FREE SAMPLE

OPTIONS EXPLAINED SIMPLY

THE FUNDAMENTAL PRINCIPLES COURSE

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BALBINDER CHAGGER

Options Explained Simply - The Fundamental Principles Course

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DEDICATION

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ABOUT THE AUTHOR

Balbinder Chagger has a rigorous understanding of Futures and Options, consolidated over thirteen years of professional practice in the Market Risk and Product Control functions of several international investment banks.

He has formally recognised teaching skills, acquired while studying a PGCE in Secondary School Mathematics at the UCL Institute of Education, London, and also while working as a mathematics teacher. His ability to teach simply enables you to understand easily.

He is a Chartered Accountant of the ICAEW, has an MBA from Cass Business School, London, and a BSc in Computer Engineering from City, University of London.

Balbinder has also written two novels: *Burden of Proof* and *Duty to Mitigate*.

PREFACE

Welcome to *Options Explained Simply - The Fundamental Principles Course.*

My objective is to explain Futures and Options simply enough to enable a wide audience to understand them easily.

Balbinder Chagger
July 2021

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INTRODUCTION

An Option is a Derivative, which is a contract whose value depends on (i.e., is *derived* from) the value of an Underlying asset. For example, a Microsoft Stock is an asset and a Microsoft Option is a contract whose value depends on the market price of the Microsoft Stock. Options can be based on any underlying asset, not only on shares.

Options Explained Simply - The Fundamental Principles Course will give you an intuitive and sound understanding of what Futures and Options are, how they are valued, and how they behave in changing market conditions. It will empower you to analyse Futures and Options intelligently.

To be able to understand Options, you need to understand Futures and Forwards. To be able to understand these, you need to understand Spot transactions and some fundamental concepts, namely: Arbitrage; Expected Value; Risk; and the Time Value of Money. It is with these fundamental topics that the course begins.

No prior specialised financial knowledge is required to be able to follow this course. Furthermore, nor is required any advanced mathematical ability. The level of mathematics usually associated with finance is advanced and sophisticated; it is beyond the level most people pursue an education in mathematics to. A layer of advanced mathematics intimidates most people and makes financial instruments appear beyond their abilities to comprehend. But for the advanced mathematics, understanding Futures and Options is within the capability of a wide audience. To facilitate learning and understanding, this course uses simple mathematics; all that is required is confidence with arithmetic, basic algebra, calculating averages, simple interest, and reading tables and graphs.

The following steps are also taken to promote learning and understanding:

- The subject matter is often taught with reference to familiar, real-life scenarios.

- The amount of detail is simplified to keep the subject matter clear and unclouded by unnecessary layers of complexity.

- Visualisation, an important and powerful means for learning for most people, is utilised extensively. Often, the written explanations given are complemented with graphical illustrations to clarify the subject matter more than words alone do. The calculations presented are visually transparent with every key step in them shown clearly. Colour is used to emphasise and clarify key points, as exemplified in this introduction.

CONTENTS

PART 1

FUNDAMENTALS

In this part, we learn about Spot, Position Types, Risks, Arbitrage, and the Time Value of Money.

Lesson 1

SPOT

In this lesson, we learn what Spot trades are.

1.1 Spot Trades

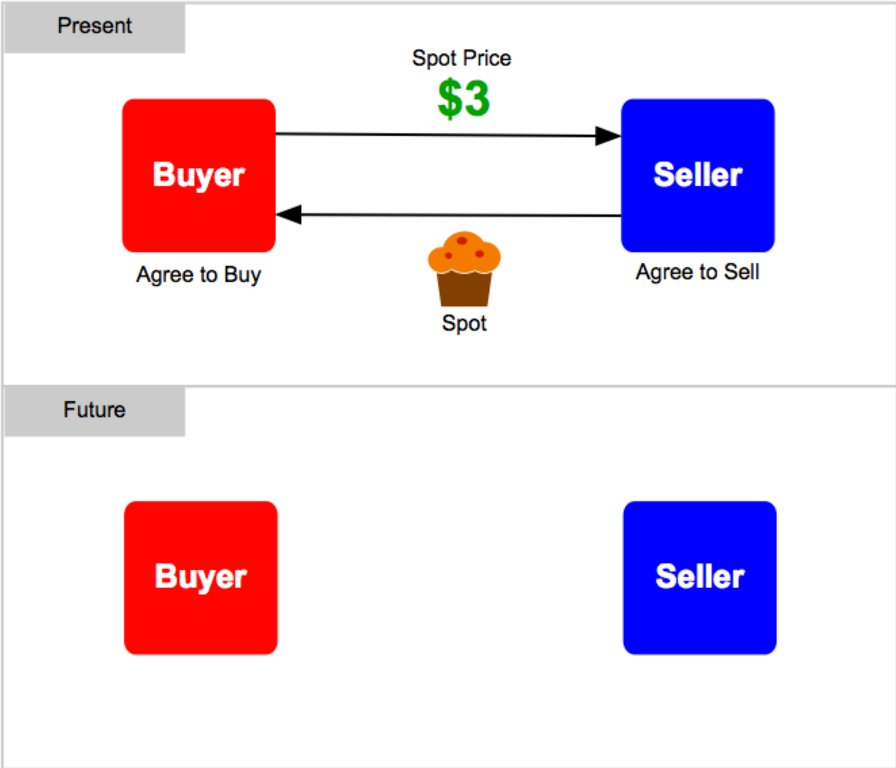
Say we want a muffin. We walk into a cake shop. We see a muffin we like. Its price is $3. We pay the shop $3. It gives us the muffin. We leave. What just occurred here is a Spot transaction. It is depicted in Fig 1.1.

In a Spot transaction, the following things happen simultaneously in the present:

- The trading Agreement is made (i.e., who will buy, who will sell, what will be traded, and the trade price).
- The trade is Performed (i.e., delivery and payment are made in accordance with the agreement).

The trading parties (i.e., the Buyer and the Seller) initiate and complete the transaction in the present. The transaction does not create any future commitments between them. Both parties move on free of each other.

Fig 1.1 Spot Transaction



In the financial investment world, the thing that is traded is called the Spot. Its price is referred to as the Spot Price.

Anything that can be bought and sold can be Spot-traded. This includes physical products, like a muffin, and intangible services, like a foot massage.

Depending on what the Spot is, there may be some customary time gap between the trade being agreed and its performance, to allow for practicalities. For example, a meal in a restaurant might take around 20 minutes to prepare and deliver after it has been ordered (i.e., the agreement made), and it is customary to pay for it later, after it has been consumed. For other kinds of Spots, the time gap may be longer, perhaps even a few days. But essentially, the trade is agreed and performed in the present.

You may be familiar with some things that are traded in the financial investment world, such as Stocks (Company Shares), Foreign Currencies (Cash), Bonds (Loans), Commodities (e.g., Corn), and Metals (e.g., Gold). These are all Spots and can be Spot-traded.

For example, say we want to buy 100 shares in Apple. We call our stockbroker for a Spot Price quote. Say the quote is $120 per share. If we are happy with the quote, then we can proceed and buy the shares. Our bank account is debited $12,000, and we become the owners of 100 shares in Apple.

Lesson 2

POSITION TYPES

In this lesson, we learn what the terms Long, Flat, and Short mean.

In the financial investment world, the terms Long, Flat, and Short are used to express positions types. They are used in the following two ways:

1. To express ownership of assets.

2. To express risk exposures.

Their use to express risk exposures is explained in the next lesson. In this lesson, we learn how they are used to express ownership of assets.

2.1 Expressing Ownership of Assets

We use the term Long to express that we own an asset. For example, if we say we are Long 3 Houses, this means we own 3 Houses. The **+** sign is commonly used to denote Long positions (e.g., +3 Houses). Usually though, the + sign is omitted (e.g., 3 Houses).

We use the term Short to express that we owe an asset. For example, if we say we are Short $1,000, this means we owe $1,000. The **–** sign is commonly used to denote Short (e.g., -$1,000).

We use the term Flat to express that we have no position in an asset, i.e., we neither own nor owe it. For example, if we say we are Flat Gold, this means we neither own nor owe Gold.

The use of the **+** and **–** signs is useful because it enables us to sum up the individual positions in a particular asset mathematically to an overall total. For example, if we are +$2,000 in our Savings account and are -$1,200 in our Current account, then we can sum the two positions up and say we are +$800 overall.

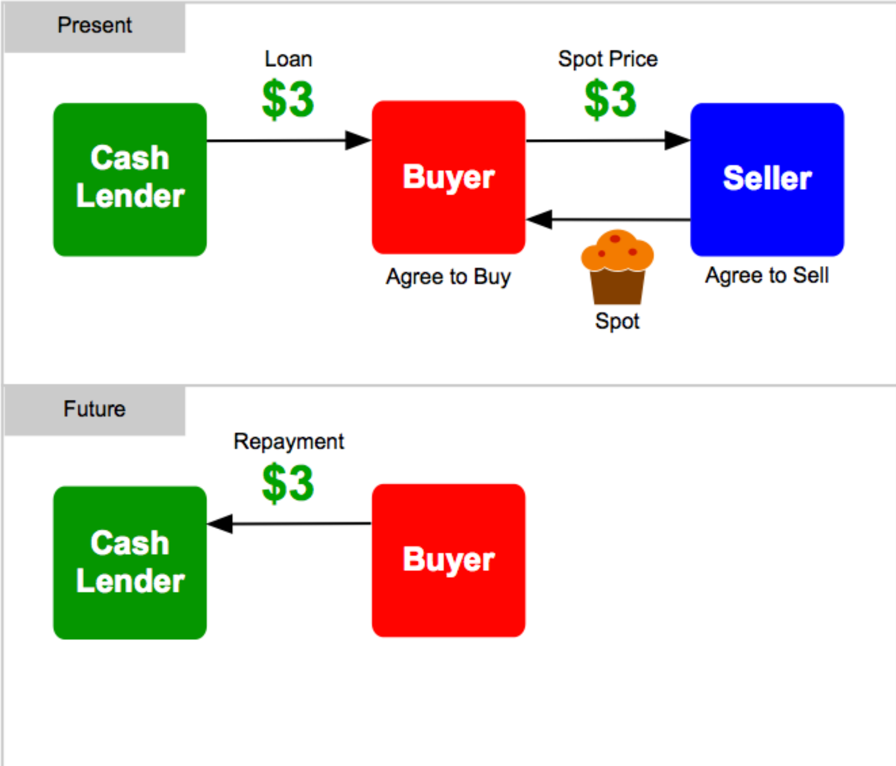
Long and Short positions often bring about costs and benefits upon their holders. For example, a Long Property position might benefit the owner with rental income, but also entail repair and maintenance costs. Similarly, a Long Cash position (e.g., a bank deposit) might earn interest income, while a Short Cash position (e.g., a bank loan) might incur interest charges.

To exemplify their use, let us apply these terms to the example of the Spot transaction we looked at in Lesson 1 concerning a muffin.

In this example, say when we walk into the shop we have $3. We do not have a muffin at the time though. We are Long Cash $3 and Flat muffins. We use the $3 to pay for the muffin. This makes us Flat Cash and Long 1 muffin (i.e., we own a muffin).

Now, suppose we walked into the shop being Flat Cash (i.e., we do not have any money to our name). Can we still pay for the muffin? Yes we can, if we can firstly borrow $3. A common way to borrow money is through a credit card loan. We can pay for the muffin with a credit card. We end up being Short Cash $3 (i.e., we owe $3 to the credit card company) and Long 1 muffin. At some future date, we have to pay $3 back to the credit card company to flatten out our Short Cash position. We might also have to pay some credit charges too. This example is depicted in Fig 2.1.

Fig 2.1 Spot Transaction with Borrowed Funds

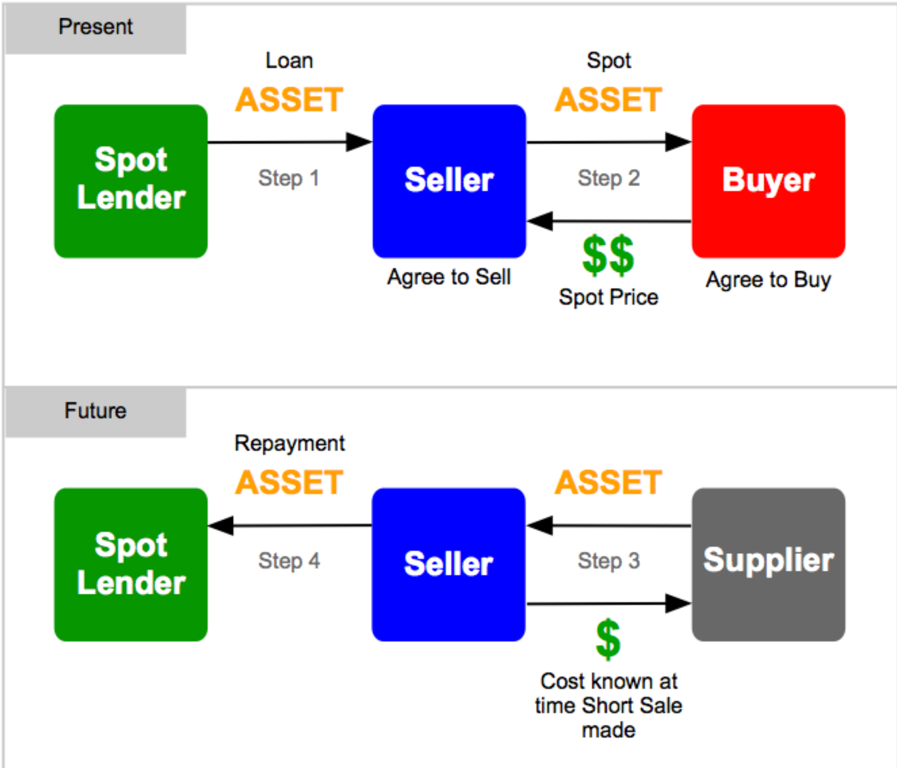


Now, suppose we walked into the shop and the shop is Flat muffins (i.e., it has no muffins). Can it still sell and deliver a muffin to us? Yes it can, if it can borrow one first from somewhere, say from a neighbouring cake shop. This results in it being Short 1 muffin (i.e., it owes a muffin to the lender). Eventually, it will have to return a muffin to the lender, and, perhaps, pay some borrowing charges too. In reality though, it is unlikely the shop would borrow a muffin in this manner because muffins just are not lent and borrowed in the world like cash is. But other assets are, like, Stocks. There are lots of large pension companies out there sitting on huge Long Stock positions. They are only too happy to earn some extra income on their positions by lending them out in return for some fees from the borrowers.

2.2 Short Position Types

Appreciate that we can sell and deliver an asset without owning it first. The asset must firstly be borrowed from a lender, and then it can be delivered to the buyer. Thus, we end up with a Short position in the asset, which we must settle up later on.

Fig 2.2 Covered Short Sale



There are two types of Short positions, as follows:

- Covered Short
- Uncovered Short

A Covered Short sale entails selling an asset Short in the certain knowledge that we will receive a supply of the asset at a later date and at a known cost. A Covered Short sale is depicted in Fig 2.2, in 4 steps. The supply received is applied to settle up and close out the Short position. A Covered Short sale is a riskless strategy, meaning the end profit is determinable from the outset, at the time of the sale. The profit is based essentially on the following facts, which are known with certainty at the time of the sale:

- The Spot Price of the sale.
- The cost of the anticipated supply.

To determine the complete profit, there will be other details to take into account too, like:

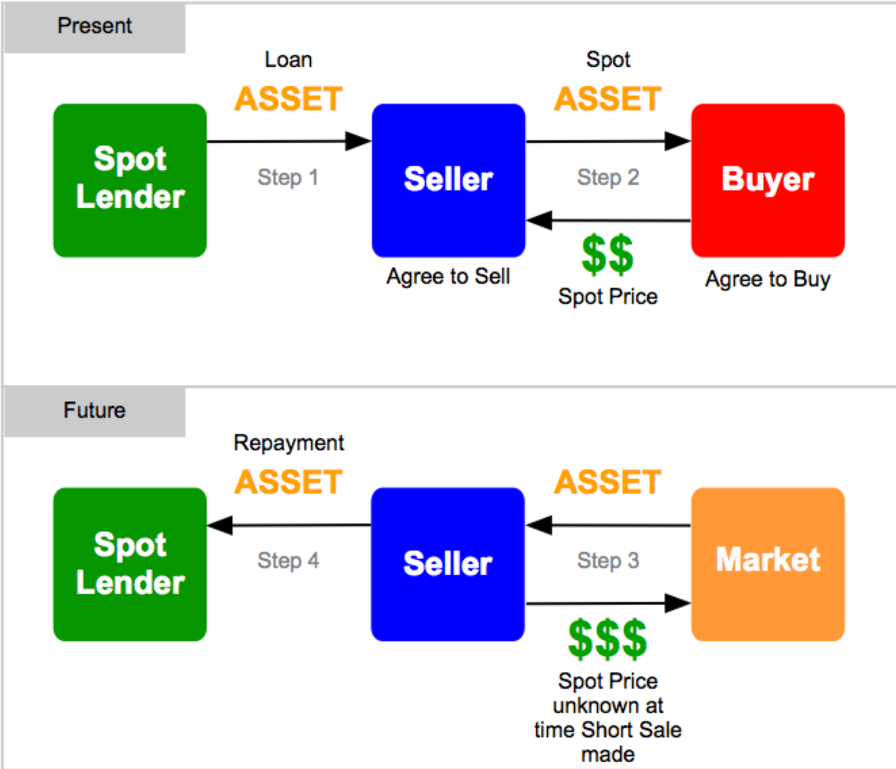
- The cost of borrowing the asset.
- The interest income that can be earned on the sale proceeds received.

These details too can be known with certainty at the time of the sale and factored into the profit calculation.

To exemplify a Covered Short sale, say an Apple company employee is informed today that in a month from now she will be awarded a bonus in the form of 100 Apple company shares. Even though she will not legally own the shares until a month from now, her financial interest in them begins today. Today, she knows what the Spot Price of the shares on the Stock market is. Say it is $120 per share. It could go up or down over the next month. She has no guarantee what the shares will be worth on the day she becomes their legal owner. Her risk is they might be worth less than they are today. If she is happy with their $120 market value today and does not want to take the risk of them being worth less, then she can eliminate the risk by selling Short 100 shares today. The sale is a Covered Short sale because it is done in the certain knowledge that 100 shares will be received in a month's time at zero cost.

The Short sale gives her a Long Cash position of $12,000 ($100 \times 120$) and a Short Stock position of 100 Apple shares. She can determine her end profit right from the outset, at the time of the sale, to be $12,000 ($12{,}000 - 0$), plus any interest she can earn on the $12,000 sale proceeds, and less any charges payable on borrowing the shares for the Short sale.

Fig 2.3 Uncovered Short Sale



In contrast, an Uncovered Short sale entails selling an asset without an anticipated future supply of it at a known cost. At some point in the future, the Short position will have to be closed out. This will have to be done by buying the asset on the open market at the prevailing Spot Price, which is an unknown figure when the Short sale is made. The Uncovered Short sale is depicted in Fig 2.3, in 4 steps.

An Uncovered Short sale is a risky, speculative strategy, meaning the end profit is undeterminable at the time of the sale because the cost of acquiring the asset is unknown. The sale is usually based on the speculative view that the Spot Price will drop and the asset can be bought cheaper than it was sold for. But, there is the chance the Spot Price increases. If it does, then the asset will have to be purchased at a higher Spot Price than it was sold for, and the strategy will result in a financial loss. The actual result cannot be known at the time of the sale, and can go either way.

Lesson 3

SPOTS RISK

In this lesson, we learn about the risk Spots give exposure to.

3.1 Risk Source

The financial value of a position in a particular asset depends on the following factors:

- Number of units (Quantity)
- Type of position (Long or Short)
- Market price of a unit (Spot Price)

We can express the value mathematically as follows:

$$PositionValue = Quantity \times SpotPrice$$

The number of units we hold is under our complete control. We can buy and sell them as we wish, and adjust our position to suit our desire. Therefore, the quantity is not a source of risk. But, we have no control whatsoever over the Spot Price; the market determines it. We have to accept the Spot Price, whatever it is, as a matter of fact. It can move up and down. As it fluctuates, the value of our position changes accordingly. If the Spot Price rises, then the following happens:

- A Long position earns a profit, because we own a more valuable position. Note the value of a Long position moves in the same direction as the Spot Price movement.

- A Short position incurs a loss, because we owe a more valuable position. Note the value of a Short position moves in the opposite direction to the Spot Price movement.

If the Spot Price falls, then the opposite happens, as follows:

- A Long position incurs a loss, because we own a less valuable position. Again, note the value of a Long position moves in the same direction as the Spot Price movement.

- A Short position earns a profit, because we owe a less valuable position. Again, note the value of a Short position moves in the opposite direction to the Spot Price movement.

In summary, Long Spot position values react in the same directions as the movements in the Spot Price, and Short position values react in the opposite directions.

3.2 Delta: Spot Price Risk Measure

The Spot Price (i.e., the market given price) is a source of risk to our Spot position because it affects its value; we have no control over it, and it can move against us. This applies to a position in any Spot asset. For example, if we have a position in Gold, then the position's value depends on Gold's Spot Price. Similarly, if we have a position in Crude Oil, then the position's value depends on Crude Oil's Spot Price.

It is very long-winded to have to say *how a position's value changes relative to Spot Price movements*. So, the financial investment world just says Delta instead, for short. Delta (the Greek letter, uppercase Δ, lowercase δ or δ) is the formal, technical name given to the relationship between the Spot Price and the position's value. If someone says he has a Delta in Coffee, then everyone understands that he has a position whose value reacts to movements in the Spot Price of Coffee. In other words, the person has a risk exposure to the Spot Price of Coffee.

It would be useful to know the following things also about the position:

- Whether its value reacts in the same or opposite direction to the Spot Price movement.

- The size of the reaction.

The financial investment world has thought about these aspects and has agreed standard ways to communicate them, as follows:

- The terms Long/Short are used to communicate that the position value changes in the same/opposite direction as the Spot Price movement.

- A number is used to communicate the amount the position value changes by.

- The number communicates the amount by which the position value changes as the Spot Price increases by 1.

- The number is calculated under the assumption that all other factors affecting the position's value remain static while only the Spot Price increases. Later, when we look at Forwards and Options, we will appreciate there are also other factors, besides Spot Price, that affect some positions' values.

Appreciate that Delta is a standardised Risk Measure; it communicates in a *standardised* way how a position's value reacts to the Spot Price. It is the first of several risk measures we will encounter as we progress through this course.

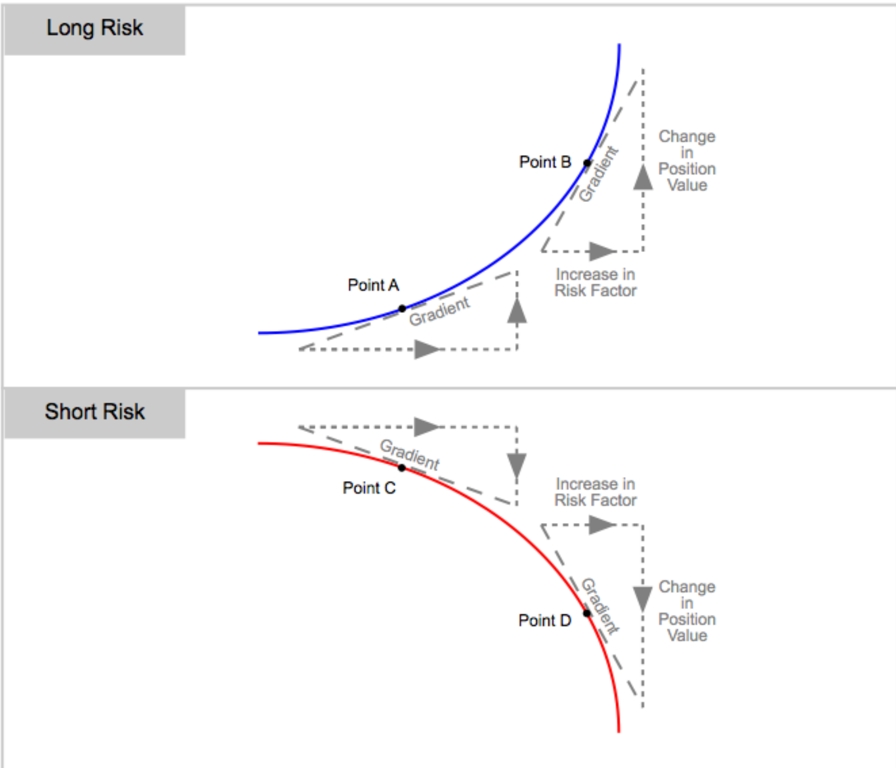
If someone says she is Long 100 Delta in Corn, then everyone understands she has a risk exposure to Corn's Spot Price such that if it rises by $1, then she will make a $100 profit. Similarly, if someone says he is Short 200 Delta in Microsoft, then everyone understands he has a risk exposure to Microsoft's Spot Price such that if it rises by $1, then he will suffer a $200 loss.

Delta can be expressed mathematically as follows:

$$Delta = \frac{ChangeInPositionValue}{RiseInSpotPrice}$$

Delta communicates a Rate of Change (i.e., how quickly the Position Value changes as the Spot Price increases by 1).

Fig 3.1 Rates of Change



A Rate of Change communicates how much something changes for a given *increase* in some factor. It can be thought of as a gradient, communicating the degree of change. A flat, horizontal gradient communicates there is no change. An upward gradient communicates the change is in the same direction; a downward gradient communicates the change is in the opposite direction. The steeper the gradient is, the larger is the reaction to an increase in the factor. Furthermore, a Rate of Change value corresponds to a specific point. At another point, the Rate of Change may be a different amount. These aspects are illustrated in Fig 3.1.

Inflation is an example of a Rate of Change that we are all familiar with. It exemplifies the above aspects of Rates of Changes. Inflation tells us how the cost of things reacts to the passing of time (usually 1 year). An Inflation value of, say, 3% tells us things costing $100 today will cost $103 in a year from now. The 3% value corresponds to now. Next month (i.e., at a different point in time), Inflation could be some other value, say 2.9%.

3.3 Delta of a Long Spot Position

Understanding financial principles is often made easier by considering actual things. The explanations in this course are based on Stocks because most people are familiar with them, and also because they pay a dividend, which serves to illustrate some financial principles.

Fig 3.2 Long 1 Stock Delta vs Spot Price

Position	LONG STOCK										
Spot Price	0	100	200	300	400	500	600	700	800	900	1000
Stock Value	**0**	**100**	**200**	**300**	**400**	**500**	**600**	**700**	**800**	**900**	**1000**
Stock Value Change		200	200	200	200	200	200	200	200	200	200
Spot Price Change		200	200	200	200	200	200	200	200	200	200
Delta		**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	

The value of a Long Stock position is calculated as follows:

$$PositionValue = NumberOfShares \times SpotPrice$$

The value of a Long 1-share position at various Spot Prices is shown in Fig 3.2. Each of the Spot Price increments is $100. When the Spot Price is $0, the position value is also $0. As the Spot Price rises, the value of the position also rises. This signifies the Delta is positive (Long). We see in Fig 3.2 that the position value rises by a constant $100 for every $100 rise in the Spot Price (i.e., a dollar for dollar reaction). This signifies the Delta is +1 (or 100%) at every Spot Price ($100/100$). This is corroborated by a graph plot of the position value against the Spot Price (Fig 3.3) showing the position value sits on an upward sloping straight line whose gradient is +1.

We can prove mathematically the Delta value is +1 at a particular Spot Price. A simple way to calculate the Delta at a particular observation point is to look at how the position value changes between two nearest available equidistant points either side of it; the observation point lies exactly in the middle of the two points. For example, to calculate the Delta at the $500 Spot Price, consider how the position's value changes from a Spot Price of $400 to $600, the nearest Spot Prices for which we have values. This simple calculation is valid because the $500 Spot Price lies exactly in the middle of the $400 to $600 Spot Price range.

$$Delta = \frac{ChangeInPositionValue}{RiseInSpotPrice}$$

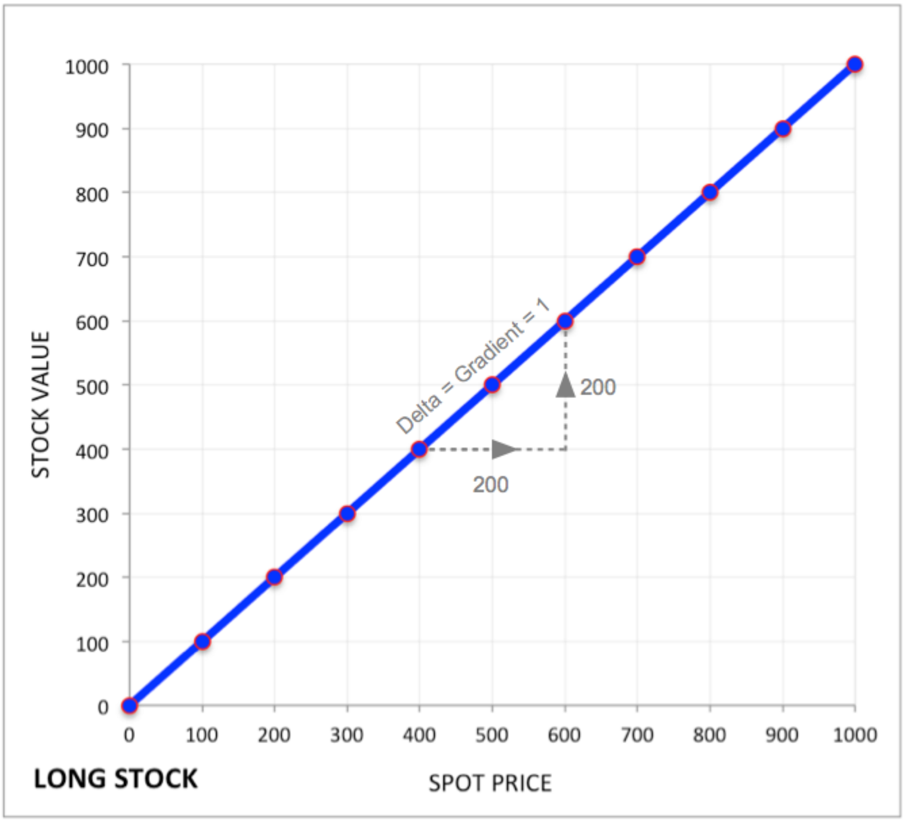
$$Delta = \frac{FinalValue - InitialValue}{FinalSpotPrice - InitialSpotPrice}$$

$$Delta = \frac{600 - 400}{600 - 400} = \frac{200}{200} = +1.0$$

The Delta at the other Spot Prices in Fig 3.2 can be calculated in this way too.

Fig 3.4 shows the Delta of the Spot plotted against the Spot Price. It is +1 at every Spot Price.

Fig 3.3 Long Stock Value vs Spot Price



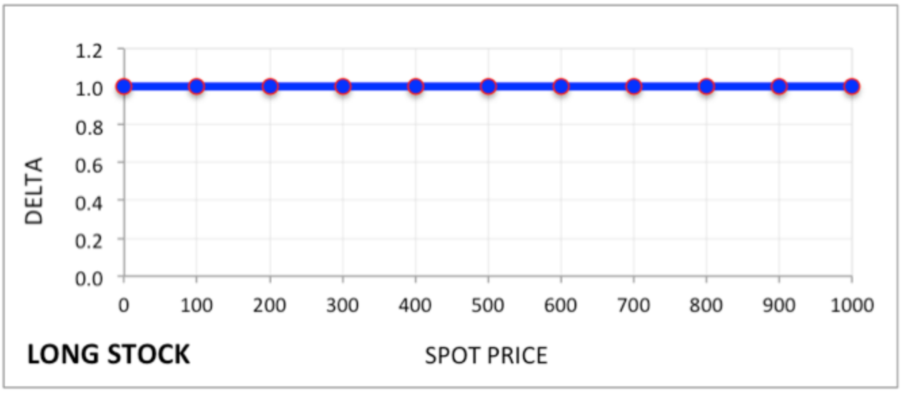
When the relationship between two things (in this case, between a Spot Price and a Position Value) remains the same over a range of values, then the relationship is said to be linear over the range. So, the Delta of a Long 1-share position is linear and is +1. This applies to all Spot types, not only to Stocks. Hence, the Delta of a Long 1 unit of a Spot is linear and +1.

It follows the Delta of a Long 2-unit Spot position is +2 (or +200%), and so on for larger numbers of units. If someone says her holding in a Stock gives her a 300 Delta exposure, then we can say the following:

- She is Long 300 shares (because the Delta of a Long 1 share position is +1).

- If the Spot Price rises by $1, then she will earn a profit of $300.

Fig 3.4 Long Stock Delta vs Spot Price



We can also say how her position value will react to any amount of change in the Spot Price of the Stock, not only to a rise of $1. For example, we can say the following:

- If the Spot Price falls by $1, then she will suffer a loss of $300.
- If the Spot Price rises by $20.5, then she will profit $6,150 ($20.5 \times 300$).

When a position's Delta is linear, then the change in the position's value due to a Spot Price movement is explained completely as follows:

$$ChangeInValue = Delta \times ChangeInSpotPrice$$

$$ChangeInValue = Delta \times (FinalSpotPrice - InitialSpotPrice)$$

Later, when we study Futures and Options, we will see Delta can take on other values besides 1. Furthermore, we will see Delta can also be non-linear, meaning it can be a different value at different Spot Prices.

3.4 Delta of a Short Spot Position

As the Delta of a Long 1 unit Spot position is linear and +1, then it follows the Delta of a Short 1 unit Spot position is linear and -1.

The value of a Short Stock position is calculated as follows:

$$PositionValue = -NumberOfShares \times SpotPrice$$

The $-$ sign denotes the position is Short. The value of a Short 1 share position at various Spot Prices is shown in Fig 3.5.

Fig 3.5 Short Stock Delta vs Spot Price

Position	SHORT STOCK										
Spot Price	0	100	200	300	400	500	600	700	800	900	1000
Stock Value	**0**	**-100**	**-200**	**-300**	**-400**	**-500**	**-600**	**-700**	**-800**	**-900**	**-1000**
Stock Value Change		-200	-200	-200	-200	-200	-200	-200	-200	-200	-200
Spot Price Change		200	200	200	200	200	200	200	200	200	200
Delta		**-1.0**	**-1.0**	**-1.0**	**-1.0**	**-1.0**	**-1.0**	**-1.0**	**-1.0**	**-1.0**	

Each of the Spot Price increments is $100. As the Spot Price rises, the value of the position falls (i.e., it becomes a larger negative number). Hence, the Delta is negative (Short). The position value falls by a constant $100 for every $100 rise in the Spot Price (i.e., a dollar for dollar reaction). Therefore, the Delta is -1 at every Spot Price. This is corroborated by a graph plot of the position value against the Spot Price (Fig 3.6) showing the position value sits on a downward sloping straight line whose gradient is -1. So, the Delta of a Short 1-share position is linear and is -1. Again, this applies to all Spot positions, not only to Stocks.

Fig 3.7 shows the Delta of the Spot plotted against the Spot Price. The Delta is -1 at every Spot Price.

Fig 3.6 Short Stock Value vs Spot Price

If someone says his holding in a Stock gives him a -500 Delta exposure, then we can say the following:

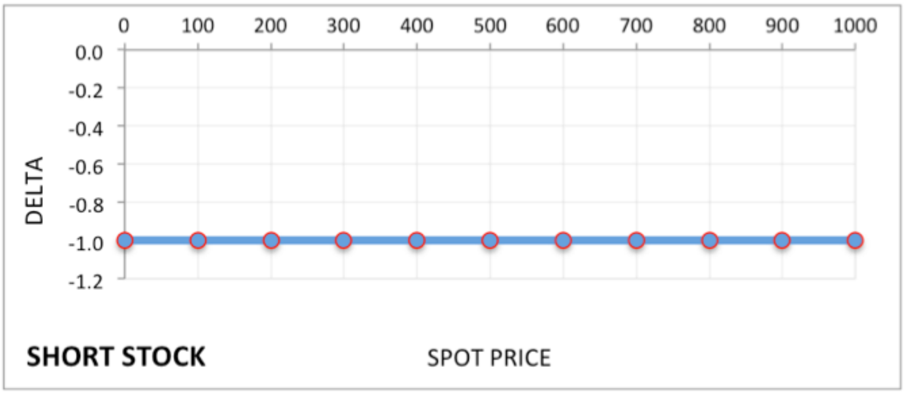
- He is Short 500 shares (because the Delta of 1 Short Stock is -1).
- If the Spot Price rises by $1, then he will suffer a $500 loss.

We can also say how his position value will react to any amount of change in the Spot Price of the Stock, not only to a rise of $1. For example:

- If the Spot Price falls by $1, then he will profit $500.

- If the Spot Price drops by \$32.25, then he will profit \$16,125 (-32.25×-500).

Fig 3.7 Short Stock Delta vs Spot Price



Lesson 4

ARBITRAGE

In this lesson, we learn what Arbitrage is and why it is important.

Arbitrage is the concept of profiting by exploiting price imbalances. There are two types of arbitrages, as follows:

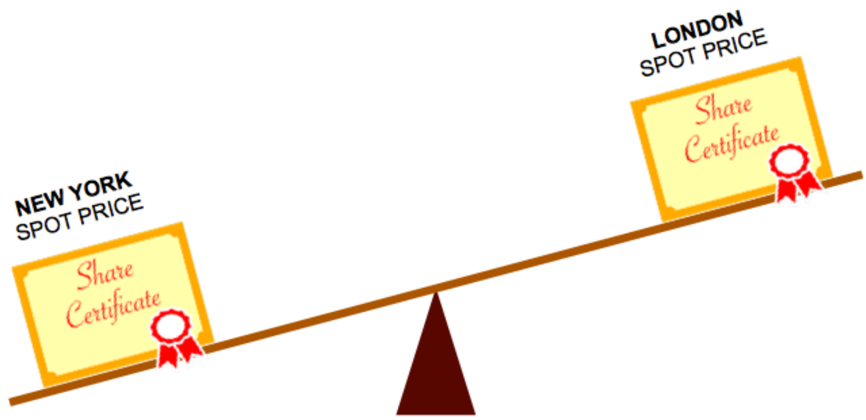
1. Deterministic Arbitrage
2. Statistical Arbitrage

4.1 Deterministic Arbitrage

An arbitrage opportunity is Deterministic if the profit from it can be determined from the outset with absolute certainty, i.e., there is no risk involved.

For example, suppose a company's shares are trading for £10 on the London Stock Exchange and for $13 on the New York Stock Exchange while the £/$ currency exchange rate is £1=$1.2. As the shares are of the one and the same company, then their value ought to be equal, regardless of the location and currency. But, as it stands, they are unequal. The London £10 Spot Price implies the New York Spot Price ought to be $12, and the New York $13 Spot Price implies the London Spot Price ought to be £10.83. Instead of being equal, the Spot Prices have spread apart by $1 (£0.83), for some reason, and are imbalanced, as depicted in Fig 4.1. The Spot Price in London is cheaper than the one in New York. The price imbalance may be due to some kind of market inefficiency; perhaps some news has reached one location but not yet the other. The reason is unimportant. The fact is the Spot Prices are out of line with each other, and the situation presents an opportunity to make a certain profit of $1 (£0.83).

Fig 4.1 Deterministic Arbitrage Opportunity

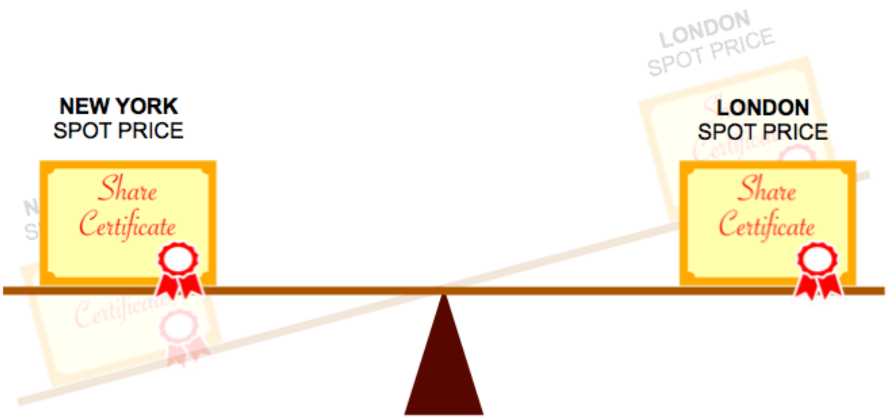


We can exploit this arbitrage opportunity by executing two Spot trades simultaneously: one, buying the *relatively* cheaper London share; and the other, selling the *relatively* expensive New York share. The London trade makes us Long 1 share, for which we pay out £10 (equivalent to $12), and the New York trade makes us Short 1 share, for which we receive $13 (equivalent to £10.83). The cash flows on trading into the strategy sum up to a profit of $1 (£0.83).

Note the Long position gives us a +1 Delta risk exposure, and the Short position, a -1 Delta exposure. Although we actually have 2 separate positions across 2 locations, overall we have no Delta risk exposure (+1 and -1 sum to 0). Our portfolio (i.e., the combined positions) will neither benefit nor suffer in value from any Spot Price movements; gains on one position will be offset by losses on the other, and vice versa. The portfolio is riskless in terms of Spot Price movements.

Our act of buying the London share contributes, albeit in a miniscule way, to raising the demand for it in the market. This, in turn, tends to raise its Spot Price. Similarly, our act of selling the New York share contributes to lowering its demand and, hence, its Spot Price. In other words, our trades contribute to influencing the Spot Prices back into a balanced state by tending to narrow the Price Spread that exists between them. Other Arbitrage traders who also spot this opportunity will exploit it in the same way as we do. The collective influence of everyone's trades will tend to drive the Spot Prices back towards balance so the Price Spread between them narrows until there is no longer any arbitrage opportunity remaining to be exploited. This is the importance of Deterministic Arbitrage; it drives imbalanced prices back into alignment, as depicted in Fig 4.2.

Fig 4.2 Deterministic Arbitrage's Role



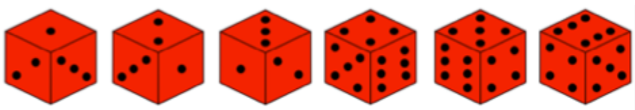
There are infinite possible Spot Price and £/$ Exchange Rate combinations at which these two share prices can be in alignment with each other. Say the alignment occurs at Spot Prices £9.70 and $11.155, and at an exchange rate of £1=$1.15. Then, we have exploited the arbitrage opportunity fully and we should exit the strategy by trading out of our two positions. On selling down our Long position in London, we receive £9.70 ($11.155), and on buying up our Short position in New York, we pay out $11.155 (£9.70). The cash flows sum to $0 (£0). On trading out of the strategy, we neither earn a profit nor suffer a loss. We retain the overall cash flow of $1 (£0.83) that we collected at the start, on entering the strategy. Thus, we profit $1 (£0.83), as we had determined we would from the outset.

4.2 Statistical Arbitrage

An arbitrage opportunity is Statistical if the profit from it cannot be determined from the outset with absolute certainty, i.e., risk is involved. This means we expect theoretically to make a particular amount of profit, but in practice we are uncertain to realise our expectation because there is risk inherent in the situation.

For example, say there is a game where a fair 6-sided die is rolled and the player receives the dollar value of the number that is rolled. If a 4 is rolled, then the player receives $4. Say the game costs $3 to play per go. Then, the possible outcomes of a roll are shown in Fig 4.3.

Fig 4.3 Die Game



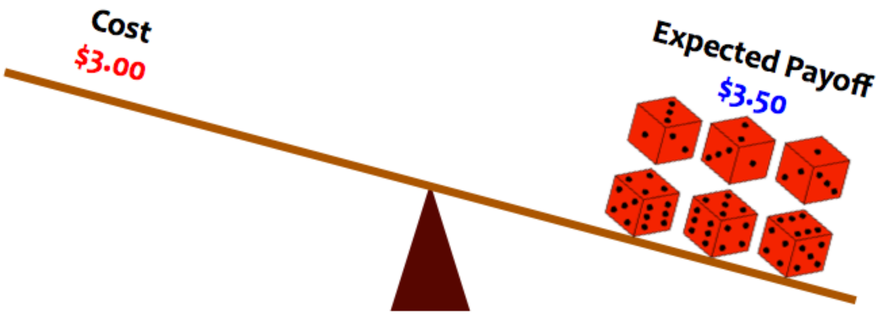
							Averages
Die Roll							3.5
Payout	$1	$2	$3	$4	$5	$6	$3.50
Cost of play	$3	$3	$3	$3	$3	$3	$3.00
Profit/Loss	$2	$1	$0	$1	$2	$3	$0.50

We cannot say for certain how much we will win in this game because we cannot say which number we will roll; there is risk involved. We know there are 6 numbers on a die and the die is fair. So, the chance of any number being rolled is equal, and is $^1/_6$.

If we play this game once only, then the $^1/_6$ chance value is meaningless and irrelevant. We could be very unlucky and end up $2 out of pocket because we rolled a 1, or we could be very lucky and end up $3 better off because we rolled a 6.

If we play this game repeatedly, then the $^1/_6$ chance value becomes meaningful and relevant. We expect rolled numbers to average out to 3.5, meaning we expect to make an arbitrage profit of $0.50 per play $(3.5 - 3)$. This is depicted in Fig 4.4. Note that our expectation of $0.50 profit can never be realised on any single play though, because a die does not have a face with $3^1/_2$ dots on it. A $3^1/_2$ can never actually be rolled and we can never actually make a $0.50 profit on any single throw. Understand, then, that an Expected Value is a theoretical value; it may or may not be one of the possible outcomes.

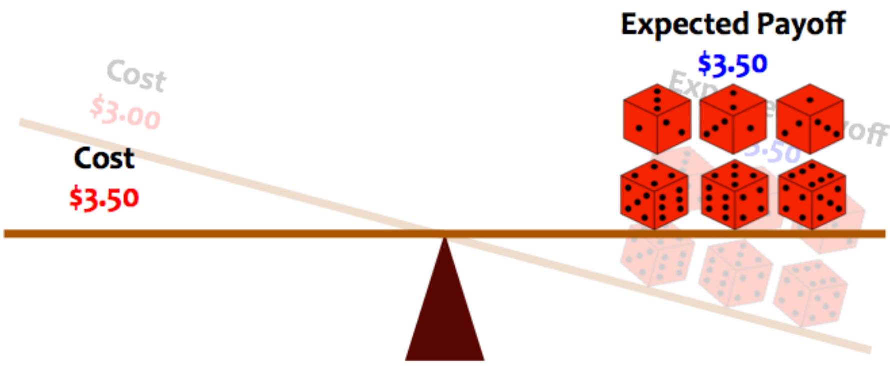
Fig 4.4 Statistical Arbitrage Opportunity



What we have in this game is a theoretical arbitrage profit opportunity of $0.50 per play. After 100 plays, we expect to make $50 (100×0.50). However, our expectation is not guaranteed to materialise. The $50 profit is a theoretical result based on the $^1/_6$ probability of each number being rolled. The number of times each number actually gets rolled may be somewhat different to what the probabilities suggest. But, the more times we play, the more the probabilities will get borne out and the closer will our profit be to our expectation. This is the nature of probabilities; they are based on the notion of infinite trials. After 1,000 plays, we expect to make $500 (1000×0.50). After 10,000 plays, we expect to make $5,000 (10000×0.50). So, we should keep playing this game over and over again, infinite times, because then we would make an infinite profit.

As we play this game more and more times, the game organiser will suffer an increasing amount of loss. This ought to trigger him to review the price per play and increase it to $3.50, where the statistical arbitrage opportunity disappears. At $3.50 per play, there is no arbitrage opportunity; players will be indifferent to playing and the organiser will be indifferent to operating this game. This is the importance of Statistical Arbitrage; it too drives imbalanced prices back into alignment, as depicted in Fig 4.5.

Fig 4.5 Statistical Arbitrage's Role



At a price per play of more than $3.50, the game organiser is the one who expects to make the profit. You might think nobody will play the game if it is priced above $3.50 per go, but you would be wrong; the gambling industry is built on this type of Statistical Arbitrage opportunity in favour of the operators.

To take advantage of Statistical Arbitrage opportunities, the following conditions are necessary:

- Correct outcomes and probability values – to determine correct Expected Values. In the die game example above, it is possible to determine the outcomes and their probabilities absolutely because everything about the game is known and understood fully; there are exactly six outcomes, each with the same probability of occurrence. However, in investment scenarios, some possible outcomes and their probabilities might have to be estimated or guessed, or might not even be known about at all until after the event.

- Large number of goes/plays - so the probabilities become borne out.

- Sufficient funds - to be able to keep playing. A series of loss making outcomes might occur before any profiting ones. If the losses incurred wipe out the funds needed to keep playing, then the large number of plays necessary for the probabilities to be borne out is prevented and the expected profit can never be realised.

Lesson 5

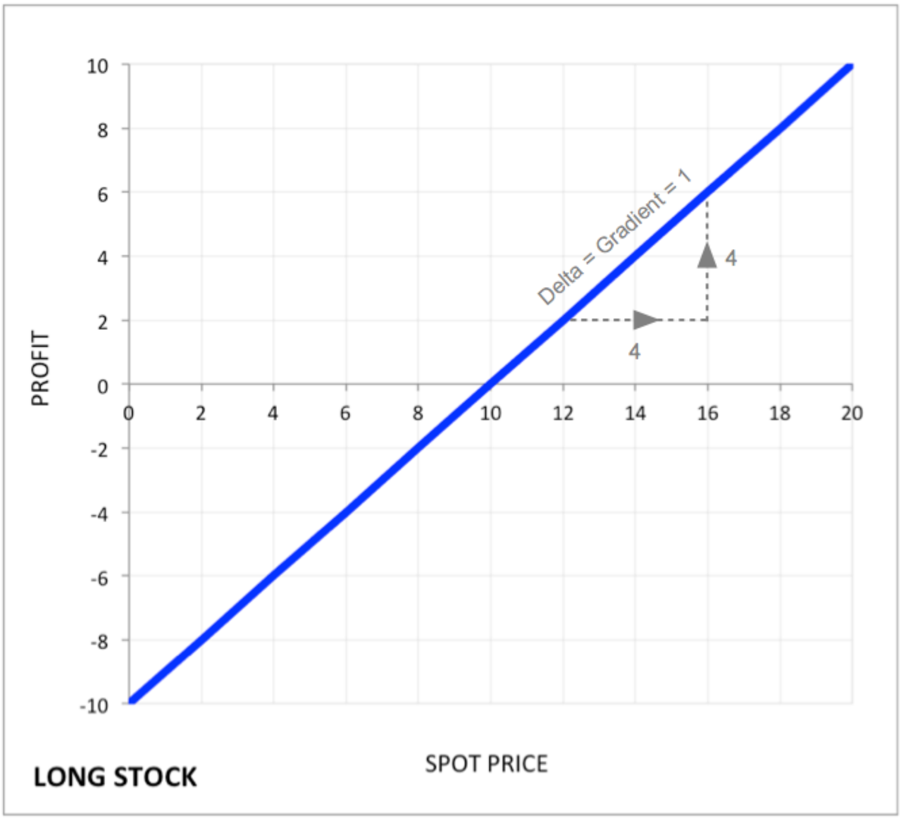
RATIONALITY

In this lesson, we learn that financial concepts are based on objective and rational thinking.

In the Deterministic Arbitrage example in Lesson 4, the London Stock is cheaper than the New York Stock. We buy the cheaper Stock and sell the more expensive one, simultaneously. Suppose, instead, we buy the £10 London Stock only, because it is the cheaper one. Then, we have a +1 Delta risk exposure, meaning movements in the Spot Price (over which we have no control) will cause us gains or losses, as shown in Fig 5.1.

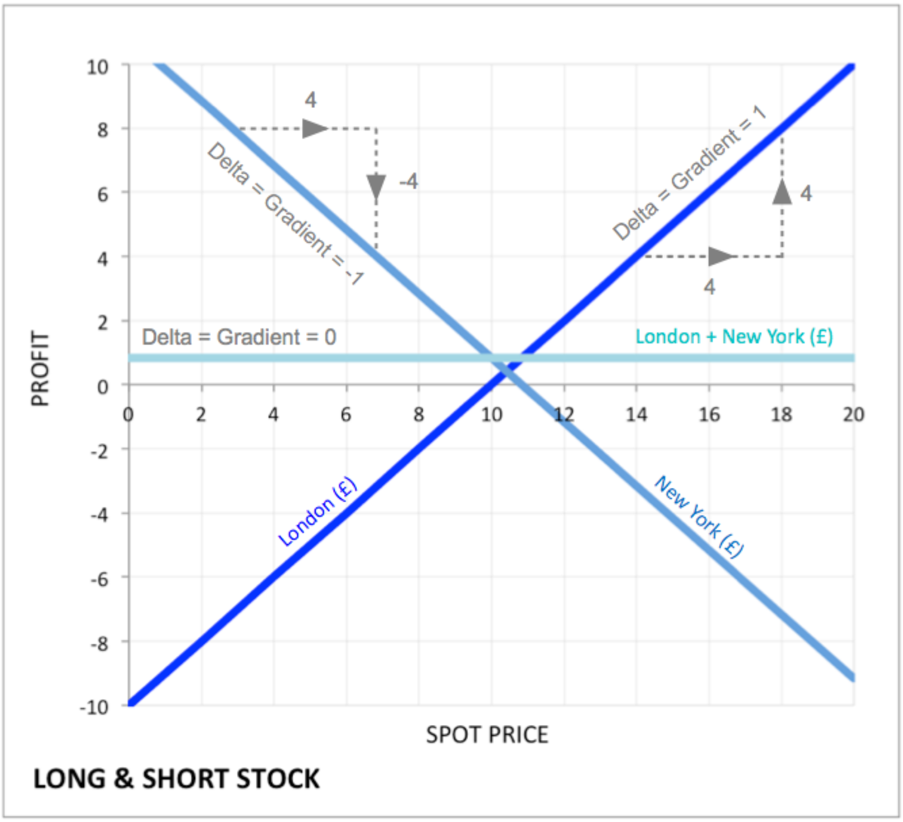
If the Spot Price rises above £10, then we profit. But, the Spot Price might fall below £10. Then, we will suffer loss. We do not know in which direction, or by how much, the Spot Price will move. Buying the London Stock only is a risky investment strategy. It is a speculative strategy based on a subjective opinion that the Spot Price will rise. We cannot be certain it will rise. Suppose the company goes bust, which is a possibility. Then, the Spot Price will crash to £0 and we will lose the whole of our £10 investment. This strategy is based on speculation entailing subjective opinion and hope.

Fig 5.1 London Stock Profit vs Spot Price



In contrast, the strategy of buying the London Stock and selling the New York Stock simultaneously is a rational one, based on facts and logical thinking. We do not form any subjective opinion about the values of the Stocks per se. We do not form any speculative opinion about the value of the company per se, e.g., it is under/over-valued because it is a great/poor business. Our assessment of the situation is formed rationally, based on logical analysis, i.e., the two Stocks are of the one and the same company and ought to be worth the same. We identify the relationship between the two Stocks and understand the meaning of the Price Spread between them. We accept the two Spot Prices as facts given by the market and we focus on the relationship between the Spot Prices, i.e., the Price Spread, the source of our profit. We execute the two trades with the intention to gain exposure to the Price Spread only, and to eliminate exposure to Spot Price movements.

Fig 5.2 London and New York Stock Profit vs Spot Price



We are not interested in the movements of the Spot Prices per se; we are only interested in them coming into alignment at some point. Even if the company goes bust and the Spot Prices become £0 and $0, our strategy will still work as we determined, as can be seen in Fig 5.2, because the prices will be in alignment.

Understand that financial concepts are based on objectivity and rationality.

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