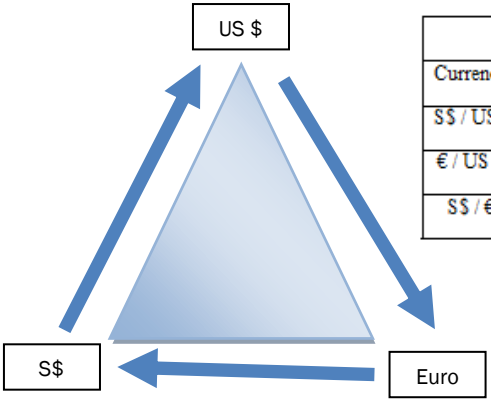
B) Repay the $1,000 8% loan, which is $1,080

C) Keep the difference of $20.76 as an arbitrage profit.

Triangular Arbitrage

We had seen earlier how cross rates were derived. When the cross rates quoted in the market are not in line with those derived from the corresponding currency pairs there emerges an opportunity for risk-free profits called ***"Triangular Arbitrage".*** Here's an example—

What is Triangular Arbitrage ?



Given Information		
Currency	Bid	Ask
S$ / US$	1.2490	1.2510
€ / US $	0.7160	0.7190
S$ / €	1.7450	1.7880

Using the information given above, if you were also given US $1,000,000, could you use triangular arbitrage to make a profit?

Step 1

Find out how much you would have if you went along the sides of the triangle and converted all your money.
Using your initial $1,000,000, buy Euros. Ask price for Euro = 0.7190.
Therefore total number of Euros = € 719,000

Step 2

Using the Euros, buy as many Singapore Dollars as you can.
Bid price for S$ / € = 0.7190.
Therefore total number of S$ = 719,000 x 1.7450 = $1,254,655

Step 3

Sell the Singapore dollars in hand for US dollars at the market rate.
Ask price for S$ / US$ = 1.2510.
Therefore total number of US$ = 1,254,655 / 1.2510 = $ 1,002,921.7

Total profit = $2,921.7
This process can be continued forever until the Ask price adjusts to the equilibrium level of 1.2547 after which no further arbitrage opportunities will be available.

Summary

In this module, we took a look at Spot and Forward FX, the way they are quoted and their uses. We also took a look at FX Swaps. In countries where there are capital controls, non deliverable forwards and non deliverable swaps are used where the payments are netted out in USD or a corresponding G10 currency. We took a look at deriving forward rates using the Interest Rate parity and the Purchasing Power parity relations, and also at deriving cross rates for currency quotes where neither currency in the pair is the USD.
Finally, we looked at arbitrage profit opportunities when forward rates or cross rates were out of line with those implied from parity relations. The two arbitrage opportunities we saw were Covered Interest Arbitrage and Triangular Arbitrage.

Try for yourself

1. Suppose the quote for GBP in New York is 1.3110 GBP/USD, what is the corresponding quote for USD in London?

2. The current USD/SEK spot rate is 6.414. Assuming the annual interest rates in the United Stares and Sweden are 4% and 8% per year respectively, what is the 1-year USD/SEK forward rate.

3. NZD/USD is quoted today as 0.6000—0.6010. What is the percentage spread on the USD ?

4. Given spot NZD/USD = 0.3500 and spot SEK/NZD = 0.3100, Calculate the SEK/USD cross rate.

5. Assume that the Philippine peso is at a 1-year forward discount of 1.25% to the Thai baht, and Thailand's 1 year interest rate is at 3%. If Interest Rate Parity holds exactly, what is the approximate the Philippines interest rate?

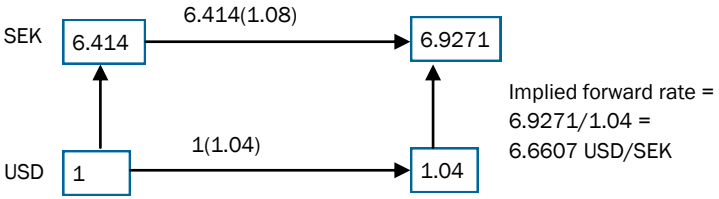
6. Suppose the spot rate is 0.7102 CHF/USD. Swiss and US interest rates are 7.6% and 5.2% respectively. If the 1 year forward rate is 0.7200 CHF/USD, an investor could earn arbitrage profits by investing in which currency?

7. The Bid –ask quotes for USD, GBP and EUR are as below—
   USD/EUR: 0.7000—0.7010
   GBP/USD: 1.7000—1.7010
   GBP/EUR: 1.2000—1.2010
   What are the potential arbitrage profits from triangular arbi trage based on an initial position of USD 1 million?

Answers

1. The quote for USD in London is 1/1.3110 = 0.7628 USD/GBP

2. The one year forward rate is computed as below—



3. Percentage Spread is computed as a percentage of the ask price. % spread = 0.0010/0.6010 = 0.1664%

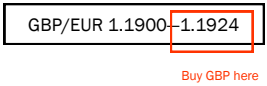
4. (NZD/USD)*(SEK/NZD) = 0.3500*0.3100 = 0.1085 USD/SEK. Hence 1/0.1085 = 9.2166 SEK/USD

5. According to Interest Rate parity, the forward discount / premium equals the difference in nominal interest rates. Since the PHP is at a discount to the THB, the interest rates in the Philippines must be higher. From interest rate parity we can hence write, 1.25% = Rp—3%, or Rp = 4.25%

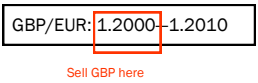
6. We can notice that the CHF is appreciating with respect to the USD by observing the 1 year forward rate. Further, the Swiss interest rates are higher than the USD interest rates too! This is a win-win. By investing in CHF, it is possible to earn excess returns due to the greater rates as well as the appreciating currency.

7. First let's compute the GBP/EUR cross rate implied by the first 2 currency pairs. Starting with 1 GBP, sell to get 1.7000 USD, sell to get (1.7000*0.7000) EUR. This is the bid rate. Similarly ask rate is the product of the 2 ask rates. This gives an implied cross rate of GBP/EUR 1.1900—1.1924

Implied Cross Rate



Market Cross Rate



As we can see from the 2 quotes, there's an arbitrage that exists. In order to exploit this arbitrage we will have to buy GBP from the implied quote and sell at the market.

This is done as follows—

You have	USD 1,000,000
Sell USD and Buy GBP at 1.7010	GBP 1,000,000/1.7010 GBP 587,889.47
Sell GBP and Buy EUR at the market	EUR 587,889.47 * 1.2000
Sell the EUR and Buy USD at 0.7010	USD 705,467.36/0.7010 USD 1,006,372.84
Arbitrage Profits	USD 1,006,372.84—1,000,000 USD 6,372.84

Notes

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