CME Group

CURRENCIES

Understanding FX Futures

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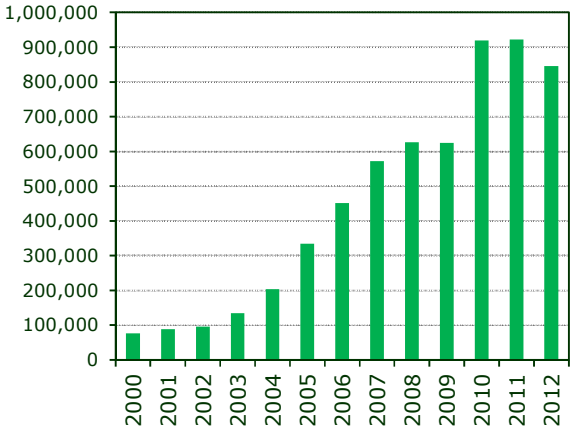
It is often said that the world is getting smaller and nowhere is this more apparent than in the increasingly globalized world of international commerce.

A number of factors have coalesced in the early 21st century to promote free trade across distance and political boundaries. Political advances promoting free trade include reduction or elimination of restrictive tariffs, capital controls and subsidization of local businesses. Technical advances include reduced transportation costs promoted by containerization of products for ocean shipping, and advanced telecommunication systems lead by the emergence of the World Wide Web.

Thus, today's modern corporation frequently conducts business outside its native country and, in the process, earns revenues or incurs liabilities denominated in currencies apart from their native currency. In the process, these corporations may become exposed to the risk that foreign exchange rates are unpredictable and can fluctuate in adverse directions. These uncertainties may make it difficult to manage current cash flows, plan future business expansion or to succeed in a competitive market environment.

FX Futures & Options
Average Daily Volume



CME has offered FX futures and options dating back to the breakdown of the post WWII Bretton Woods agreement in 1972 that imposed fixed exchange rates between the world's currencies. These contracts provide an ideal tool to accept FX risk exposure or manage those risks in an uncertain world.

Spot Exchange Rates
(as of Friday, April 12, 2013)

Currency	ISO CODE	In USD	per USD
AMERICAS			
Argentina peso	ARS	0.1943	5.1461
Brazil real	BRL	0.5077	1.9697
Canada dollar	CAD	0.9866	1.0135
Chile peso	CLP	0.002128	470.00
Colombia peso	COP	0.0005475	1,826.50
Ecuador US dollar	USD	1.0000	1.0000
Mexico peso	MXN	0.0828	12.0780
Peru new sol	PEN	0.3868	2.585
Uruguay peso	UYU	0.05299	18.8705
Venezuela fuerte	VEF	0.157480	6.3500
ASIA-PACIFIC			
Australian dollar	AUD	1.0507	0.9517
1-mth forward		1.0483	0.9539
3-mth forward		1.0435	0.9583
6-mth forward		1.0366	0.9647
China yuan	CNY	0.1614	6.1947
Hong Kong dollar	HKD	0.1288	7.7620
India rupee	INR	0.01834	54.5200
Indonesia rupiah	IDR	0.0001030	9,712
Japan yen	JPY	0.010162	98.41
1-mth forward		0.010164	98.39
3-mth forward		0.010168	98.35
6-mth forward		0.010177	98.26
Malaysia ringit	MYR	0.3287	3.0427
New Zealand dollar	NZF	0.8588	1.1644
Pakistan rupee	PKR	0.01018	98.245
Phillippines peso	PHP	0.0242	41.349
Singapore dollar	SGD	0.8085	1.2369
South Korean won	KRW	0.0008855	1,129.25
Taiwan dollar	TWD	0.03337	29.965
Thailand baht	THB	0.03441	29.062
Vietnam dong	VND	0.00004797	20,848
EUROPE			
Czech Rep koruna	CZK	0.05060	19.762
Denmark krone	DKK	0.1758	5.6869
Euro area euro	EUR	1.3111	0.7627
Hungary forint	HUF	0.004438	225.33
Norway krone	NOK	0.1751	5.7108
Poland zloty	PLN	0.3195	3.1296
Russia ruble	RUB	0.03218	31.075
Sweden krona	SEK	0.1573	6.3566
Switzerland franc	CHF	1.0783	0.9274
1-mth forward		1.0786	0.9271
3-mth forward		1.0794	0.9264
6-mth forward		1.0808	0.9252
Turkey lira	TRY	0.5592	1.7882
UK pound	GBP	1.5344	0.6517
1-mth forward		1.5341	0.6518
3-mth forward		1.5336	0.6520
6-mth forward		1.5331	0.6523
MIDDLE EAST/AFRICA			
Bahrain dinar	BHD	2.6523	0.3770
Egypt pound	EGP	0.1455	6.8739
Israel shekel	ILS	0.2760	3.6236
Jordan dinar	JOD	1.4123	0.7081
Kuwait dinar	KWD	3.5082	0.2851
Lebanon pound	LBP	0.0006614	1,511.95
Saudi Arabia riyal	SAR	0.2667	3.7501
South Africa rand	ZAR	0.1118	8.9436
UAE dirham	AED	0.2723	3.6728

Source: Wall Street Journal, April 15, 2013

Product innovation, liquidity and financial surety are the three pillars upon which CME Group has built its world class derivatives market. CME Group provides products based on a wide range of frequently transacted currencies; liquidity offered on the state-of-the-art CME Globex® electronic trading platform; and, financial sureties afforded by its centralized clearing system.

This document is intended to provide a perspective on the FX trading landscape, including interbank or over-the-counter (OTC) products, as well as exchange-traded structures such as CME FX futures and options on futures. We dig in by explaining how FX futures are priced relative to spot rates and how they may be used as an effective risk-management vehicle.

Spot FX Transactions

Currencies are typically identified by reference to their "ISO 4217" codes as established by the International Standards Organization (ISO) and illustrated in our table.

A spot or outright currency transaction is simply the exchange of one currency for another currency, at the current or spot rate, or a "currency pair." While the transaction may be concluded immediately in a variety of interbank markets, sometimes via telephone, or increasingly via electronic trading systems, payment or settlement typically is concluded two business days hence.

It is possible, if mutually agreed, to settle or value a transaction on a one business day basis, as is the standard convention with transactions between the Canadian dollar (CAD) and U.S. dollar (USD). Quotes may be in either "American terms" or "European terms."

E.g., consider the Swiss franc (CHF) vs. U.S. dollar (USD) currency pairing. Conventionally, one quotes this currency pair in interbank markets in European terms, or in terms of Swiss francs per one (1) U.S. dollar. Thus, one may quote 0.9274 CHF per 1 USD as of April 12, 2013. The American terms quote is simply the reciprocal of the European terms quote.

$$American\ Quote = \frac{1}{Euro\ Quote}$$

Thus, one may quote the currency pair in American terms, or USD per CHF, as 1.0783 USD per 1 CHF.

$$1.0783\ USD\ per\ 1\ CHF = \frac{1}{0.9274\ CHF\ per\ 1\ USD}$$

Since 1978, convention has been to quote most currencies in European terms. There are some notable exceptions to this rule such as the EUR, the GBP and other British commonwealth currencies such as the AUD and NZD, which are generally quoted in American terms.

Most currencies are quoted to the 4th place past the decimal or 0.0001, also known as a "pip" or a "tick." However, practices may vary with respect to currencies whose values are very small or very large in relative terms.

Select Spot Cross Rates
(As of April 12, 2013)

	USD	EUR	GBP	CHF	JPY	CAD
USD	-	1.3111	1.5344	1.0783	0.010162	0.9866
EUR	0.7627	-	1.1703	0.8224	0.007750	0.7525
GBP	0.6517	0.8545	-	0.7027	0.006622	0.6430
CHF	0.9274	1.2159	1.4230	-	0.009424	0.9150
JPY	98.41	129.028	151.005	106.114	-	97.091
CAD	1.0135	1.3289	1.5553	1.0929	0.010300	-

It is also, of course, possible to trade "cross-rates" or transactions which do not involve U.S. dollars and are not quoted as such. For example, one may trade the GBP/EUR rate. Either currency might be utilized as the base rate but there are some conventions that tend to prevail in the interbank markets. For example, one normally quotes the pairing of the Euro and Japanese yen (EUR/JPY) as so many Japanese yen per 1 unit of Euro currency. The British pound and Swiss franc pairing (GBP/CHF) is normally quoted in Swiss francs per 1 unit of British pounds. [1] The quote may readily be interpreted by noting that the base currency is mentioned first.

Outright Forwards

An outright forward contract is almost identical in operational terms to a spot transaction with the significant difference that the value or settlement

[1] Note that British pounds are also frequently referred to as "pounds sterling," "sterling" or "cable."

date is deferred. Rather than settle two days hence, outright forwards are typically traded for settlement in 1 week, 2 weeks, 1 month, 2 months, 3 months, 6 months, 12 months forward … also referred to as "straight dates."

While the outright forward contract may be settled some days, weeks or months later, no consideration is necessarily passed between buyer and seller when the transaction is consummated. However, many dealers will demand that customers post some acceptable collateral to cover market risks in the interim, particularly if a trade goes "underwater."

OTC instruments may be configured to the demands of the moment. Thus, one may closely match the quantity traded and the value date to one's specific needs. Of course, dealers may make their customers pay a price for such customization in the form of a wider bid/ask spread.

The value of an outright forward relative to the spot value of the currency may be modeled by taking into consideration the costs and benefits associated with purchasing and carrying the currency over the life of the forward transaction.

Consider the prospect of purchasing one currency with another currency on a forward basis. The forward price may be calculated as follows, where R_{term} represents the short-term rate at which one may effectively borrow the "term" currency; R_{base} represents the short-term rate that may be earned by investing in the "base" currency; and, d represents the number days until the settlement date. [2]

$$Forward\ Price = Spot\ Price\ x \left(\frac{1 + \left[R_{term}\ x \left(\frac{d}{360} \right) \right]}{1 + \left[R_{base}\ x \left(\frac{d}{360} \right) \right]} \right)$$

E.g., find the 3-month forward price for the EUR/USD currency pair where the spot price = 1.313700, U.S. 3-month rates = 0.2780%; and, Euro 3-month rates = 0.1290%. The 90-day forward price is calculated at 1.314189 as follows.[3] [4]

$$Forward\ Price = 1.313700\ x \left(\frac{1 + \left[0.002780\ x \left(\frac{90}{360} \right) \right]}{1 + \left[0.001290\ x \left(\frac{90}{360} \right) \right]} \right)$$
$$= 1.314189$$

One may calculate the appropriate forward price, or "fair value," as illustrated above and compare it to prevailing forward prices. If the prevailing forward price exceeds the fair value of the forward price by some margin, presumably, one might execute an arbitrage by selling the forward and buying spot currency. Or, if the prevailing forward price were much less than its fair value, one might buy the forward and sell spot. This arbitrage activity may have the impact of enforcing fair pricing in the marketplace.

But another way of analyzing the situation is to calculate the implicit terms or base interest rate and compare it to prevailing rates. This is readily accomplished by solving our forward pricing equation above for the base rate as follows.

$$R_{base} = \left(\frac{360}{d} \right) x \left[\frac{Spot\ Price\ x \left(1 + \left[R_{term}\ x \left(\frac{d}{360} \right) \right] \right)}{Forward\ Rate} - 1 \right]$$

E.g., find the implicit 3-month base interest rate for the EUR/USD currency pair. The observed 3-month forward price = 1.314500; the spot price = 1.313700; and, the terms rate = 0.27800%.

$$R_{base} = \left(\frac{360}{90} \right) x \left[\frac{1.313700\ x \left(1 + \left[0.002780\ x \left(\frac{90}{360} \right) \right] \right)}{1.314500} - 1 \right]$$
$$= 0.0344\%$$

Thus, the implicit base rate is calculated at 0.0344% while the observed base rate = 0.1290%. Thus, the market is pricing a base rate that is 0.0946%

[2] The "terms" currency is also sometimes referred to as the "counter" or the "quoted" currency in the sense that the transaction is quoted in so many units of the terms currency per 1 unit of the base currency.

[3] When referring to a currency pair, the "base" currency is always referred to first, following by a reference to the "terms" currency. Thus, if we quote the EUR/USD pairing, the Euro represents the base currency and the U.S. dollar represents the terms currency.

[4] The convention in most markets is to calculate short-term rates based on a 360-day count assumption, but some short-term rate markets, including the U.K., employ a 365-day count.

(=0.1290% - 0.0344%) lower than the observed base rate.

This is consistent with an observation that the fair value or calculated 3-month forward price = 1.314200 while the observed 3-month forward price = 1.314500. Thus, the market appears to be trading 3 "pips" (=1.314500 – 1.314200) above its fair value.

This suggests that one might consider selling the forward EUR/USD contract and buying spot EUR/USD. This implies a possible arbitrage profit of 3 pips or the possibility of effectively borrowing Euros at an implicit rate that is lower than prevailing rates.

Some central banks impose restrictions on foreign ownership or usage of their national currencies in capital or current accounts. These currencies are said to be "inconvertible" or "non-deliverable." Some of the most significant currencies that generally are not deliverable include the CNY, INR and RUB. [5]

Still, these currencies may be traded as "Non-Deliverable Forwards" (NDFs). Rather than culminating in a delivery of currency, NDFs are settled with a cash payment for the net profit or loss denominated in the readily negotiable currency.

FX Swaps

An FX swap may be thought of as a combination of two offsetting currency transactions separated by time and constitute the largest segment of the FX marketplace in terms of daily turnover. An FX swap is executed when you swap one currency for another on a nearby value date ("near date") only to reverse the transaction on a subsequent value date ("far date.")

A large proportion of FX swaps entail a spot trade as the near date transaction - a "short dated FX swap." Frequently, the far date transaction occurs within a week. But dealers often quote FX swaps with the full range of straight dates, *i.e.,* 1-week, 2-weeks, 1-month, 2-months, etc., as the far date. Dealers often offer a high degree of flexibility and may be willing to quote prices for odd dates and forward swaps where the near-term leg is executed as a forward rather than a spot transaction.

A "spot-next" FX swap is executed by delivering a currency one day and reversing the trade on the subsequent business day. Note that the spot transaction is typically settled two business days subsequent to the deal date. A "tom-next" swap is transacted by executing the spot transaction on a "pre-spot" basis or one day earlier than normal convention, *i.e.,* tomorrow as opposed to two business days hence, reversing the trade on the subsequent business day.

Or, one may execute a "spot-week" or "spot-2 week" FX swap. A "forward FX swap" is generally considered one where the near date transaction is settled, not on a spot basis two days hence, but on some forward date.

A "buy-sell" swap implies the purchase of a fixed quantity of the base currency on the near date only to be offset with the sale of a fixed quantity of the base currency on the far date. Conversely, a "sell-buy" swap implies the opposite … the sale of a fixed quantity of the base currency subsequently offset with its re-purchase.

FX swaps may be thought of as akin to repurchase or repo agreements in fixed income markets where one borrows or lends cash on a temporary basis collateralized with an equivalent value of a fixed income item, most often a U.S. Treasury security. Like a repo or an FX forward transaction, the value of an FX swap reflects an interest rate, or more accurately, the interest rate differential between the two currencies.

FX swaps are typically quoted in terms of pips as follows, where R_{term} represents the short-term rate that may be earned by investing the "term" currency; R_{base} represents the short-term rate associated with the "base" currency; and, d represents the number of days between the far and near dates.

[5] Note that the People's Bank of China (PBOC) has taken steps over the past several years to liberalize the CNY. Thus, an offshore market in Chinese yuan is now available in Hong Kong where the currency is often referred to as "CNH."

$$Swap\ Points = Spot\ Price\ x \left[\left(\frac{1 + \left[R_{term}\ x \left(\frac{d}{360}\right)\right]}{1 + \left[R_{base}\ x \left(\frac{d}{360}\right)\right]}\right) - 1\right]$$

E.g., find the swap points associated with a 90-day EUR/USD swap. Let us refer to our previous example where the spot EUR/USD rate is quoted at $1.313700; U.S. 3-month rates = 0.2780%; and, European 3-month rates = 0.1290%. A three-month or 90-day swap rate may be calculated as 4.89 pips as follows.

$$Swap\ Points = 1.313700\ x \left[\left(\frac{1 + \left[0.002780\ x \left(\frac{90}{360}\right)\right]}{1 + \left[0.001290\ x \left(\frac{90}{360}\right)\right]}\right) - 1\right]$$
$$= 0.000489\ or\ 4.89\ pips$$

Thus, we expect the 3-month swap to be trading at 0.000489 or 4.89 pips above the spot rate of $1.313700.

FX swap transactions are often used to manage one's currency positions on a short-term basis. They may also be deployed to speculate on fluctuations in the interest rate differentials between two countries.

An FX swap must be distinguished from a so-called "currency swap" transaction. A currency swap entails an element of an FX swap as well as an element of an interest rate swap. Parties to a currency swap will initially exchange two currencies on a spot basis, swap a series of periodic floating interest rate payments denominated in the respective currencies involved in the transaction and ultimately conclude the transaction by re-exchanging the two currencies.

Currency swaps differ from interest rate swaps (IRS) to the extent that an interest rate swap typically implies the periodic exchange of a stream of fixed vs. floating rate payments in a single currency rather than in two different currencies. But like an IRS, there are many variations on the theme including fixed vs. fixed rate; fixed vs. floating rate; or, floating vs. floating rate currency swaps.

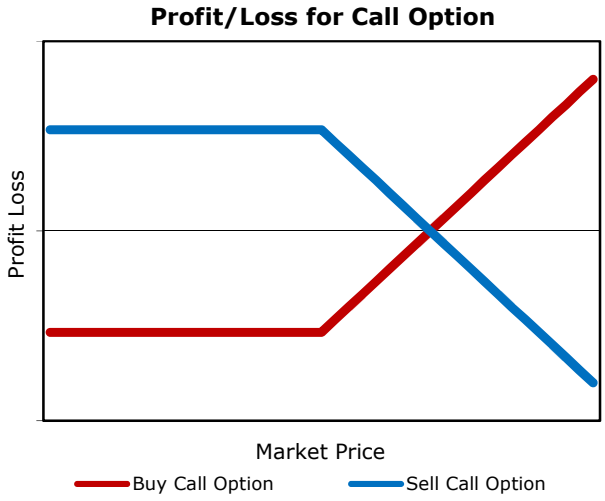
OTC Currency Options

The interbank FX markets had become quite aggressive and inventive with respect to the use of options beginning in the early 1980s. Options provide a very flexible structure that may be tailor made to meet the risk management or speculative needs of the moment.

Options may generally be categorized as either calls or puts. Call options convey the right, but not the obligation, to buy a specified quantity currency at a particular strike or exercise price on or before an expiration date. One may either buy a call option, paying a negotiated price or premium to the seller, writer or grantor of the call; or, sell, write or grant a call, thereby receiving that premium.

Put options convey the right, but not the obligation, to sell a specified quantity currency at a particular strike or exercise price on or before an expiration date. Again, one may buy or sell a put option, either paying or receiving a negotiated premium or price.

Options may be configured as European or American style options. A European style option may only be exercised on its expiration date while an American style option may be exercised at any time up to and including the expiration date.



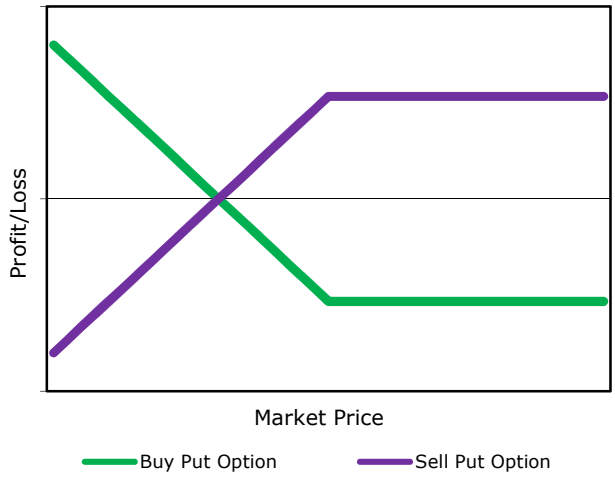
The purchase of a call option is an essentially bullish transaction with limited downside risk. If the market should advance above the strike price, the call is considered "in-the-money" and one may exercise the call by purchasing currency at the exercise price even when the exchange rate exceeds the exercise price. This implies a profit that is diminished only by the premium paid up front to secure the option. If the market should decline below the strike price, the option is considered "out-of-the-money" and may

expire, leaving the buyer with a loss limited to the premium.

The risks and potential rewards which accrue to the call seller or writer are opposite that of the call buyer. If the option should expire out-of-the-money, the writer retains the premium and counts it as profit. If, the market should advance, the call writer is faced with the prospect of being forced to sell currency when the exchange rate is much higher, such losses cushioned to the extent of the premium received upon option sale.

The purchase of a put option is essentially a bearish transaction with limited downside risk. If the market should decline below the strike price, the put is in-the-money and it may be exercised by selling currency at an exchange rate that may be less the exercise price. If the market should advance above the strike price, the option is out-of-the-money, implying a loss equal to the premium.

Profit/Loss for Put Option



The risks and potential rewards which accrue to the put writer are opposite that of the put buyer. If the option should expire out-of-the-money, the writer retains the premium and counts it as profit. If, the market should advance, the put writer is faced with the prospect of being forced to buy currency at an exercise price that is greater than the prevailing exchange rate. But such losses are cushioned to the extent of the premium received upon option sale.

While one may dispose of an option through an exercise or abandonment (expiration *sans* exercise), there is also the possibility that one may liquidate a long/short option through a subsequent sale/purchase.

As such, option traders utilize a variety of mathematical pricing models to identify appropriate premium values not the least of which is the Black-Scholes option pricing model. Several factors including the relationship between market and exercise price, term until expiration, market volatility and interest rates impact the formula. Frequently, options are quoted in terms of volatility and converted into monetary terms with use of these formulae.

By combining options of varying types (puts or calls), exercise prices and expiration dates, one may create an almost infinite variety of strategies which may be tailored to suit one's unique needs.

Currency Futures Fundamentals

Currency futures were developed in 1972 by Chicago Mercantile Exchange Chairman Leo Melamed, working in concert with the Nobel Prize winning economist Milton Friedman. This development may be considered a direct response to the breakdown of the Bretton Woods Accord and represented the first financial futures contract ever successfully introduced.

Over the years, many currency contracts have been added and the listings now include contracts on Euros vs. U.S. dollars (EUR/USD), Japanese yen vs. U.S. dollars (JPY/USD), British pounds vs. U.S. dollars (GBP/USD), Swiss francs vs. USD (CHF/USD), Canadian dollars vs. USD (CDN/USD), Australian dollars vs. USD (AUD/USD), Mexican pesos vs. USD (MXN/USD), New Zealand dollars vs. USD (NZD/USD), Russian ruble vs. USD (RUB/USD), South African rand vs. USD (ZAR/USD), Brazilian real vs. USD (BRL/USD), and many others.

Most recent additions to the line-up include Chinese renminbi vs. USD (RMB/USD) and Korean won vs. USD (KRW/USD). Further, CME lists smaller sized or "E-mini" versions of several of our more popular FX futures contracts. The aforementioned contracts are generally quoted vs., and denominated in, the U.S. dollar.

Major cross-rate contracts included EUR/GBP, EUR/JPY, EUR/CHF, GBP/CHF, GBP/JPY and many

others. CME Group further offers options on many of these currency futures contracts.

Options on CME Currency Futures

In addition to operating the primary venue for the trade of FX futures, CME also offers options exercisable for futures, commencing in 1982. Note that upon exercise, rather than delivering actual currency, these contracts contemplate the establishment of a currency futures position. These contracts are accessible through the CME Globex electronic trading platform and are offered on an American style and European style basis.

Exchange traded options are similar to exchange traded futures with respect to their relatively high degree of standardization. And like currency futures, trading volumes in options on currency futures have been growing very quickly in recent years.

Mechanics of Currency Futures

Futures may be considered akin to a forward contract, and typically are priced as such, except that they are traded on a regulated futures exchange subject to standardized terms and conditions. Exchange traded currency futures have historically been distinguished from OTC FX transactions by their standardization vs. flexibility or customization inherent in working with a dealer. But exchanges are introducing greater degrees of flexibility in their trading practices.

FX futures are traded on the CME Globex® electronic trading platform and on the floor of the Exchange in an open outcry environment, although the predominant mode of trade is electronic. These contracts generally call for delivery of a specified quantity of a specified currency, or a cash settlement, during the months of March, June, September and December (the "March quarterly cycle"). [6]

Thus, one may buy or sell 12,500,000 JPY for delivery on the third Wednesday of June 2013; or, 125,000 Euros for delivery on the third Wednesday of September 2013. Traders who "go long" or buy JPY/USD futures are committed to take or accept delivery of 12,500,000 JPY while, traders who "go short" or sell EUR/USD futures are committed to make delivery of 125,000 Euros. The short making delivery is compensated by the buyer accepting delivery by an amount equal to the futures settlement price quoted in USD on the last day of trading.

Noting that the JPY/USD futures contract is based on 12,500,000 yen, this means that the June 2013 contract was valued at $126,475.00 (=12,500,000 yen x 0.010118 dollars/yen). The minimum allowable price fluctuation or "tick" in JPY/USD futures is $0.000001 yen per dollar or $12.50 (=$0.000001 x 12,500,000 yen). [7]

Digging in a bit more deeply, the table below illustrates how JPY/USD futures may be quoted. The contract is quoted in "American" terms, *i.e.*, in terms of dollars per foreign unit. This is at variance from the typical interbank practice of quoting foreign exchange transactions in terms of foreign unit per U.S. dollar.

One may readily convert these quotes from dollars per foreign unit to foreign units per dollar by simply taking the reciprocal. *E.g.,* if June 2013 JPY/USD futures close at 0.010118 dollars per yen, this may readily be converted into 98.8338 Japanese yen per one U.S. dollar (= 1/0.010118).

American vs. European Term Quotes
(As of April 12, 2013)

CME Quotes	American Terms	European Terms
USD per EUR	1.3085	0.7642
USD per JPY	0.010118	98.8338
USD per GBP	1.5338	0.6520
USD per CHF	1.0763	0.9291

These popular currency futures tend to be sized smaller than most typical institutional interbank

[6] Table 1 in our appendix below includes contract specifications for four of the most popularly traded CME Group currency futures contracts including the EUR/USD, JPY/USD, GBP/USD and CHF/USD pairings.

[7] Table 2 in our appendix below illustrates quotation practices in four of the most popular CME Group currency futures markets. Table 3 depicts how the contract and minimum price increment (or "tick" size) translates into monetary values.

currency transactions in the range of perhaps $100,000 to $200,000 in notional value. This is intended to render the contracts accessible to retail in addition to institutional traders and thereby add another element of liquidity to the marketplace, noting that one might readily trade in multiples of a single standard contract size.

Like any futures contract, FX futures are secured by performance bonds that are posted by both buyers and sellers. The performance bond or margin requirement will reflect one day's maximum anticipated price movement. Subsequently, these positions are marked-to-market (MTM) daily by the Exchange clearing house. *I.e.,* any profits or losses are posted to the trader's account on a daily basis. Thus, there are no paper profits or losses in futures.

Deliverable vs. Non-Deliverable Futures

The four major currency futures highlighted above call for the actual delivery of these currencies on deposit at designated foreign financial institutions through the Continuous Linked Settlement (CLS) system. CLS may be thought of as essentially an escrow service ensuring that payment of one currency is made vs. the other currency.

But often it becomes impractical to provide for such delivery when, for example, exchange restrictions are in force with respect to a particular currency. Under such cases, the currency may trade as non-deliverable forward (NDF) in the over-the-counter or interbank currency markets as described above. There are in fact some currency futures contracts based on non-deliverable currencies which are settled in cash upon futures contract expiration. This provision allows CME to extend the futures product line to currencies including the RMB, BRL and other generally inconvertible currencies. These contracts are cash settled vs. a representative price surveyed from the interbank NDF markets.

The Basis

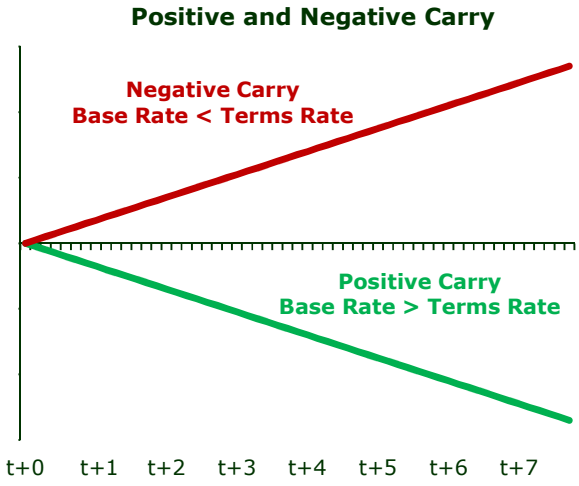
Futures are most closely compared to outright FX forward transactions and are priced in accordance with so-called cost of carry considerations. Futures market participants refer to "the basis" or the relationship between futures and spot prices. The basis may be thought of as the futures price less the spot price of the currency pairing.

$$Basis = Futures\ Price - Spot\ Price$$

The basis may be either positive or negative contingent upon the relationship between short-term interest rates prevailing with respect to the so-called "base" and "terms" currencies. [8] The appropriate level for the futures contract, or the "fair market value," is precisely analogous to the calculation of a forward price as follows.

$$Futures\ Price = Spot\ Price\ x \left(\frac{1 + \left[R_{term}\ x \left(\frac{d}{360} \right) \right]}{1 + \left[R_{base}\ x \left(\frac{d}{360} \right) \right]} \right)$$

Where the terms rate exceeds the base rate, futures should trade at premium to the spot price of the currency and the basis (of futures less spot) may be quoted as a positive number. This is a condition known as "negative carry" in futures markets because costs are incurred to buy and carry base currency.



But when the terms rate is less than the base rate, futures should trade at a discount to spot and the basis may be quoted at a negative number. This is a circumstance known as "positive carry" because earnings accrue from buying and carrying the base currency. Thus, the futures basis is analogous to

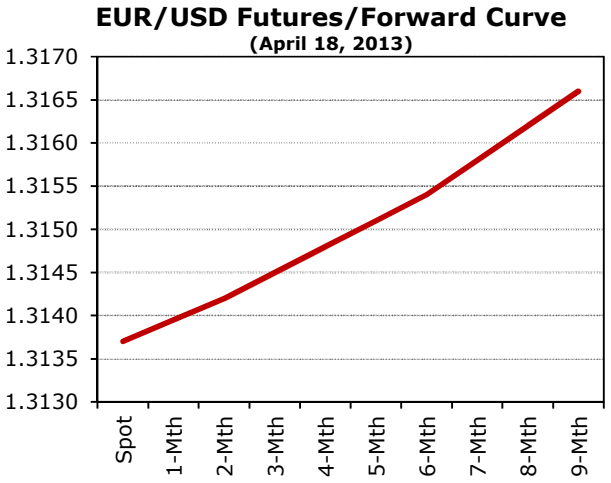
[8] As discussed above, CME FX futures are generally quoted in terms of U.S. dollars (USD) per the named currency. Thus, USD is generally considered the terms currency and the other currency in the pairing is the base currency.

"forward points" as quoted in interbank or OTC currency markets.

E.g., consider the basis for June 2013 EUR/USD futures as of April 16, 2013. The spot value of the EUR/USD was quoted at 1.3137 while the June 2013 EUR/USD futures contract was quoted at 1.3143. Thus, the basis is calculated as 0.0006 or 6.0 pips.

$$Basis = 1.3143 - 1.3137 = \ 0.0006 \ or \ 6.0 \ pips$$

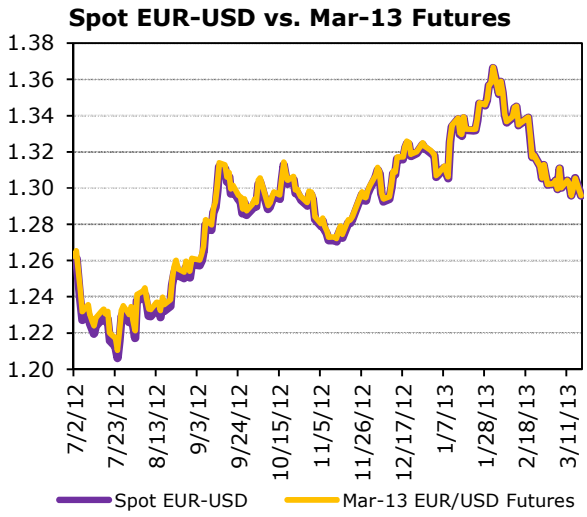
I.e., the consolidated futures and forward EUR/USD curve is trading at higher and higher levels in successively deferred maturities or settlement dates, as depicted in Table 4 and our graphic below. This reflects a condition of negative carry because short-term EUR denominated interest rates are less than short-term USD interest rates. *I.e.,* U.S. rates ("terms rate") exceed Euro rates ("base rate").



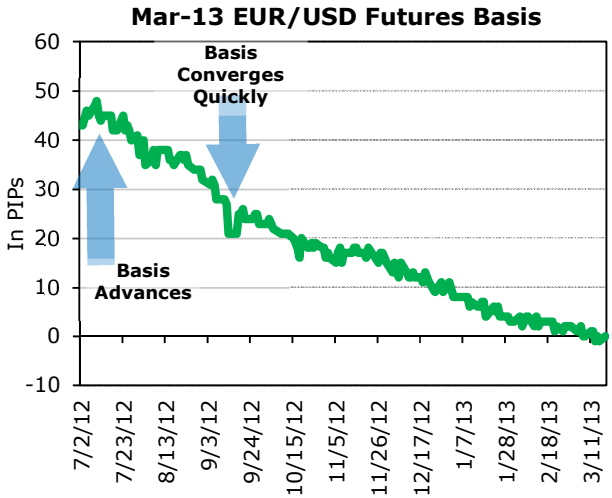
Note that we apply different short-term rates to different terms in recognition of the shape of the U.S. and Euro denominated short-term yield curves as illustrated in Table 4.

But the impact of these carry considerations is diminished over time as we approach the expiration of the futures or forward contract. This is intuitive to the extent that interest costs and expense diminish as a function of a diminished term to expiration.

As a result, the basis or differential of futures relative to spot prices is said to "converge" towards zero as expiration approaches. By the time the futures contract becomes deliverable, the futures contract becomes a direct proxy for the spot delivery of the currency in question and the basis is expected to converge to essentially zero.

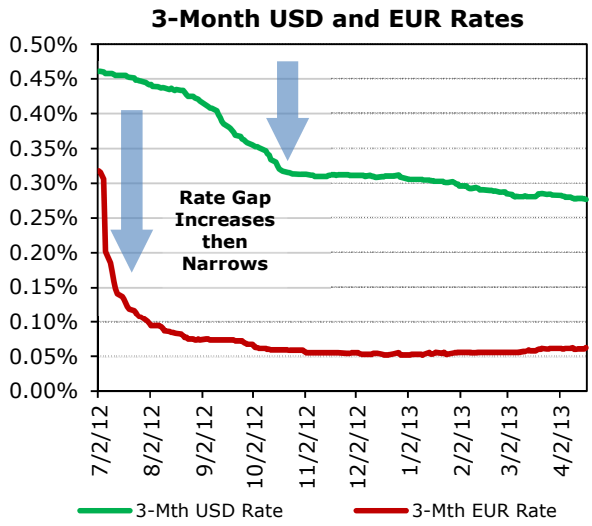


We may observe this effect by examining the relationship of the spot EUR/USD exchange rate vs. the March 2013 futures. Note that the two values fluctuate in close parallel one to the other. But if we isolate the basis as illustrated below, we see that it generally converged rather steadily towards zero by the time the March delivery occurred.



This graphic suggests that basis relationships are really quite predictable as dictated by the relationship between short-term interest rates associated with the two currencies that comprise the transaction. That is, of course, attributable to the fact that arbitrageurs monitor and promptly act upon situations where futures and spot prices are misaligned.

But there are two interesting "wiggles" in the value of the basis observed in July 2012 and in September 2012. The basis advanced a bit in July 2012 and subsequently converged or declined rather quickly in September 2012. Both of these occasions were prompted by the relative movement in the relevant U.S. and European short-term interest rates.



We see that European rates declined rather sharply in July 2012 as the European sovereign debt crisis flared up and easy money policies were enacted in response. Subsequently in September 2012 we see U.S. rates declining as well. Thus, the interest rate differential increased in July and converged in September, accounting for the slight spike and subsequent swift convergence of the March 2013 EUR/USD futures basis.

Fair Value and Arbitrage

Assume that futures prices are trading above their fair value. Under those circumstances, an arbitrageur may sell futures and buy an equivalent amount of the spot currency, eventually making delivery of the currency in satisfaction of the futures contract.

E.g., if Mar-13 EUR/USD futures were priced above their fair value of 1.3142, as illustrated in our calculation below, one might buy 125,000 Euros in the spot markets (or the equivalent of one futures contract) at the spot value of 1.3137 Euros per U.S. dollar on April 16th (for value April 18th) and eventually make delivery against the futures contract some 64 days later on June 19th.

If one leverages the transaction by borrowing at prevailing short-term U.S. rates to purchase the Euros, holding the position over the next 64 days until futures contract expiration, one would incur $79 in associated USD finance costs at a rate of 0.277%.

Presumably, one invests those Euros over the next 64 days at 0.055%, earning $16. The net cost associated with buying and carrying EUR over the 64 day period equals $164,275 or 1.3142.

Any excess over that 1.3142 at which one might be able to sell EUR/USD futures represents a potential profit. By buying and carrying spot Euros and selling EUR/USD futures, arbitrageurs' trading activities may be expected to bid up the spot currency and/or push down futures to reestablish equilibrium pricing levels.

Buy 125,000 EUR @ 1.3137 EUR/USD	-$164,212
Finance USD @ 0.277% over 64 days	-$79
Invest EUR @ 0.055% over 64 days	$16
Net cost over 64 days	-$164,275
Divided by 125,000 EUR	1.3142
Expected futures price	1.3142

If, on the other hand, futures prices were to trade below their fair value, one might buy futures and sell an equivalent amount of the currency in the spot markets, eventually taking repossession of the currency by accepting delivery of the currency in satisfaction of the futures contract.

Of course, by selling spot EUR for USD, one enjoys the opportunity to invest those dollars at the prevailing U.S. denominated rate of 0.277%, foregoing the opportunity to invest in EUR at 0.055%. Any amount under fair value of 1.3142 at which one might be able to buy futures represents a potential profit on the part of an arbitrageur.

Sell 125,000 EUR @ 1.3137 EUR/USD	$164,212
Invest USD @ 0.277% over 64 days	$79
Finance EUR @ 0.055% over 64 days	-$16
Net cost over 64 days	$164,275
Divided by 125,000 EUR	1.3142
Expected futures price	1.3142

By selling spot EUR and buying futures, this may have the effect of pushing down spot EUR and/or bidding up EUR/USD futures to establish an equilibrium price level at the fair value. In other

words, arbitrage activity essentially enforces fair value pricing.

As a practical matter, of course, one must also consider costs attendant to arbitrage, *i.e.,* slippage, commissions, fees, etc. As such, futures tend to trade within a "band" above and below its theoretical fair value and the width of that band is a reflection of the amount of those costs.

$$Fair\ Value - Arbitrage\ Costs < Futures\ Price < Fair\ Value + Abritrage\ Costs$$

Thus, when futures fall below that band, arbitrageurs may be recommended to buy futures and sell spot. When futures rise above that band, arbitrageurs may be recommended to sell futures and buy spot. In the context of currency futures, that band tends to be rather tight as the arbitrage is rather straightforward and the attendant costs are low.

Hedging with FX Futures

A firm faced with the risk of volatile exchange rates has many alternate means to address those risks. One of the most efficient and effective risk management tools in this regard is found in the form of CME currency futures contracts. Let's explore the possibilities.

The first thing that must be considered when constructing a hedging strategy is the amount of risk exposure to which one is subject. That is intuitive to the extent that the purpose of a hedge is to offset possibly adverse price fluctuations in one market with an (ideally) equal and opposite exposure in the hedging vehicle such as futures.

The identification of a "hedge ratio" (HR) in the context of currencies is a simple function of the relationship between the exposure to be hedged and the futures contract size.

$$Hedge\ Ratio\ (HR) = Value\ of\ Risk\ Exposure \div Futures\ Contract\ Size$$

E.g., assume that a company, domiciled in the U.S. and whose financial statements are denominated in U.S. dollars, agrees to sell goods to be delivered a couple of months later for a future payment of €50,000,000. As a result, the firm is exposed to the risk of a declining EUR vs. USD.

$$Hedge\ Ratio = €50{,}000{,}000 \div €125{,}000 = 400\ EUR/USD\ FX\ Futures$$

The appropriate strategy might be to sell EUR/USD futures to address the risk exposure. The hedge ratio is found by comparing that €50,000,000 risk exposure with the €125,000 futures contract size.

Short Hedge

In other words, the appropriate hedge ratio is a simple linear function of the amount of the risk exposure.

E.g., it is February 1, 2012 and the spot value of the USD/Euro rate is at $1.3158 per one EUR. This implies that the current value of that forthcoming payment of €50,000,000 was worth $65,790,000. The company wishes to protect this anticipated cash flow by selling futures. Thus, the firm sells 400 Sep-12 EUR/USD futures at 1.3173. Note that the basis at the time was quoted at 15 pips (= 1.3173 less 1.3158).

By August 1, 2012, the spot value of the EUR had fallen vs. the U.S. dollar to 1.2237. As a result, the value of those 50,000,000 EUR had declined some $4,605,000 to $61,185,000. That decline might well represent the difference between a profit and a loss on the sale.

	Spot Rate	€50MM in USD	Sep-12 Futures	Basis
2/2/12	1.3158	$65,790,000	Sell 400 @ 1.3173	15 pips
8/1/12	1.2237	$61,185,000	Buy 400 @ 1.2243	6 pips
		-$4,605,000	+$4,650,000	+9 pips
Net Gain of $45,000				

But by selling those 400 futures contracts, the company would have generated a profit that offset spot market losses. September 2013 futures declined from 1.3173 to 1.2243. This translated into a futures market profit of $4,650,000 for the company. This profit offset the spot market losses plus added another $45,000 or 9 pips to the bottom line.

Why did the transaction result in a net profit? The answer is found in basis fluctuation. Note that the futures/spot basis declined from its original level of -15 pips to 9 pips (= 1.3173 – 1.2243). Our company was effectively "short the basis" because it was short EUR in the futures market and long EUR in the spot market.

Long Hedge

Our prior example focused on a situation involving the sale of futures to offset the possibility that the EUR might decline relative to the USD, or a "short hedge." But we might likewise examine the opposite situation involving the purchase of futures (short cash) or a "long hedge."

E.g., consider the plight of a U.S. based importer who has contracted to purchase goods from a Mexican firm and agreed to pay 250,000,000 Mexican pesos (MXN) in return. In this case, the importer must be wary about the possibility that the value of the MXN will strengthen vs. the USD in the interim between the time the contract is executed and the payment is due.

Our first order of business is to identify the appropriate hedge ratio. CME MXN/USD futures call for the delivery of 500,000 Mexican pesos and is quoted in USD per MXN. Thus, the appropriate hedge ratio is calculated at 500 futures contracts as follows.

$$Hedge\ Ratio = 250{,}000{,}000\ MXN \div 500{,}000\ MXN$$
$$= 500\ MXN/USD\ Futures$$

On January 15, 2013, spot USD/MXN was quoted in European terms at 12.6103 MXN per 1 USD. But CME MXN/USD futures are quoted in American terms. Thus, taking the reciprocal of that number, we may quote the rate at $0.079300 per MXN. Thus, 250,000,000 MXN equates to $19,825,000 and it is that value that our company wishes to "lock-up" by buying MXN/USD futures contracts.

By April 15, 2013, the exchange rate fluctuates to 12.2820 MXN per USD or $0.081420 per USD. Thus, that 250 million MXN payment now translates into $20,355,000. This implies an unhedged loss of $530,000.

	Spot Rate	250 mil MXN in USD	Dec-08 Futures	Basis
1/15/13	12.6103 or 0.079300	$19,825,000	Buy 500 @ 0.078050	-12.50 pips
4/15/13	12.2820 or 0.081420	$20,355,000	Sell 500 @ 0.081900	4.8 pips
		-$530,000	+$962,500	+17.30 pips
Net Gain of $432,500				

Our company executes a long hedge by buying 500 June 2013 MXN/USD futures at the prevailing price of 0.078050. By April 15, 2013, the value of the Jun-13 contract advanced to 0.081900 which translates into a profit of $962,500 in the futures market, for a net gain of $432,500.

This attractive net gain was facilitated by an advance in the basis. Note that by being effectively short spot and long futures, you are "long the basis" and positioned to benefit from the 17.30 pip advance in the basis (=4.8 pips less -12.50 pips).

Concluding Note

To learn more about this product, visit www.cmegroup.com/fx.

Table 1: Specifications of Popular CME FX Futures

	EUR/USD Futures	JPY/USD Futures	GBP/USD Futures	CHF/USD Futures
Trade Unit	125,000 EUR	12,500,000 JPY	62,500 GBP	125,000 CHF
Minimum Price Fluctuation (Tick)	$0.0001 per EUR ($12.50)	$0.000001 per JPY ($12.50)	$0.0001 per GBP ($6.25)	$0.0001 per CHF ($12.50)
Price Limits	No Limits			
Contract Months	1st 6 months in March quarterly cycle (March, June, Sep & Dec)			
CME Globex® Hours	Sundays thru Thursdays: 5:00 pm to 4:00 pm the following day (Chicago time)			
Trading Ends	On 2nd business day before 3rd Wednesday of contract month			
Delivery	Thru Continuous Linked Settlement (CLS) Facilities			
Position Limits	No Limits			
Ticker	"6E"	"6J"	"6B"	"6S"

Table 2: Select FX Futures Pricing
(as of April 12, 2013)

	Settle-ment	Reci-procal	RTH Volume	Globex Volume	Open Interest
EUR/USD Futures (125,000 EUR)					
Jun-13	1.3085	0.7642	3,177	239,944	214,401
Sep-13	1.3094	0.7637		241	1,609
Dec-13	1.3106	0.7632		21	235
Mar-14	1.3116	0.7624			13
Jun-14	1.3129	0.7617			12
JPY/USD Futures (12,500,000 JPY)					
Jun-13	0.010118	98.8338	2,164	204,326	209,005
Sep-13	0.010125	98.7654		325	1,863
Dec-13	0.010136	98.6582		14	130
Mar-14	0.010149	98.5319			22
Jun-14	0.010163	98.3961		2	2
Sep-14	0.010179	98.2415		1	1
GBP/USD Futures (62,500 GBP)					
Jun-13	1.5338	0.6520	6,826	75,947	204,539
Sep-13	1.5332	0.6522		10	276
Dec-13	1.5329	0.6524		1	33
Mar-14	1.5327	0.6524			33
CHF/USD Futures (125,000 CHF)					
Jun-13	1.0763	0.9291	6,734	29,290	51,004
Sep-13	1.0777	0.9279			23

Note: "B" stands for bid; "A" for ask

Table 3: Sizing Select FX Futures
(as of April 12, 2013)

	Contract Size	Jun-13 Contract	Contract Value	Tick Size	Tick Value
EUR/USD Futures	125,000	1.3085	$163,562.50	$0.0001	$12.50
JPY/USD Futures	12,500,000	0.010118	$126,475.00	$0.000001	$12.50
GBP/USD Futures	62,500	1.5338	$95,862.50	$0.0001	$6.25
CHF/USD Futures	125,000	1.0763	$134,537.50	$0.0001	$12.50

Table 4: EUR/USD Futures and Forward Curve
(Intra-Day Observation on April 16, 2013)

	Maturity	Days	Price	Basis (Pips)
Spot	4/18/13	2	1.313700	
1-Mth Forward	5/20/13	34	1.313950	2.5
2-Mth Forward	6/18/13	63	1.314200	5.0
Jun-13 Futures	6/19/13	64	1.314300	6.0
3-Mth Forward	7/18/13	93	1.314500	8.0
Sep-13 Futures	9/18/13	155	1.315400	17.0
6-Mth Forward	10/18/13	185	1.315400	17.0
Dec-13 Futures	12/18/13	246	1.316000	23.0
9-Mth Forward	1/21/14	280	1.316600	29.0