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FX Derivatives Trader School

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For my wife and daughters: Laura, Rosie, and Emily.

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PREFACE

In 2004 I started on an FX derivatives trading desk as a graduate. I wrote down everything I learned: how markets worked, how FX derivatives contracts were risk-managed, how to quote prices, how Greek exposures evolve over time, how different pricing models work, and so on. This book is a summary of that knowledge, filtered through a decade of trading experience across the full range of FX derivatives products.

In 2011 I started sending out monthly "Trader School" e-mails to traders on the desk, covering a wide range of topics. The e-mails were particularly popular with new joiners and support functions because they gave an accessible view of derivatives trading that did not exist elsewhere. This book collects together and expands upon those e-mails.

Part I covers the basics of FX derivatives trading. This is material I wish I'd had access to when originally applying for jobs on derivatives trading desks. Part II investigates the volatility surface and the instruments that are used to define it. Part III covers vanilla FX derivatives trading and shows how the FX derivatives market can be analyzed. Part IV covers exotic FX derivatives trading, starting with the most basic products and slowly increasing the complexity up to advanced volatility and multi-asset products. This material will mostly be useful to junior traders or traders looking to build or refresh their knowledge in a particular area.

Fundamentally, the aim of the book is to explain derivatives trading from first principles in order to develop intuition about derivative risk rather than attempting to be state of the art. Within the text, experienced quant traders will find many statements that are not entirely true, but are true the vast majority of the time. Endlessly caveating each statement would make the text interminable.

Traders can only be successful if they have a good understanding of the framework in which they operate. Importantly though, for derivatives traders this is not the same as fully understanding derivative mathematics. Therefore the mathematics is kept to an accessible "advanced high school" level throughout. Some mathematical rigor is lost as a result of this, but for traders that is a price worth paying.

Also in the interests of clarity, some other important considerations are largely ignored within the analysis, most notably, credit risk (i.e., the risk of a counterparty defaulting on money owed) and interest rates (i.e., how interest rate markets work in practice). Derivative product analysis is the primary concern here and this is cleaner if those issues are ignored or simplified.

Regulations and technology are causing significant changes within the FX derivatives market structure. The most important changes are increasing electronic execution, increasing electronic market data, more visibility on transactions occurring in the market, and less clear distinctions between banks and their clients. These changes will have profound and lasting effects on the market. However, the ideas and techniques explored within the book hold true no matter how the market structure changes.

Finally, and most importantly, if you are a student or new joiner on a derivatives trading desk: *Do the practicals*. I can guarantee that if you complete the practicals, you will hit the ground running when you join a derivatives trading desk. *Do them*. Do them *all*. Do them all *in order*. Do not download the spreadsheets from the companion website unless you are completely stuck. When you're trying to learn something, taking the easy option is never the right thing to do. The practicals require the ability to set up Excel VBA (Visual Basic for Applications) functions and subroutines. If you aren't familiar with this, there is plenty of material online that covers this in detail.

The very best of luck with your studies and careers,

Giles Jewitt, London, 2015.

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This publication reflects the views of the author only.

This publication is intended to be educational in nature and should be used for information purposes only.

Any opinions expressed herein are given in good faith, but are subject to change without notice.

Any strategies discussed are strictly for illustrative and educational purposes only and are not to be construed as an endorsement, recommendation, or solicitation to buy or sell any financial securities.

All rates and figures used are for illustrative purposes only and do not reflect current market rates.

FX Derivatives Trader School

PART I

THE BASICS

Part I lays the foundations for understanding FX derivatives trading. Trading within a financial market, market structure, and the Black-Scholes framework are all covered from first principles. FX derivatives trading risk is then introduced with an initial focus on vanilla options since they are by far the most commonly traded contract.

CHAPTER 1

Introduction to Foreign Exchange

The *foreign exchange (FX) market* is an international marketplace for trading **currencies**. In FX transactions, one currency (sometimes shortened to CCY) is *exchanged* for another. Currencies are denoted with a three-letter code and **currency pairs** are written CCY1/CCY2 where the **exchange rate** for the currency pair is the number of CCY2 it costs to buy one CCY1. Therefore, trading EUR/USD FX involves exchanging amounts of EUR and USD. If the FX rate goes higher, CCY1 is getting relatively stronger against CCY2 since it will cost more CCY2 to buy one CCY1. If the FX rate goes lower, CCY1 is getting relatively weaker against CCY2 because one CCY1 will buy fewer CCY2.

If a currency pair has both elements from the list in Exhibit 1.1, it is described as a *G10 currency pair*.

The most commonly quoted FX rate is the **spot rate**, often just called **spot**. For example, if the EUR/USD spot rate is 1.3105, EUR 1,000,000 would be exchanged for USD 1,310,500. Within a spot transaction the two cash flows actually hit the bank account (*settle*) on the **spot date**, which is usually two business days after the transaction is agreed (called T+2 settlement). However, in some currency pairs, for example, USD/CAD and USD/TRY (Turkish lira), the spot date is only one day after the transaction date (called T+1 settlement).

Another set of commonly traded FX contracts are **forwards**, sometimes called **forward outrights**. Within a forward transaction the cash flows settle on some future date other than the spot date. When rates are quoted on forwards, the **tenor** or **maturity** of the contract must also be specified. For example, if the EUR/USD 1yr (one-year) forward FX rate is 1.3245, by transacting this contract in EUR10m

EXHIBIT 1.1 **G10 Currencies**

CCY Code	Full Name	CCY Code	Full Name
AUD	Australian dollar	JPY	Japanese yen
CAD	Canadian dollar	NOK	Norwegian krone
CHF	Swiss franc	NZD	New Zealand dollar
EUR	Euro	SEK	Swedish krona
GBP	Great British pound	USD	United States dollar

(ten million euros) **notional**, each EUR will be exchanged for 1.3245 USD (i.e., EUR10m will be exchanged for USD13.245m in one year's time). In a given currency pair, the spot rate and forward rates are linked by the respective **interest rates** in each currency. By a no-arbitrage argument, delivery to the forward maturity must be equivalent to trading spot and putting the cash balances in each currency into "risk-free" investments until the maturity of the forward. This is explained in more detail in Chapter 5.

Differences between the spot rate and a forward rate are called **swap points** or **forward points**. For example, if EUR/USD spot is 1.3105 and the EUR/USD 1yr forward is 1.3245, the EUR/USD 1yr swap points are 0.0140. In the market, swap points are quoted as a number of **pips**. Pips are the smallest increment in the FX rate usually quoted for a particular currency pair. In EUR/USD, where FX rates are usually quoted to four decimal places, a pip is 0.0001. In USD/JPY, where FX rates are usually only quoted to two decimal places, a pip is 0.01. In the above example, an FX swaps trader would say that EUR/USD 1yr swap points are at 140 ("one-forty").

Pips (sometimes called "points") are also used to describe the magnitude of FX moves (e.g., "EUR/USD has jumped forty pips higher" if the EUR/USD spot rate moves from 1.3105 to 1.3145). Another term used to describe spot moves is **figure**, meaning one hundred pips (e.g., "USD/JPY has dropped a figure" if the USD/JPY spot rate moves from 101.20 to 100.20).

FX swap contracts contain two FX deals in opposite directions (one a buy, the other a sell). Most often one deal is a spot trade and the other deal is a forward trade to a specific maturity. The two trades are called the **legs** of the transaction and the notionals on the two legs of the FX swap are often equal in CCY1 terms (e.g., buy *EUR10m* EUR/USD spot against sell *EUR10m* EUR/USD 1yr forward). FX swaps are quoted in swap point terms (the difference in FX rate) between the two legs. In general, swap points change far less frequency than spot rates in a given currency pair.

A trader takes up a new FX position by buying USD10m USD/CAD spot at a rate of 0.9780. This means buying USD10m and simultaneously selling CAD9.78m. This position is described as "long ten dollar-cad," meaning USD10m has been bought

and an equivalent amount of CAD has been sold. If USD10m USD/CAD had been sold at 0.9780 instead, the position is described as "short ten dollar-cad." Note that the long/short refers to the *CCY1* position. The concept of selling something you don't initially own is a strange one in the real world but it quickly becomes normal in financial markets where trading positions can flip often between long (a net bought position) and short (a net sold position).

USD/CAD spot jumps up to 0.9900 after it was bought at 0.9780: The trader is a hero! Time to sell USD/CAD spot and lock in the profit. Selling USD10m USD/CAD spot at 0.9900 results in selling USD10m against buying CAD9.9m. The initial bought USD10m and new sold USD10m cancel out, leaving no net USD position, but the initial sold CAD9.78m and new bought CAD9.9m leave CAD120k profit. This is important: FX transactions and positions are usually quoted in CCY1 terms (e.g., *USD*10m USD/CAD) while the profit and loss (P&L) from the trade is naturally generated in CCY2 terms (e.g., *CAD*120k).

A **long** position in a financial instrument *makes money* if the price of the instrument *rises* and *loses money* if the price of the instrument *falls*. Mathematically, the intraday P&L from a long spot position is:

$$P\&L_{CCY2} = Notional_{CCY1}.(S_T - S_0)$$

where S_0 is the initial spot rate and $S_T$is the new spot rate.

Exhibit 1.2 shows the P&L from a long spot position. As expected, P&L expressed in CCY2 terms is linear in spot.

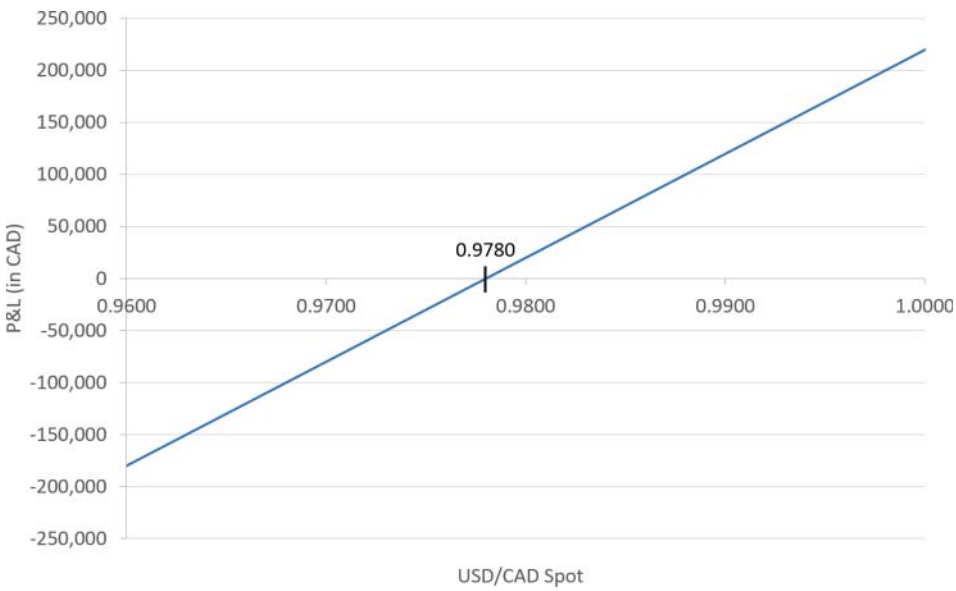


EXHIBIT 1.2 P&L from long USD10m USD/CAD spot at 0.9780

A **short** position in a financial instrument *makes money* if the price of the instrument *falls* and *loses money* if the price of the instrument *rises*. The intraday P&L from a short spot position is also:

$$P\&L_{CCY2} = Notional_{CCY1}.(S_T - S_0)$$

However, the notional will be negative to denote a short position.

Exhibit 1.3 shows the P&L from a short spot position. Again, P&L expressed in CCY2 terms is linear in spot.

If the P&L from these spot deals is brought back into CCY1 terms, the conversion between CCY2 and CCY1 takes place at the prevailing spot rate. Therefore, the CCY1 P&L from a spot position is:

$$P\&L_{CCY1} = Notional_{CCY1}.\frac{(S_T - S_0)}{S_T}$$

At lower spot levels, an amount of CCY2 will be worth relatively more CCY1 (spot lower means CCY2 stronger and CCY1 weaker). At higher spot levels, an amount of CCY2 will be worth relatively fewer CCY1 (spot higher means CCY1 stronger and CCY2 weaker). This effect introduces curvature into the P&L profile as shown in Exhibit 1.4.

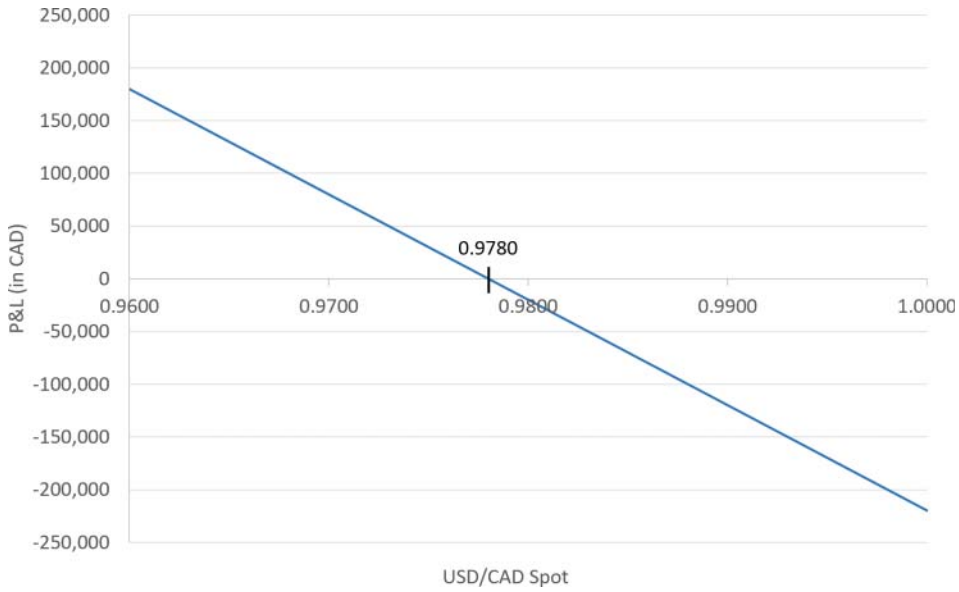


EXHIBIT 1.3 P&L from short USD10m USD/CAD spot at 0.9780

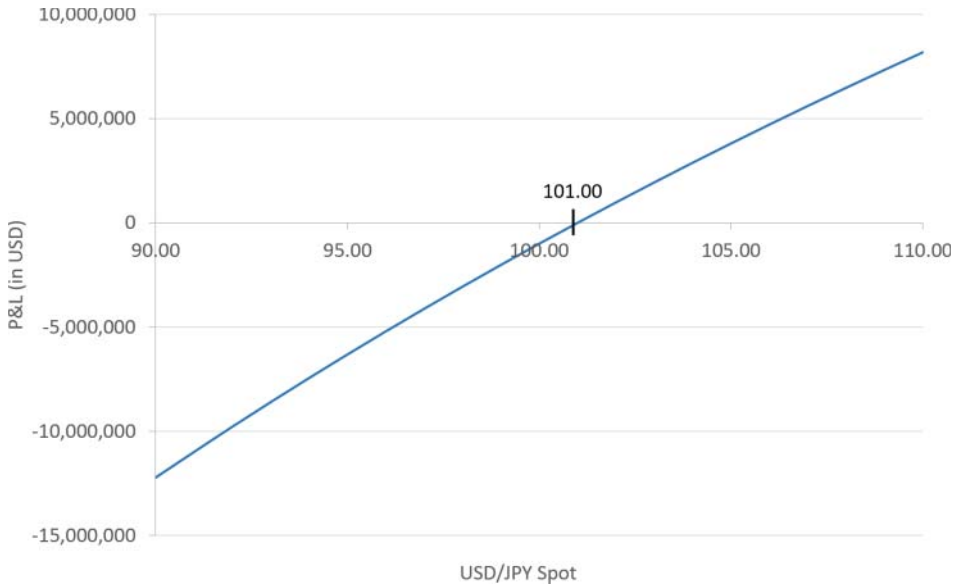


EXHIBIT 1.4 P&L from long USD100m USD/JPY spot at 101.00

Practical Aspects of the FX Market

The international foreign exchange market is enormous, with trillions of dollars' worth of deals transacted each day. The most important international center for FX is London, followed by New York. In Asia, Tokyo, Hong Kong, and Singapore are roughly equally important.

The USD is by far the most frequently traded currency with the majority of FX trades featuring USD as either CCY1 or CCY2. EUR/USD is the most traded currency pair, followed by USD/JPY and then GBP/USD.

FX traders draw a distinction between **major currency pairs**: the most commonly traded currency pairs, usually against the USD, and **cross currency pairs**. For example, EUR/USD and AUD/USD are majors while EUR/AUD is a cross. FX rates in cross pairs are primarily determined by the trading activity in the majors. The FX market is highly efficient so if EUR/USD spot is trading at 1.2000 and AUD/USD spot is trading at 0.8000, EUR/AUD spot will certainly be trading at 1.5000 (1.2/0.8).

Exhibit 1.5 is a mocked-up screen-grab of a market-data tool showing live spot rates in major G10 currency pairs. In practice these rates change (*tick*) many times a second.

Pair	Bid	Offer	Day Low	Day High
EUR/USD	1.3651	1.3652	1.3647	1.3688
GBP/USD	1.6898	1.6899	1.6856	1.6913
USD/CHF	0.8933	0.8934	0.8923	0.8950
AUD/USD	0.9237	0.9238	0.9221	0.9274
NZD/USD	0.8567	0.8568	0.8556	0.8587

EXHIBIT 1.5 Sample G10 spot rates

G10 currency pairs are (mostly) freely floating with no restrictions on their trading. The G10 FX markets are tradable 24 hours a day between Wellington Open (9 A.M. Wellington, New Zealand time) on Monday through to New York Close (5 P.M. New York time) on Friday.

In G10 pairs, the market convention for quoting a currency pair can be deduced from this ordering: EUR > GBP > AUD > NZD > USD > CAD > CHF > NOK > SEK > JPY. For example, the CAD against GBP FX rate is quoted in the market as GBP/CAD. Unfortunately, with market convention rules there are often exceptions. For example, the majority of the market quotes EUR against GBP as EUR/GBP but some U.K. corporates trade in GBP/EUR terms since GBP is their natural notional currency.

Emerging market (EM) countries often have mechanisms in place to control currency flows. For example, some EM currencies have limited spot open hours and some *peg* their currency at a fixed level or maintain it within a trading band by buying and selling spot or by restricting transactions. When trading in an emerging market currency it is vital to learn exactly how the FX market functions in that country. EM majors are quoted as the number of EM currency to buy one USD (i.e., USD/CCY).

In currency pairs with restrictions on spot transactions, **Non-Deliverable Forward** (**NDF**) contracts are often traded. NDFs settle into a single cash payment (usually in USD) at maturity rather than the two cash flows in a regular FX settlement. The **fix**, a reference FX rate published at a certain time every business day in the appropriate country, is used to determine the settlement payment.

Up-to-date FX rates can be found on the Internet using, for example, Yahoo finance (http://finance.yahoo.com/) or XE.com (http://www.xe.com/).

What Do FX Traders Call Different Currency Pairs?

Nobody on the trading floor calls USD/JPY "*you-ess-dee-jay-pee-why*." Major currency pairs have names that are well established and widely used. Standardized

EXHIBIT 1.6 **Selected G10 Currency Pair Names**

Currency Pair	Common Name
USD/CAD	"dollar-cad"
USD/JPY	"dollar-yen"
GBP/USD	"cable" (FX prices between London and New York used to be transmitted over a cable on the Atlantic ocean floor.)
EUR/USD	"euro-dollar"
AUD/USD	"aussi-dollar"
NZD/USD	"kiwi-dollar"
EUR/CHF	"euro-swiss" or "the cross"
EUR/NOK	"euro-nock" or "euro-nockie"
EUR/SEK	"euro-stock" or "euro-stockie"

EXHIBIT 1.7 **Selected EM Currency Pair Names**

Currency Pair	Common Name
USD/HKD	"dollar-honkie"
USD/CNY	"dollar-china"
USD/SGD	"dollar-sing"
USD/MXN	"dollar-mex"
USD/TRY	"dollar-try" or "dollar-turkey"
USD/ZAR	"dollar-rand"
USD/BRL	"dollar-brazil"

language is common in financial markets. It enables quick and accurate communication but it exposes those who are not experienced market participants. For this reason, using the correct market terms is important. See Exhibits 1.6 and 1.7 for common G10 and EM currency pair names.

CHAPTER 2

Introduction to FX Derivatives

The FX market can be split into three main product areas with increasing complexity:

1. Spot: guaranteed currency exchange occurring on the spot date.
2. Swaps / Forwards: guaranteed currency exchange(s) occurring on a specified date(s) in the future.
3. **Derivatives**: contracts whose value is *derived* in some way from a reference FX rate (most often spot). This can be done in many different ways, but the most common FX derivative contracts are **vanilla call options** and **vanilla put options**, which are a *conditional* currency exchange occurring on a specified date in the future.

Vanilla Call and Put Options

Vanilla FX call option contracts give the *right-to-buy* spot on a specific date in the future while vanilla FX put option contracts give the *right-to-sell* spot on a specific date in the future. The term *vanilla* is used because calls and puts are the standard contract in FX derivatives. The vast majority (90%+) of derivative transactions executed by an FX derivatives trading desk are vanilla contracts as opposed to **exotic contracts**. Exotic FX derivatives (covered in Part IV) have additional features (e.g., more complex payoffs, barriers, averages).

To understand how call and put options work, forget FX for the moment and think about buying and selling apples (not Apple Inc. stock, but literally the green round things you eat). Apples currently cost 10p each. I know that I will need to buy

100 apples in one month's time. If I simply wait one month and then buy the apples, perhaps the prevailing price will be 5p and hence I can buy the apples cheaper than they currently are *or* perhaps the price will be 15p and hence more expensive *or* perhaps they will cost 10p, 1p, or 999p. The point is that there is *uncertainty* about how much the apples will cost and this uncertainty makes planning for the future of my fledgling apple juice company more difficult. Call and put options allow this uncertainty to be controlled.

One possible contract that could be purchased to control the risk is a one-month (1mth) call option with a **strike** of 10p and a **notional** of 100 apples. Note the different elements within the contract: the date in the future at which I want to complete the transaction (maturity: one month), the direction (I want to buy apples; therefore, I purchase a call option), the level at which I want to transact (strike: 10p) and the amount I want to transact (notional: 100 apples). After buying this call option, one month hence, at the maturity of the contract, if the price of apples is above the strike (e.g., at 15p) I will **exercise** the call option I bought and buy 100 apples at 10p from the seller (also known as the **writer**) of the option contract. Alternatively, if the price of apples is below the strike (e.g., at 5p), I don't want or need to use my right to buy them at 10p; hence the call option contract **expires**. Instead I will buy 100 apples directly in the market at the lower rate.

Therefore, by buying the call option, the **worst-case purchasing rate** is known; under no circumstances will I need to buy 100 apples in one month at a rate higher than 10p (the strike). This reduction in uncertainty comes at a cost: the **premium** paid upfront to purchase the call option. It is not hard to imagine that the premium of the call option will depend on the details of the contract: How long it lasts, how many apples it covers, the transaction level, plus crucially the **volatility** of the price of apples will be a key factor. The more volatile the price of apples, the more the call option will cost.

Exhibit 2.1 shows the P&L profile from this call option at maturity, presented in familiar hockey-stick diagram terms but without the initial premium included.

At the option maturity, if the price of apples is below the strike (10p), the call option has no value because the underlying can be bought cheaper in the market. If the price of apples is above the strike at maturity, the call option value rises linearly with the value of the underlying.

Mathematically, the P&L at maturity from this call option is:

$$P\&L = Notional \,.\, max(S_T - K,\ 0)$$

where *Notional* is expressed in terms of number of apples, S_T is the price of apples at the option maturity, and K is the strike. Often $max(S_T - K,\ 0)$ is written $(S_T - K)^+$.

It is worth noting that the P&L at maturity from the contract depends only on the price of apples at the moment the option contract matures; the path taken to get there is irrelevant.

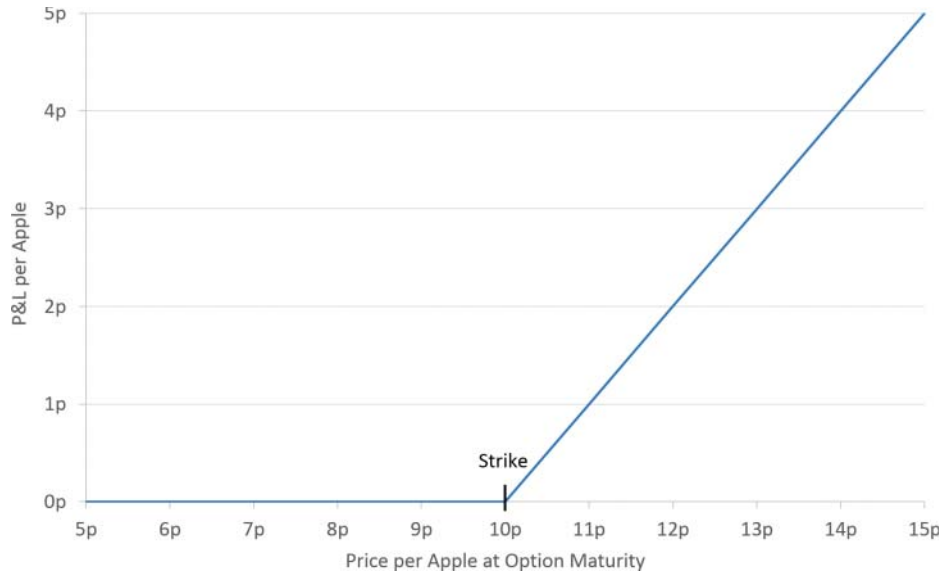


EXHIBIT 2.1 P&L per apple at maturity from call option with 10p strike

Put options are the right-to-sell the underlying. This can be conceptually tricky to grasp at first—*buying* the right to *sell*. Imagine you own a forest of apple trees. You know that by the end of August you will harvest at least 1,000 apples, which you will then want to sell. Again, uncertainty arises from the fact that the future price of apples is unknown. To control this uncertainty, a put option maturing on August 31 could be bought with a notional of 1,000 apples and a strike of 10p.

This time, at the option maturity, if the price of apples is below the strike (e.g., at 5p), the put option will be **exercised** and 1,000 apples will be sold at 10p to the option seller. Alternatively, if the price of apples is above the strike (e.g., at 15p), the put option will **expire** and 1,000 apples can instead be sold in the market at a higher rate.

By buying the put option, the **worst-case selling rate** is known; under no circumstances will I need to sell 1,000 apples at a rate lower than 10p (the strike) at the end of August. The cost of buying this derivative contract will depend on the exact contract details, plus, again, the more volatile the price of apples, the more the option will cost. Exhibit 2.2 shows the P&L profile from this put option at maturity.

Mathematically, the P&L at maturity from this put option is:

$$P\&L = Notional \,.\, max(K - S_T,\ 0)$$

Bringing these concepts into FX world, the underlying changes from the price of apples to an FX spot rate. At the option maturity, the prevailing FX spot rate will

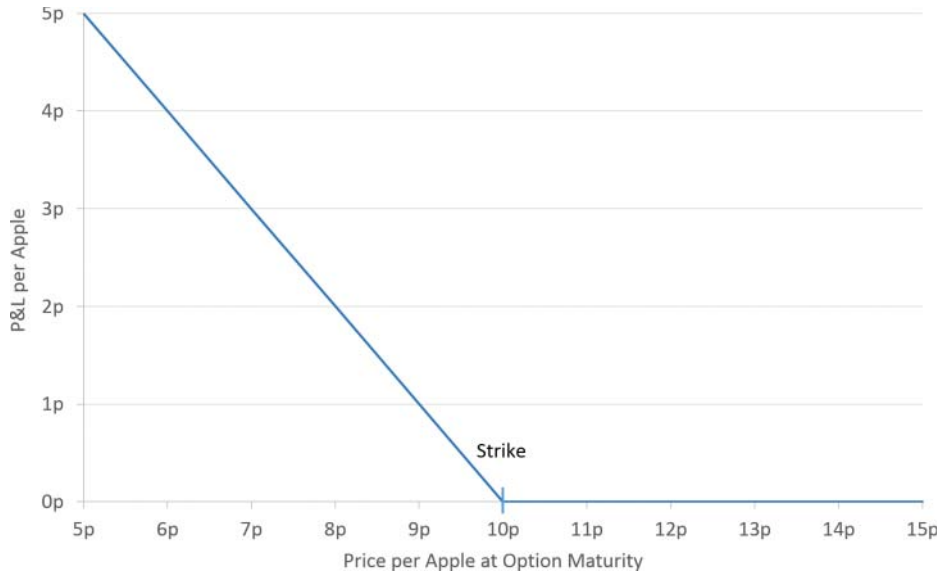


EXHIBIT 2.2 P&L per apple at maturity from put option with 10p strike

be compared to the strike to determine whether a vanilla option will be exercised or expired.

There are actually two main kinds of vanilla option:

1. European vanilla options can be exercised only *at* the option maturity.
2. American vanilla options can be exercised *at any time* before the option maturity.

European vanilla options are the standard product in the FX derivatives market because they are easier to risk manage and mathematically simpler to value. Henceforth, any mention of a *vanilla* option means a European-style contract. American vanilla options are covered in Chapter 27.

The following details are required to describe a vanilla FX option contract:

Currency pair: The spot FX rate in this currency pair is the reference rate against which the value of the vanilla option will be calculated at maturity.

Call or put (call = right-to-buy/put = right-to-sell): FX transactions exchange two currencies: one that is bought and one that is sold. Therefore, a vanilla option in a particular currency pair is simultaneously a right-to-buy one currency and a right-to-sell the other. Therefore, vanilla options are simultaneously a call on CCY1 and a put on CCY2 or vice-versa. Most often only the CCY1 direction is specified when describing the contract, so, for example, a EUR/USD call option is actually a EUR call and a USD put.

Maturity/expiry: The date on which the owner of the option decides whether to exercise their option or let it expire. There is actually a third option to *partially exercise* the option, which is explored in Chapter 9.

Cut: The exact time on the expiry date at which the option matures.

The two most common cuts in G10 currency pairs are:

- New York (NY): 10 A.M. New York time, which is usually 3 P.M. London time.
- Tokyo (TOK): 3 P.M. Tokyo time, which is 6 A.M. or 7 A.M. London time, depending on the time of year.

Strike: The rate at which the owner of the option has the right to exchange CCY1 and CCY2 at maturity.

Notional: The amount of cash (usually expressed in CCY1 terms) that can be exchanged at maturity. Vanilla option notionals can be converted between CCY1 and CCY2 terms using the strike as shown in Exhibit 2.3 since the strike is the level at which CCY1 and CCY2 are potentially exchanged at maturity.

Mathematically, the P&L at maturity from a long (bought) CCY1 call option is:

$$P\&L_{CCY2} = Notional_{CCY1} \,.\, max(S_T - K,\ 0)$$

where S_T is the spot FX rate at the option maturity and K is the strike. The CCY1 call P&L at maturity is the same as a long FX position (to the maturity date, i.e. a forward) above the strike. Exhibit 2.4 shows the P&L at maturity from a long USD/CAD call option (USD call/CAD put).

Likewise, the P&L at maturity from a long (bought) CCY1 put option is:

$$P\&L_{CCY2} = Notional_{CCY1} \,.\, max(K - S_T,\ 0)$$

The CCY1 put P&L at maturity is the same as a short FX position below the strike. Exhibit 2.5 shows the P&L at maturity from a long USD/CAD put option (USD put/CAD call).

Exhibit 2.6 shows a USD/JPY vanilla contract in an FX derivatives pricing tool. Traders use systems like this to price vanilla option contracts.

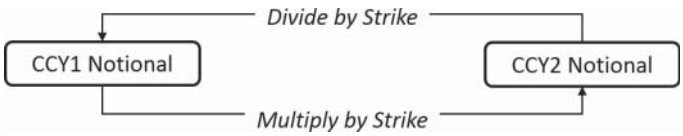


EXHIBIT 2.3 Converting between CCY1 and CCY2 notionals

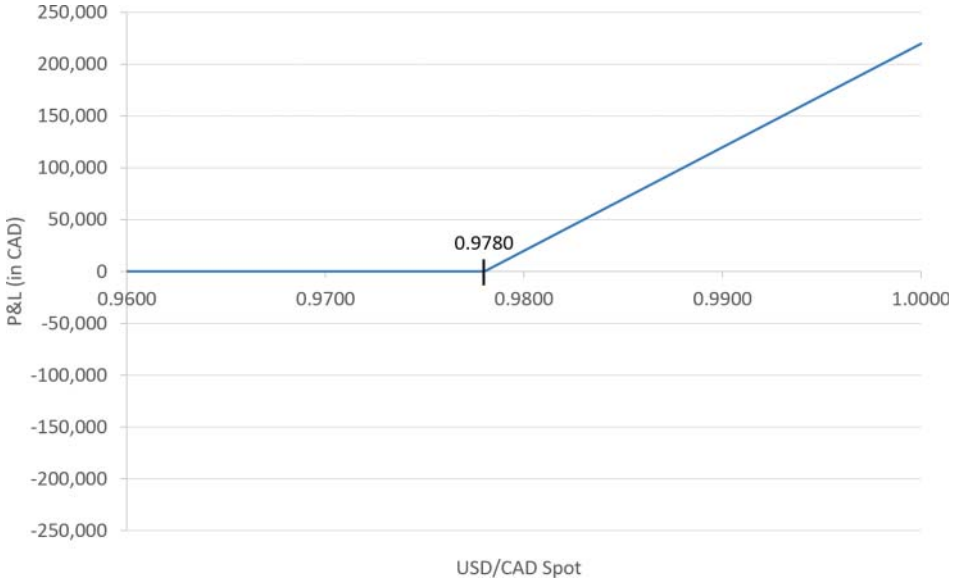


EXHIBIT 2.4 P&L at maturity from long USD10m USD/CAD call option with 0.9780 strike

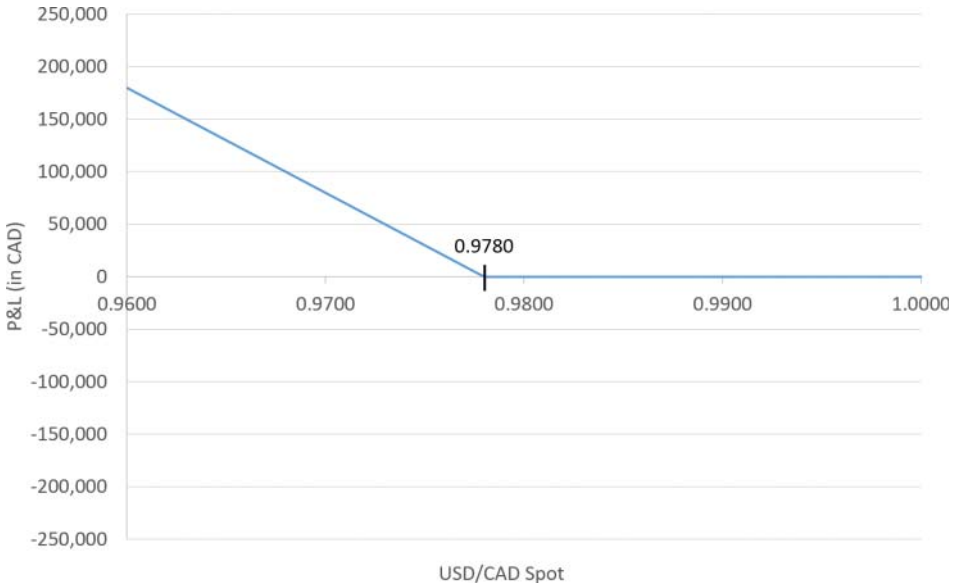


EXHIBIT 2.5 P&L at maturity from long USD10m USD/CAD put option with 0.9780 strike

Contract Details	Leg 1
Currency Pair	USD/JPY
Horizon	Fri 18-Oct-13
Spot Date	Tue 22-Oct-13
Strategy	Vanilla
Call / Put	USD Call / JPY Put
Maturity	1M
Expiry Date	Wed 20-Nov-13
Delivery Date	Fri 22-Nov-13
Cut	NY
Strike	80.00
Notional	USD5m
Market Data	
Spot	79.50
Swap Points	-2.00
Forward	79.48
Deposit (USD)	0.35%
Deposit (JPY)	0.07%
ATM Volatility	7.00%
Pricing Volatility	**7.25 / 7.65%**
Outputs	
Output Currency	USD
Premium	**0.44 / 0.48%**
Price Spread	0.04%

EXHIBIT 2.6 FX derivatives pricing tool showing a USD/JPY vanilla contract

Within the pricing tool, the **horizon** is the current date (i.e., today). On the **expiry date** (Nov. 20, 2013) at 10 A.M. NY time (since the option is priced to NY cut), the owner (buyer) of this European-style vanilla option will contact the writer (seller) of the option to inform them if they want to exercise the option.

If the spot rate at maturity is above the strike (80.00), the option is said to be **in-the-money (ITM)**. In this case the option will be exercised because the option gives its owner the right to transact at a better rate than the spot level. If the option is exercised, on the **delivery date** (Nov. 22, 2013; the delivery date is calculated from the expiry date in the same way that the spot date is calculated from the horizon—see Chapter 10 for more information on tenor calculations), the option owner will get longer USD5m versus shorter JPY400m while the option writer will get the opposite position.

If the spot rate at maturity is below the strike (80.00), the option is said to be **out-of-the-money (OTM)**. The option owner should let the option expire because USD/JPY spot can be bought more cheaply in the market.

Note that for a put option with all other contract details the same, the ITM and OTM sides flip: the ITM side is below the strike and the OTM side is above the strike.

Within the pricing tool, both volatility and premium prices are shown for the contract. Some market participants want prices quoted in volatility terms while

others want prices quoted in premium terms. The **Black-Scholes formula** provides the link between volatility and premium. The formula takes as inputs the vanilla option contract details: maturity, option type (call or put), strike, plus market data: current spot, current forward/interest rates to the option maturity. The final input is *volatility* and the Black-Scholes formula can then be used to calculate the *option premium*. In Exhibit 2.6, a *two-way volatility* (explained in Chapter 3) is given and the Black-Scholes formula is used to calculate an equivalent *two-way premium*. It may seem strange that a price would be quoted in volatility terms but this is exactly how the FX derivatives market works. The essence of an FX derivative trader's job is to buy and sell exposure to FX volatility.

Practical Aspects of the FX Derivatives Market

FX derivatives trading volumes are roughly 5% of total foreign exchange trading volumes, equating to hundreds of billions of U.S. dollars' worth of transactions every day. Currency pairs that have higher trading volumes in their spot, forward, and FX swap markets tend to also have higher trading volumes in their FX derivatives markets.

The majority of FX derivatives trading occurs in contracts with maturities of one year and under. However, in some currency pairs long-dated contracts are traded—sometimes out to ten years or even longer.

Vanilla options in G10 currency pairs are usually **physically delivered**, meaning that at maturity, if the option is exercised, an exchange of cash flows (i.e., an FX spot trade) occurs.

In some emerging market currency pairs, vanilla options are **cash settled**, meaning that at maturity a fix is used to determine a settlement amount that is paid as a single (usually USD) cash flow. In G10 currency pairs it is also possible to use a fix to settle derivative contracts but this is less common.

CHAPTER 3

Introduction to Trading

Fundamentally, markets are a mechanism to match buyers and sellers in order to determine the prices of goods and services. Traders interact directly with financial markets, buying and selling in order to manage their deal inventory and change their trading positions.

The process of operating within a financial market is easier to explain using a simple market. Therefore, this chapter uses a market on a single asset, like spot FX or a single equity contract, as the reference. However, the same ideas also apply to more complex markets, including FX derivatives.

Bids and Offers

The building blocks of financial markets are two types of order:

1. *Bid*: a rate at which a price maker is willing to buy
2. *Offer* (also called *Ask*): a rate at which a price maker is willing to sell

Bids and offers need to have a size associated with them. Saying, "I will buy apples for 10p each," is interesting to another market participant but not enough information; will you buy ten apples or a million apples?

There is an important distinction between price makers (also called market makers) and price takers within financial markets. Price makers leave orders in the market. Price takers come into the market and trade on existing orders. If a price taker wants to buy, the contract must be bought at a price maker's offer, and if

a price taker wants to sell, the contract must be sold at a price maker's bid. Put another way, the price maker buys at their bid and sells at their offer, while the price taker sells at a price maker's bid and buys at a price maker's offer.

Within the market for a particular financial contract, if a trader wants to buy, there are essentially two ways of doing it:

1. Pay an offer (i.e., buy from someone who is showing an offer).
2. Leave a bid and hope that someone sells to you.

To sell, again, there are two possible methods:

1. Give a bid (i.e., sell to someone who is showing a bid).
2. Leave an offer and hope that someone buys from you.

There are two major differences between these approaches. The first is that trading on existing bids and offers can be executed instantly while leaving orders can take longer and may not happen at all since it requires someone else in the market to trade on your order. Generally, this requires the market to move toward the order level. The second difference is that leaving orders usually results in transacting at a better rate.

A reduced view of the current market is often given, showing only the single best bid and single best offer in a given contract. The best bid is the highest of all current bids (i.e., the most that anyone in the market is willing to pay to buy the contract). The best offer is the lowest of all current offers (i.e., the least that anyone in the market is willing to receive to sell the contract). The best bid and best offer combine to form the tightest **two-way** price in the market (i.e., the price with the tightest bid–offer spread, or put another way, the smallest difference between bid and offer).

Exhibit 3.1 shows a snapshot of an imaginary international apple market, showing bids on the left and offers on the right with shaded backgrounds. This is called the order book, which shows the **depth** in the market (i.e., all current bids and offers in the market) and a size associated with each order. Prior to transacting, this market is anonymous (i.e., it isn't known which market participant has left any particular order) and it often also isn't clear whether an order at a particular level is one order or a collection of multiple orders aggregated together.

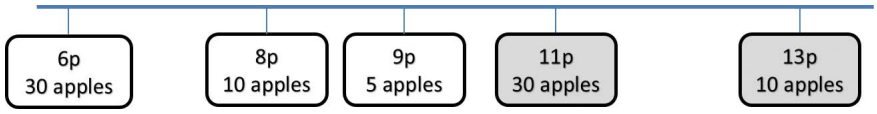


EXHIBIT 3.1 Apple market order book

In this example, the best bid is 9p and the best offer is 11p. Most of the time, the best bid is simply referred to as "the bid" and the best offer is "the offer." Lower bids and higher offers are referred to as being "behind."

For a given contract, offers are (almost) always above bids. However, in some situations, a market will be **choice**, meaning the bid and offer are at the same level. Even rarer, the offer can be below the bid—an **inverted** market. Markets rarely stay genuinely inverted for long, since the market participants showing the inverted bid and offer should be happy to trade with each other and hence restore the normal bid–offer direction. An inverted market often occurs when the relevant market participants *can't* trade with each other for some reason.

Trader X wants to buy 100 apples at 8p and trader Y wants to sell 100 apples at 8p. If trader X and trader Y each know what the other wants to do, they should be happy to trade with each other at 8p. It is therefore vital that both traders know of each other's intentions. For a market to function efficiently, *transparency* and the *flow of information* are key considerations.

Back to our apple order book: As mentioned, selling 10 apples in this market can essentially be done in two ways:

1. *Give the bids*. Five apples can be sold at 9p and five apples can be sold at 8p (so five of the 8p bid would remain). This averages at a rate of 8.5p to sell the apples but the transaction will certainly be completed.
2. *Leave an offer*. The rate of 11p already has an offer there. By "joining" (i.e., showing the same offer) the 11p offer in 10 apples, the size of that offer will go up to 40 apples.

   Note that *if* the 11p offer starts being paid, the original 11p offers will be transacted first. The offer could also be left at a higher level, at 12p or 13p, which would lead to potentially transacting at a better rate (selling higher), but the higher the offer, the lower the chance of transacting and the longer it will take.

In practice, particularly in faster markets, traders work buy or sell orders using a combination of trading on orders and placing orders. If the order was in larger size, the trader might dynamically leave (*place*) and remove (*pull*) orders, depending on how the market is reacting in order to get the best possible transaction level (*fill*).

In the apples example, if the 11p offer were to further increase in size, it is possible that bids would be pulled, or would be moved lower, since traders will see the large size on the offer and conclude that there are a large number of sellers in the market who will push the price lower. For this reason it is sometimes appropriate to transact an order in smaller chunks over time to reduce market impact.

Exchanges offer different order types that give additional control around how a bid or offer is processed. For example, *limit orders* allow buyers to define their maximum purchase price and sellers to define their minimum sale price while

fill-or-kill orders are either executed immediately in their entirety, or else the order is canceled.

Decisions on how to transact within a certain market are based on an understanding of the relationships between transaction size, probability of transacting, transaction speed, and transaction rate. These factors are often combined into one word: **liquidity**.

Leaving Orders

Bids and offers aren't always left close to the current market. A bid could be left to, for example, buy 100 apples at 5p, with the market currently trading at 10p. In general,

- When an order sells above or buys below the current market level, this is called a **take profit** order. The term "take profit" implies there is an existing position that will make money if the market moves to the order level and the order then closes out the position, hence taking profit, although the original position may not actually exist.
- When an order buys above or sells below the current market level, this is called a **stop loss** order. Again, the term "stop loss" implies there is an existing position that will lose money if the market gets to the order level and the order then closes out the position, hence stopping the loss, although the original position may not actually exist.

Bid–Offer Spread

When a trader makes a two-way price on a contract for a client, the difference between the bid and the offer is called the **bid–offer spread**. Conceptually this spread exists to cover the market maker for the potential risk of holding the position over time if the client trades on either the bid or offer. Bid–offer spread is therefore a function of (amongst other things):

- *Contract volatility*: the more volatile a contract, the wider the bid–offer spread.
- *Average holding period*: the length of time before an offsetting (or approximately offsetting) trade can be found in the market. The longer until an offsetting trade can be found, the wider the bid–offer spread.

Traders also adjust their bid–offer spreads based on risk/reward preference:

- Showing a tighter bid–offer spread (hence a higher bid and a lower offer) increases the chance of the client trading but gives a smaller spread to protect from future price changes.

- Showing a wider bid–offer spread (hence a lower bid and a higher offer) decreases the chance of the client trading but gives a larger spread to protect from future price changes.

Bid and Offer Language

When traders pay offers they say "mine!" (i.e., they're buying it). This is sometimes accompanied with a raised index finger. When traders give bids they say "yours!" (i.e., they're selling it), sometimes accompanied with an index finger pointing down.

If bids in the market are getting "given" or "hit," this is a sign the market is moving lower. If offers in the market are getting "paid" or "lifted," this is a sign that the market is moving higher.

These terms can be confusing until they are used day-to-day, at which point they quickly become second nature.

Market Making

What follows is a simplified example of some market-making activity in our imaginary international apple market. Within this market, traders request prices directly from each other and 1,000 apples have just traded in the market at 10p. Trader B comes to trader A requesting a price in 200 apples. Trader B does not disclose a buying or selling preference so trader A makes the two-way price shown in Exhibit 3.2.

The bid is 9p and the offer is 11p. Therefore, trader A has shown a bid–offer spread of 2p. Trader A is assuming that the midmarket price of apples is still 10p. Hence if trader B transacts on either side of the price, the trade will contain some spread from the midmarket price.

Trader B now has three options:

1. *Buy* 200 apples (or fewer) at 11p (i.e., pay trader A's offer). If trader B buys, trader A sells; hence trader A would have "sold at their offer."
2. *Sell* 200 apples (or fewer) at 9p (i.e., give trader A's bid). If trader B sells, trader A buys; hence trader A would have "bought at their bid."
3. *Pass*. Trader B can decide not to buy at 11p or sell at 9p and therefore can walk away from the transaction. This could happen for many reasons; perhaps better

EXHIBIT 3.2 Trader A two-way price

prices are being shown by other traders in the market (lower offers or higher bids depending on whether trader B is a buyer or a seller) or perhaps trader B has had a change of mind and no longer wants to transact. Trader B does not have to explain to trader A why the price is being passed but it can be useful to know why (called *feedback*): If another trader is, for example, showing better bids, trader A can use that information in their future price making.

Trader B *buys* 200 apples at 11p. Therefore, Trader A has sold 200 apples and Trader A's apples position has gone *shorter* by 200. Although the actual exchange of apples for money may not occur until later, trader A's *exposure* to the price of apples changes as soon as the trade is agreed.

Trader A broadly now has two options:

1. *Warehouse* the risk and "run the position" (i.e., keep the changed exposure to the price of apples).
2. *Close out* the risk by going back into the market and trading to offset the exposure.

Trader A decides to warehouse the risk. Trader C now enters the market and requests a new two-way price in 200 apples from trader A. Here are three different possible scenarios for what happens next:

Scenario 1

Trader A quotes the same two-way price shown in Exhibit 3.3.

This time, trader C *sells* 200 apples at 9p. Hence trader A buys 200 apples, exactly offsetting the first transaction. By showing two-way prices to counterparties with opposite "interests" (buy/sell directions), trader A has managed to *buy low* (at the bid) and *sell high* (at the offer). Overall, trader A's position is back where it started, having earned 200 (contract size) × 2p (spread) = 400p for these two transactions. By market making, the trader has balanced their position (hence reducing risk) while locking in a profit. This scenario illustrates the advantages of being a market maker when counterparties have offsetting interests, called *two-way flow*.

Scenario 2

Due to the initial transaction occurring, trader A believes that the price of apples is rising in the market. Plus trader A is short from the initial transaction and doesn't want to get any shorter. Therefore, trader A makes the price shown in Exhibit 3.4,

EXHIBIT 3.3 Trader A two-way price in scenario 1

EXHIBIT 3.4 Trader A two-way price in scenario 2

with a relatively better (higher) bid to make it more likely that trader C will sell, and a relatively worse (higher) offer to make it less likely that trader C will buy.

Again, trader C has three options:

1. *Buy* 200 apples at 12p.
2. *Sell* 200 apples at 10p.
3. *Pass*.

If trader C is a seller, trader A is hoping that trader C decides 10p is a good price at which to sell. Raising the bid has *increased* the probability of trader C selling but it has *reduced* the amount of spread trader A will capture if trader C does sell.

Trader C was a buyer, but another trader in the market showed a lower offer, so trader C passes trader A's price. Trader A can use this information in future price making. This scenario illustrates how market makers use their *trading position* to influence their price making.

Note how important the flow of information within the market is. Depending on the market structure, the previous trade at 11p may be known by everyone or it may only be known by the traders involved in the transaction. The longer the time between transaction and reporting, the more power market makers have because they are personally involved in more trades and hence have access to better information.

Scenario 3

Once again, trader A does not want an increased short apple exposure so quotes a higher bid and a higher offer as shown in Exhibit 3.5.

Trader C pays the offer: Trader A showed a higher price but again the offer was paid. Trader A goes to the market to get a price in 400 apples to hedge ("get out of" or "offset") the position acquired from the previous two transactions. The rate received back from the market is shown in Exhibit 3.6.

EXHIBIT 3.5 Trader A two-way price in scenario 3

EXHIBIT 3.6 Market two-way price in scenario 3

The price of apples is rising and trader A is stuck with a short position. Trader A certainly does not want to sell even more apples at 12p, and if the position is bought back at 14p, an average loss of 2.5p will be locked in. A substantial part of the market has the same position. As traders go into the market to hedge their positions, the market moves higher, which causes the trader to lose money from the short apple position. This scenario illustrates the *risks* of being a market maker arising from not being in complete control of the trading position.

Price Making and Risk Management Overview

Success in price making depends on assimilating information from the market. The more information a trader has about market activity, the more likely it is that they know the current midmarket levels, which in turn increases the chances of successfully servicing clients and capturing spread. When many banks quote on the same contract in competition, to win the trade, the trader needs to show the best price of all traders quoting on the contract, but at the same time they attempt to maximize the spread earned from the midmarket level.

The key to successful risk management is to take positions (long or short) in financial contracts that make money as time passes and the market moves. Traders talk about the market "moving against" them (when losing money) or "moving for" them (when making money). For buy-side market participants (e.g., hedge funds) the risk management process is straightforward: They go into the market and transact only deals that they think will make money based on their analysis. As seen earlier, however, for market makers it is often not their decision to take a position. Rather, positions are generated as a consequence of market-making activities when the trading desk takes on the opposite position to the client when the client transacts.

Key risk management decisions for traders therefore involve **inventory management**, or in other words, deciding when to warehouse risk and when to close it out. Traders make these decisions based on their current reading of the market: direction, liquidity, sentiment, and so on plus trading decisions are also made with reference to risk limits. P&L targets and risk limits should be in line: Greater risk gives the opportunity for greater reward but it does not *guarantee* greater reward, only greater P&L volatility. Risk limits therefore keep P&L volatility to acceptable levels.

Building a Trading Simulator in Excel

This practical demonstrates how simple financial markets work and illustrates the differences between price-taking and price-making roles. Task A sets up a ticking (moving) midmarket price. Task B then introduces a two-way price (bid and offer) around the midmarket and price-taker controls whereby the trader can pay or give the market. Finally, Task C adds the ability for the trader to act as both price taker and price maker. This practical links closely to the material discussed in Chapter 3.

Task A: Set Up a Ticking Market Price

The trading simulator has one main VBA subroutine that updates the market price. The Application.OnTime command is used to pause between market ticks.

Step 1: Set Up a Ticking Midmarket Spot

Setting up the framework mainly requires VBA development. User inputs on the sheet are initial spot, time between ticks, and how much spot increments up or down at each tick. Outputs are the current time step and current spot. Control buttons for Go/Pause and Stop are also required:

Trading Simulator

Initial Spot	**1.3000**	←*Named:* ***SpotInitial***
Time Between Ticks (sec)	**1**	←*Named:* ***TickTime***
Spot Increment	**0.0010**	←*Named:* ***SpotIncrement***
Go/Pause	Stop & Reset	
Step		←*Named:* ***Step***
Midmarket Spot		←*Named:* ***SpotMidMarket***

The input cells should be named as per the screenshot. Naming cells makes development far more flexible than referencing (e.g., cell "A5" from the VBA).

The VBA module should start like this:

```
Option Explicit
Public MarketOn As Boolean
```

The first line forces all variables within the VBA to be declared using Dim statements. This makes the VBA coding more similar to languages like C++ and encourages better programming. The second line defines a global Boolean variable called MarketOn that defines whether the market is currently ticking (MarketOn = True) or not (MarketOn = False).

The GoButton subroutine should run when the Go/Pause button is pressed, flipping the MarketOn variable and initializing the sheet if required:

```
Sub GoButton1()

    'If market is ticking, stop it. If market is not ticking, start it.
    MarketOn = Not MarketOn

    'If market was previously stopped then initialize it
    If Range("Step") = "" Then
        Range("Step") = 0
        Range("SpotMidMarket") = Range("SpotInitial")
    End If

    'Run a market tick
    MarketTick1

End Sub
```

The StopButton subroutine clears the outputs and stops the market if the Stop button is pressed:

```
Sub StopButton1()

    MarketOn = False
    Range("Step").ClearContents
    Range("SpotMidMarket").ClearContents

End Sub
```

The MarketTick subroutine updates the market by moving spot up or down by the "SpotIncrement" amount at random on each market tick. Then a future market tick is scheduled. Note how time is converted from seconds terms into day terms for the OnTime function, plus "_" is used when a code statement goes over more than one line:

```
Sub MarketTick1()

    If (MarketOn) Then
        'Move spot up or down at random
        If (Rnd() > 0.5) Then
            Range("SpotMidMarket") = Range("SpotMidMarket") + _
             Range("SpotIncrement")
        Else
            Range("SpotMidMarket") = Range("SpotMidMarket") - _
             Range("SpotIncrement")
        End If

        'Increment step
        Range("Step") = Range("Step") + 1

        'Schedule a market tick in the future
        Application.OnTime TimeValue(Now() + Range("TickTime") / 24 / _
         60 / 60), "MarketTick1"
    End If

End Sub
```

When the Go/Pause button is first pressed, the market should start ticking with the frequency specified in the cell named "TickTime." Test different inputs to make sure everything is wired up properly. In particular, check that the Go/Pause button works correctly: Pressing the button while spot is ticking should pause it; then pressing again should restart the ticks.

Step 2: Record and Chart Spot

A time series of spot can now be stored on the sheet. Again, this is primarily achieved with VBA development. Columns can be set up to store the step and spot rate, with the upper-left cell of the output named: "DataOutput."

Within the VBA, the MarketTick code needs to be extended to push the data onto the sheet. The .Offset command is used to access the appropriate cell within the sheet:

```
…
If (MarketOn) Then
  'Store data
  Range("DataOutput").Offset(Range("Step"), 0) = Range("Step")
  Range("DataOutput").Offset(Range("Step"), 1) = _
   Range("SpotMidMarket")
…
```

And the StopButton code needs to be extended to clear the stored data:

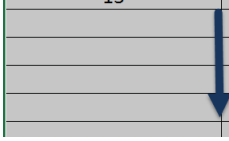
```
…
'Loop around and clear the spot ticks
Count = 0
While Range("DataOutput").Offset(Count, 0) <> ""
  Range("DataOutput").Offset(Count, 0).ClearContents
  Range("DataOutput").Offset(Count, 1).ClearContents
  Count = Count + 1
Wend
…
```

When the simulator is run, spot ticks should be recorded in the table:

Step	Spot
0	1.3000
1	1.3010
2	1.3000
3	1.2990
4	1.3000
5	1.2990
6	1.2980
7	1.2990
8	1.3000
9	1.2990

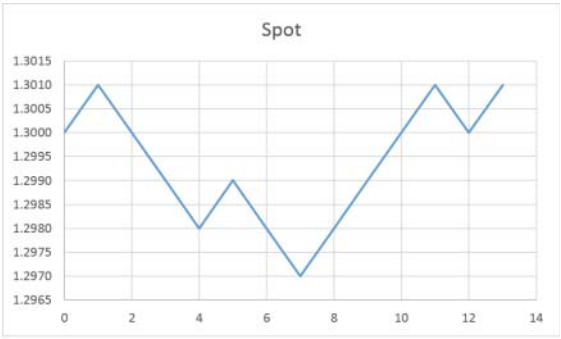
Having the ticks stored enables them to be charted. Run the simulator for a few ticks and pause it. Then select cells, starting at the title and running a large number (500ish?) of (currently mostly blank) rows down, including both step and spot columns:

Step	Spot
0	1.3000
1	1.3010
2	1.3000
3	1.2990
4	1.2980
5	1.2990
6	1.2980
7	1.2970
8	1.2980
9	1.2990
10	1.3000
11	1.3010
12	1.3000
13	1.3010



Insert an X-Y Scatter chart with straight lines between points. When the simulator is un-paused, the data should plot with the chart automatically resizing as new data is stored (up to the number of rows originally selected):

Step	Spot
0	1.3000
1	1.3010
2	1.3000
3	1.2990
4	1.2980
5	1.2990
6	1.2980
7	1.2970
8	1.2980
9	1.2990
10	1.3000
11	1.3010
12	1.3000
13	1.3010



Task B: Set Up a Two-Way Price and Price-Taking Functionality

If price takers want to buy in the market, they must pay the offer. If price takers want to sell in the market, they must give the bid. Within this task, bid and offer prices are set up and the ability to give or pay the market is introduced.

Step 1: Set Up a Two-Way Price

Within the sheet a new bid–offer spread input is required, plus bid and offer rates must be output:

Initial Spot	**1.3000**
Time Between Ticks (sec)	**1**
Spot Increment	**0.0010**
Bid-Offer Spread	**0.0030** ←*Named:* ***BidOfferSpread***
Go/Pause	Spot & Reset
Step	
Midmarket Spot	

Bid	**Offer**
↑*Named:* ***Bid***	↑*Named:* ***Offer***

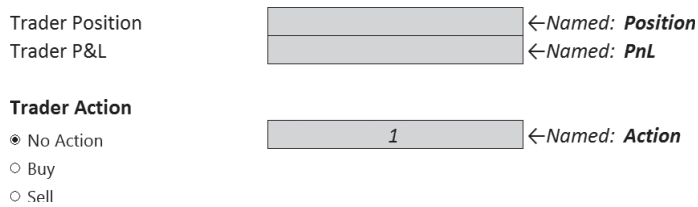
These new cells are referenced within the MarketTick VBA subroutine:

```
…
'Calculate bid and offer
Range("Bid") = Range("SpotMidMarket") - Range("BidOfferSpread") / 2
Range("Offer") = Range("SpotMidMarket") + Range("BidOfferSpread") / 2
…
```

New code also needs to be added to the GoButton and StopButton subroutines. Within GoButton, the initial bid and offer need to be set up, and within StopButton, the bid and offer output cells need to be cleared.

Step 2: Set Up Price-Taking Functionality

In order to risk manage, a trader needs to know their *position* and their *P&L*. Within the simulator both position and P&L can be added as outputs and kept updated using VBA code. In addition, at each spot tick, the trader can do one of three actions: nothing, buy (at the market offer), or sell (at the market bid), hence crossing a spread to transact. Controlling these choices could be done in many different ways in Excel but the method implemented here uses Option Buttons from the Form Control menu. These buttons should be grouped so only one of the choices can be selected at a time and the selection is then linked to an output cell that can be referenced within the VBA:



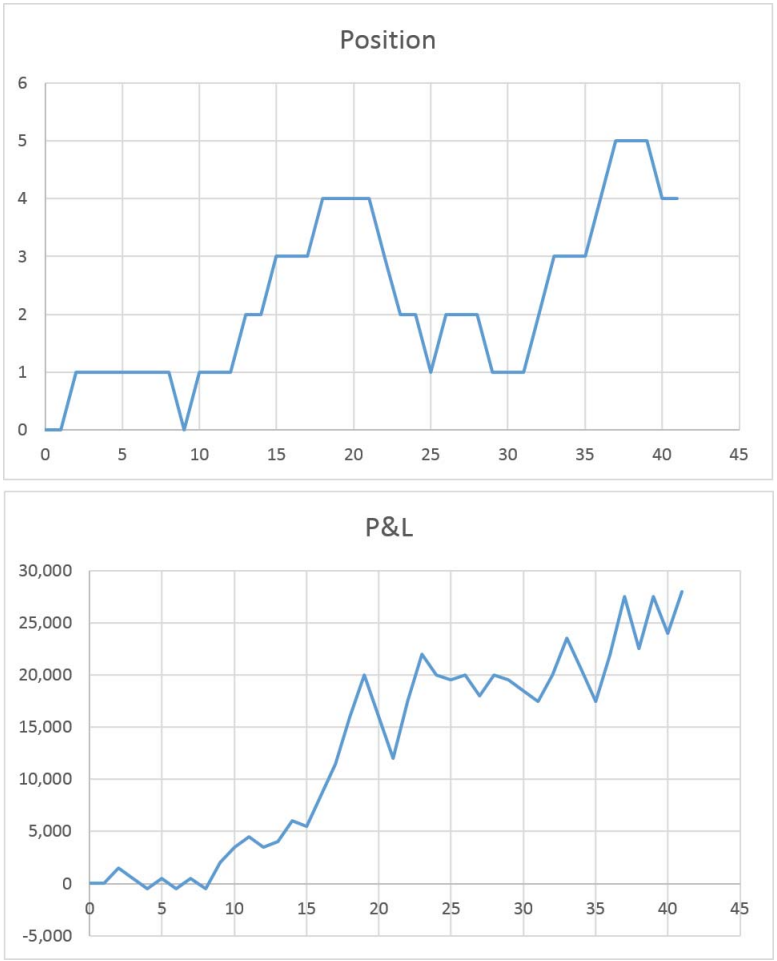
New VBA code needs to update the P&L based on the trader position and the spot move. The trader action then needs to be processed and the position updated if appropriate (and the selection reset back to "Do Nothing"):

```
Sub MarketTick4()

    Dim SpotIncrement As Double

    If (MarketOn) Then
        'Store data
        Range("DataOutput").Offset(Range("Step"), 0) = Range("Step")
        Range("DataOutput").Offset(Range("Step"), 1) = _
         Range("SpotMidMarket")
        Range("DataOutput").Offset(Range("Step"), 2) = Range("Position")
```

```
        Range("DataOutput").Offset(Range("Step"), 3) = Range("PnL")

        'Calculate spot increment
        If (Rnd() > 0.5) Then
            SpotIncrement = Range("SpotIncrement")
        Else
            SpotIncrement = -Range("SpotIncrement")
        End If

        'Update P&L
        Range("Pnl") = Range("Pnl") + Range("Position") * SpotIncrement

        'Update spot and step
        Range("SpotMidMarket") = Range("SpotMidMarket") + SpotIncrement
        Range("Step") = Range("Step") + 1

        'Calculate bid and offer
        Range("Bid") = Range("SpotMidMarket") - _
         Range("BidOfferSpread") / 2
        Range("Offer") = Range("SpotMidMarket") + _
         Range("BidOfferSpread") / 2

        'Process trader action: Buy
        If Range("Action") = 2 Then
            Range("Position") = Range("Position") + 1
            Range("Pnl") = Range("Pnl") - Range("BidOfferSpread") / 2
        End If

        'Process trader action: Sell
        If Range("Action") = 3 Then
            Range("Position") = Range("Position") - 1
            Range("Pnl") = Range("Pnl") - Range("BidOfferSpread") / 2
        End If

        'Reset the trader action
        Range("Action") = 1

        'Schedule a market tick in the future
        Application.OnTime TimeValue(Now() + _
         Range("TickTime") / 24 / 60 / 60), "MarketTick4"
    End If

End Sub
```

Again, new code must also be added to the GoButton and StopButton subroutines to set up and clear the data on the sheet as appropriate.

The P&L and position are now also stored on the sheet and can be displayed in automatically updating charts using the same method as the spot chart:



The simulator is now ready to be tested. Check that spot still ticks correctly and the buy/sell controls work as expected. Each time a trade is executed there should be an initial negative P&L impact from spread cross and the trader position should correctly increment up or down. Also, the P&L must update based on market moves.

If everything is happening too quickly, slow it down; five seconds between ticks is fine to start with while the interactions between market, position, and P&L become familiar.

It should become obvious quite quickly that crossing the bid–offer spread to transact makes it difficult to make money within this framework; all transactions result in a negative P&L change so every trade reduces expected P&L. This is an important real-world trading lesson: *Don't over-trade when there is spread cross involved*.

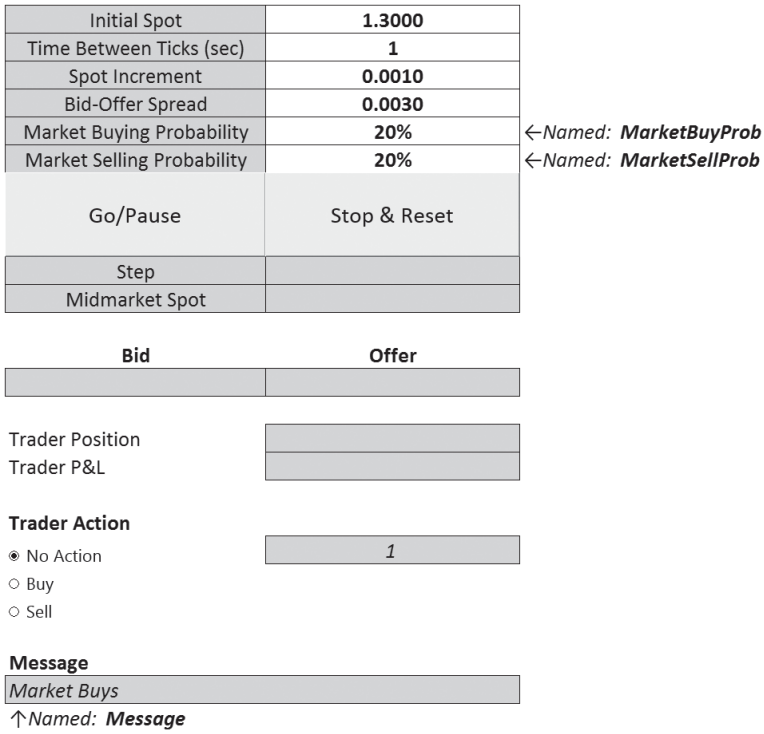
Test different combinations of bid–offer spread and spot increment to observe how their relative size impacts trading behavior and performance.

Task C: Introduce Price-Making Functionality

In practice, traders are sometimes price takers and sometimes price makers. This dynamic is achieved within the simulator by adding price-taking "market participants" to the VBA code. These price takers cause the trader position to change when they trade. Within this simplified framework, when the market participants transact they do so at the market bid and offer rather than at a price made by the trader.

This framework seeks to show how a price-making trader must deal with unpredictable flows. Should the trader wait to see if offsetting deals come in to hedge the existing position? Or should risk be immediately offset? Can the trader pre-position for the flows?

The following new inputs should be added to the sheet:



A random number within the VBA is used to determine whether the other market participants buy or sell. If there is a trade, the position and P&L must be updated accordingly.

```
…
'Process market action
MarketSignal = Rnd()
If MarketSignal < Range("MarketBuyProb") Then
    'Market Buys
    Range("Position") = Range("Position") - 1
    Range("Pnl") = Range("Pnl") + Range("BidOfferSpread") / 2
    Range("Message") = "Market Buys"
ElseIf MarketSignal >= Range("MarketBuyProb") And _
 MarketSignal < Range("MarketBuyProb") + _
 Range("MarketSellProb") Then
    'Market Sells
    Range("Position") = Range("Position") + 1
    Range("Pnl") = Range("Pnl") + Range("BidOfferSpread") / 2
    Range("Message") = "Market Sells"
Else
    'Market No Action
    Range("Message").ClearContents
End If
…
```


When running the simulator with this new functionality, the role of the trader changes. If the probability of the other market participants buying or selling is roughly equal, theoretically the trader should sit and wait for offsetting deals, reducing the position only when it gets too large and the P&L swings are too big. Skewed buy-and-sell preferences and different passive or active trading should be tested.

Extensions

The basic framework can be extended in numerous different ways to make it more realistic. Here are some suggestions:

- Add risk limits and P&L targets. Start with the limits and targets in line, then push them out of line to observe how having misaligned risk limits and P&L targets impacts trading performance.
- Evolve the spot rate over time using a volatility-based approach rather than a fixed increment, see Practical H for details.
- Introduce more interesting rules around market participant behavior so, for example, perhaps market participants are more likely to buy if spot goes lower

and sell if spot goes higher or vice versa. If the trader knows the rules, managing the flows becomes easier.

- Introduce different sized notionals. In practice, trading in larger size often means trading further away from the current midmarket.
- Most realistic (and most complicated) would be to have the trader manually making prices with the dealt side depending on the relationship between the trader price and the current market bid–offer. For example, if the current two-way market price is 1.3000/1.3030 and the trader shows a 1.3015 offer, if the price taker is a buyer, they should trade with high probability. If the trader shows a 1.3035 offer and the price taker is a buyer, they should only trade with low probability.

CHAPTER 4

FX Derivatives Market Structure

Market structure is a topic that is often skipped over. In practice though, it is vitally important because it defines how clients interact with the trading desk and how the trading desk accesses liquidity to hedge their risk.

In some financial markets all participants access a centralized market or exchange anonymously on the same terms. The FX derivatives market, however, is an over-the-counter (OTC) market, meaning that there is no centralized exchange and a clear distinction exists between banks and their clients. Note that "banks" here refers to large international banks with FX derivatives trading desks.

Fundamentally, bank FX derivatives trading desks transact with clients, aggregate and offset the risk where possible, and close out unwanted residual risk. More specifically:

- Clients come to bank trading desks for prices, often via a sales desk within the bank. Usually the client simultaneously submits the same price request to multiple banks and deals on the best price as per Exhibit 4.1. Traders usually make two-way prices for clients because they do not know for certain whether a client is a buyer or a seller of a particular contract.
- Bank trading desks transact with each other either via the **interbank broker market** or the **direct market** (a price request directly between a trader at one bank and the corresponding trader at another bank). The majority of bank-to-bank transactions occur in the interbank broker market. This structure is shown in Exhibit 4.2.

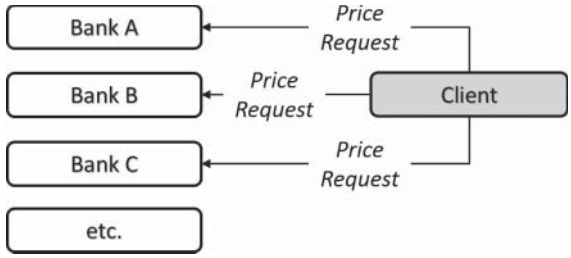


EXHIBIT 4.1 Client requesting prices from banks

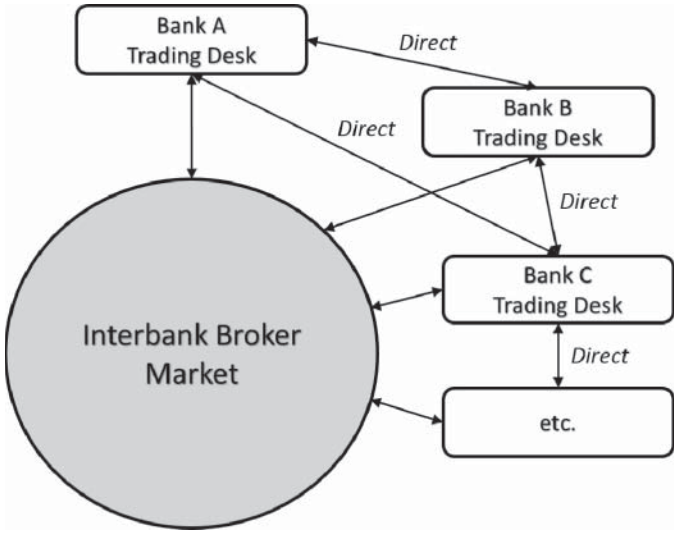


EXHIBIT 4.2 Interbank broker market interactions

Client Types

Many different types of client use FX derivatives for reasons that can generally be classified as hedging, investment, or speculation.

Corporates:

- International companies primarily concerned with managing their FX exposures and funding. For example, consider a car manufacturer with production in Europe but sales in America. This company is exposed to the EUR/USD exchange rate. If unhedged, when EUR/USD goes higher the company will be relatively less successful because the USD received from sales are worth fewer of the EUR needed to pay their workers and build new factories. Likewise, when EUR/USD goes lower the company will be relatively more successful. Fundamentally, the

success of the company should depend on their ability to design, manufacture, and sell cars rather than exchange rate fluctuations. Therefore, expected future foreign exchange exposures are hedged—potentially using FX derivatives.

Institutional:

- *Real money*: Professional money managers who use foreign exchange as an asset class. Simply put, they seek to take positions that will generate positive P&L as markets move.
- *Hedge funds*: Professional money managers but typically trade to shorter time horizons than real money.
- *Sovereigns*: Central banks/NGOs (e.g., IMF/World Bank), interested in FX volatility plus potentially manage currency reserves.

Regional Banks:

- Have smaller FX derivatives trading desks or perhaps hold no risk at all and transfer (i.e., "back-to-back") all exposures to larger banks. Regional banks usually trade with international banks as clients in a *nonreciprocal* trading relationship, meaning that the international bank cannot request prices from the regional bank.

Retail:

- Individuals who trade simple FX-linked investment products, for example, *dual currency deposits* (DCDs). Within a DCD the client deposits money in one currency for a fixed term. At the end of the term, the bank has the option to return the money either in the deposited currency or in a second currency. The client has effectively sold a call option on the deposit currency, and the premium earned from selling the option gives the client an enhanced coupon on the deposit.

Bank FX Derivatives Trading Desk Structure

FX derivatives trading desks usually deliver follow-the-sun coverage to clients from three global centers, normally London, New York, and one in Asia-Pacific. Traders within the three centers are in constant communication and they aim to provide the best possible client service in terms of pricing consistency between centers, speed, and bid–offer spread.

On the trading desk in each center there are various roles. In practice these roles often overlap and what is presented in Exhibit 4.3 is enormously simplified.

Traders are responsible for keeping desk pricing in line with the market. They make prices for clients and risk manage desk trading positions. In addition they

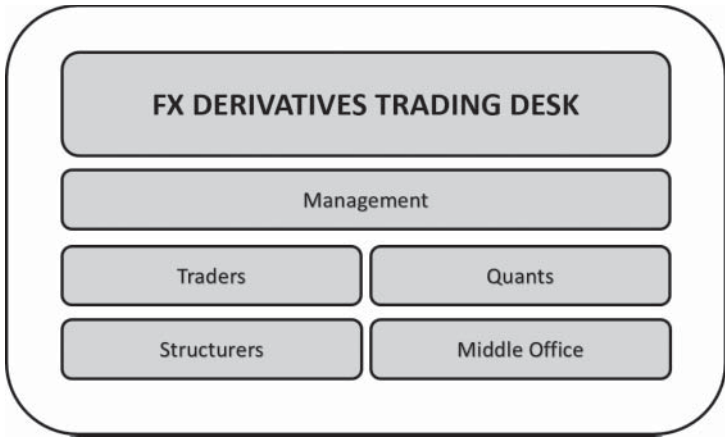


EXHIBIT 4.3 Roles on an FX derivatives trading desk

perform various other tasks that assist with their pricing or risk management, for example, market analysis and trade idea generation.

Traders are usually responsible for risk managing G10 or emerging market (EM) **currency blocks**. Related currency pairs are put together into a currency block, so, for example, the CAD block might actually contain AUD/CAD, CAD/CHF, CAD/NOK, CAD/SEK, EUR/CAD, GBP/CAD, NZD/CAD, and USD/CAD, although the majority of the risk will likely be in USD/CAD and possibly EUR/CAD. The main book-runner for a particular currency block usually sits in the most appropriate center; for example, the AUD block will normally be run out of Asia-Pacific while the Latam (Latin America) block will normally be run out of New York.

Structurers work with sales and relationship managers to understand clients' FX hedging and investment requirements. They design and construct solutions and work with traders to price more complex products. Structurers also educate sales on new derivative products offered by the trading desk.

Quants (quantitative analysts) are usually PhD-level mathematicians who develop and implement the pricing and analysis models and tools used by the trading desk.

Middle office ensure trading positions are correct and that new deals hit the trading positions quickly and accurately. In essence they are responsible for keeping desk risk management running smoothly.

Interacting with Sales Desks

FX Derivatives trading desks are, in a sense, product manufacturers. They create products for clients but it is the sales desks and relationship managers within the bank who are primarily responsible for the client relationships. The interactions between the trading and sales desks are not dwelt upon but collaboration is crucial for the overall success of the business.

Sales desks build relationships with clients by seeking to understand the clients' business and specifically their FX requirements. They provide clients with good information about what is happening in market with the aim that the trading desk is given the chance to quote on any FX contracts that the client wants to transact.

The trading desk assists the sales desk by providing them with good information about the market, coming up with relevant trade ideas, and offering quick, competitive prices in order to help build the client relationship.

Interacting with Support Functions

Trading desks do not operate in isolation; they require support from many other departments within the bank. For example, there are separate teams that do all of the following:

- Ensure the trading desk complies with their regulatory requirements.
- Monitor bank credit exposures to different counterparties across different asset classes.
- Produce official trading desk P&Ls.
- Ensure the trading desk complies with its international tax obligations.
- Deal with recruitment, contracts, and training.
- Build and maintain the desk technology infrastructure.
- Monitor trading risk to ensure risk limits are not broken.
- Ensure the trading desk has booked deals correctly and confirms deals with counterparties.
- Monitor desk pricing versus independent market sources.
- Ensure the trading desk is offering a valid range of products that can be properly priced and risk managed.
- Validate the pricing models (see Chapter 19) used by the trading desk.

Trading Internally

FX derivatives trading desks generally transact internally (i.e., within the bank) with the trading desks of other asset classes in order to hedge non-FX derivatives risk. FX spots, forwards, swaps, NDFs, interest rate products, and cash borrowing and lending will all be traded regularly by an FX derivatives trading desk.

Other departments within the bank come to the FX derivatives trading desk for advice, pricing, and execution on FX derivatives transactions. Sometimes these are for speculation. For example, a trader on the FX spot desk may wish to buy a

short-dated vanilla FX option. More often, they are linked to an underlying client transaction. For example, an M&A transaction or trade finance deal may have a structured FX component that the FX derivatives trading desk will price and ultimately risk manage.

Tips for a Trading Internship

When you first start on the trading desk, don't race through any learning material you're given: It isn't a race. Developing a good understanding of the material is far more important than showing off that you've read a 40-page document in an afternoon. On the other hand, don't just sit there waiting to be told what to do; ask junior traders for assistance in getting training material if it isn't given to you.

If you're given rubbish jobs to do, just get on and do them; put the team first. Everyone went through the same thing; getting coffees and lunches for traders gives you exposure to them. By doing this they will start to get to know you and will be more likely to help you learn.

Get the right balance between project work and learning about trading. Sitting there the whole time just doing your project is folly (and one to which I fell prey during an internship in 2001). You are there to learn what the trading job involves and whether it is a career you would like to pursue. Speak to people and make connections. At the end of the internship a range of people on the desk will be asked what they thought of you; no impression is almost as bad as a negative impression.

Go and sit with the different parts of the trading desk (structuring, middle office, quants), other teams within the same asset class (sales desks and trading desks), and other asset classes (interest rates, equities, credit). The more you understand about different roles on the trading floor, the better.

Always be on the desk over economic releases and major option expiries. This is when market activity is most likely to occur and it is important to see how traders react to this.

Tips for a Junior Trader

Don't be sloppy. This is the worst possible trait for a junior trader. Be precise when describing your position, book trades properly the first time, and be able to explain your P&L and position accurately at all times.

Learn to be aware of multiple things at once: Brokers are shouting, spot traders across the room are shouting, spot is moving, and your boss is asking you a question. This is a difficult skill but it is one that must be learned. Traders become experts at flipping from chatting about sports or the weather to quickly reacting to something that has occurred in the market. If you're sitting and talking with traders, always keep half an eye on the market because you can be sure they are.