

## Section Six: Mathematics, the Heart of Everything

In the last section we described the ‘chartist’ approach to market analysis. This method appeals to traders with a strong sense of the visual. A second approach to technical analysis involves formulae, equations and calculations. Other traders may feel more comfortable with this method. We would strongly recommend that you familiarise yourself with both disciplines and develop your own trading strategy which incorporates both.

So let’s talk about the importance of numbers in the life of a trader.

### 6.1 Elliott Wave Theory

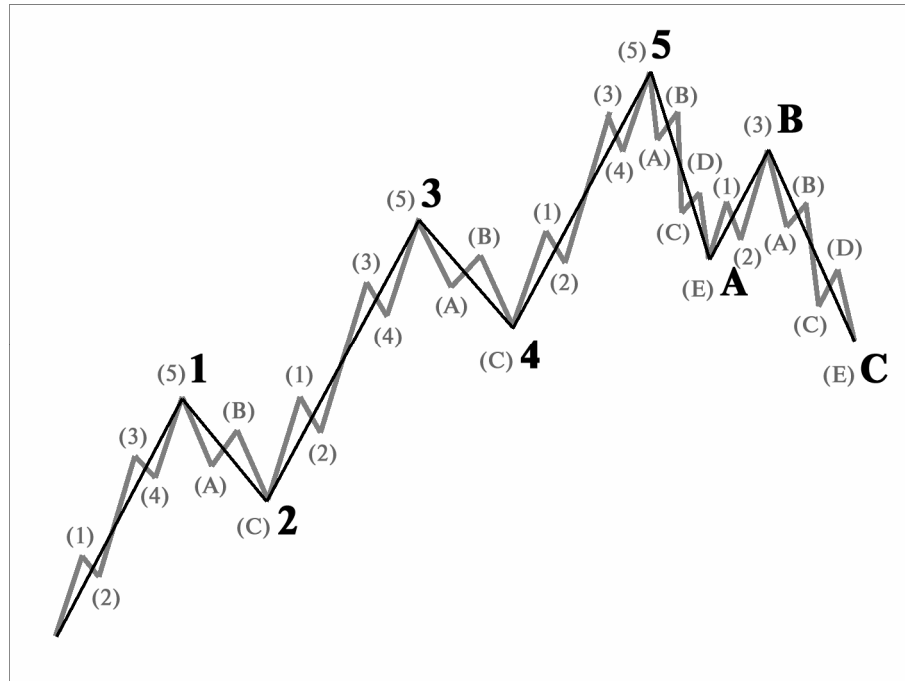
Ralph Nelson Elliott was an engineer and an accountant. In the 1930’s a serious illness meant he was confined to bed and during this time made an extremely thorough analysis of exchange prices and indices, in particular the Dow- Jones index. After making a number of very successful predictions, he published a series of articles in the magazine *Financial World*. These articles were the first published explanations of his perspective that the wave cycles of the Dow- Jones index are subject to specific rhythms. According to Elliott, these wave cycles follow a natural law – just like the sea – a peak follows a trough; an action follows a reaction. This dynamic shows its worth again and again. The cycle of rises and falls repeats itself with bankable regularity, since the market structure, taken as single whole, remains constant.

#### 6.1.1 The general theses of the Elliott wave theory

The essence **of the Elliott wave theory** is as follows:

- An ordered flow of prices in one direction is called a wave (a wave is an increase or fall as a whole, without taking into account the internal corrections of flow, – i.e., a wave exists, when a trend exists).
- A falling wave always follows a rising wave, while a rising wave always follows a falling one, i.e. the motion of one wave is always corrected by the motion of another.
- Waves numbered 1, 3, 5, A, C and also their sub-waves (1), (3), (5), (A), (C) are known as ‘impulse waves’, because they go in the direction of the trend.
- Waves 2, 4, B and also (2), (4), (b) are known as ‘corrective waves’, because they go against the trend to correct it.
- Up waves 1, 3, 5 consist of 5 (five) smaller waves, which zigzag – (1), (2), (3), (4), (5).
- Down waves 2 and 4 consist of three smaller waves (A), (B), (C);

- Down waves A and C consist of five smaller waves – (A), (B), (C), (D) and (E).
- Up wave B consists of three smaller waves (1), (2), (3);
- A wave of any order is always a sub-wave of a more powerful wave. In our example waves 1, 2, 3, 4, 5 are the five-wave sequence of a wave of a higher degree.



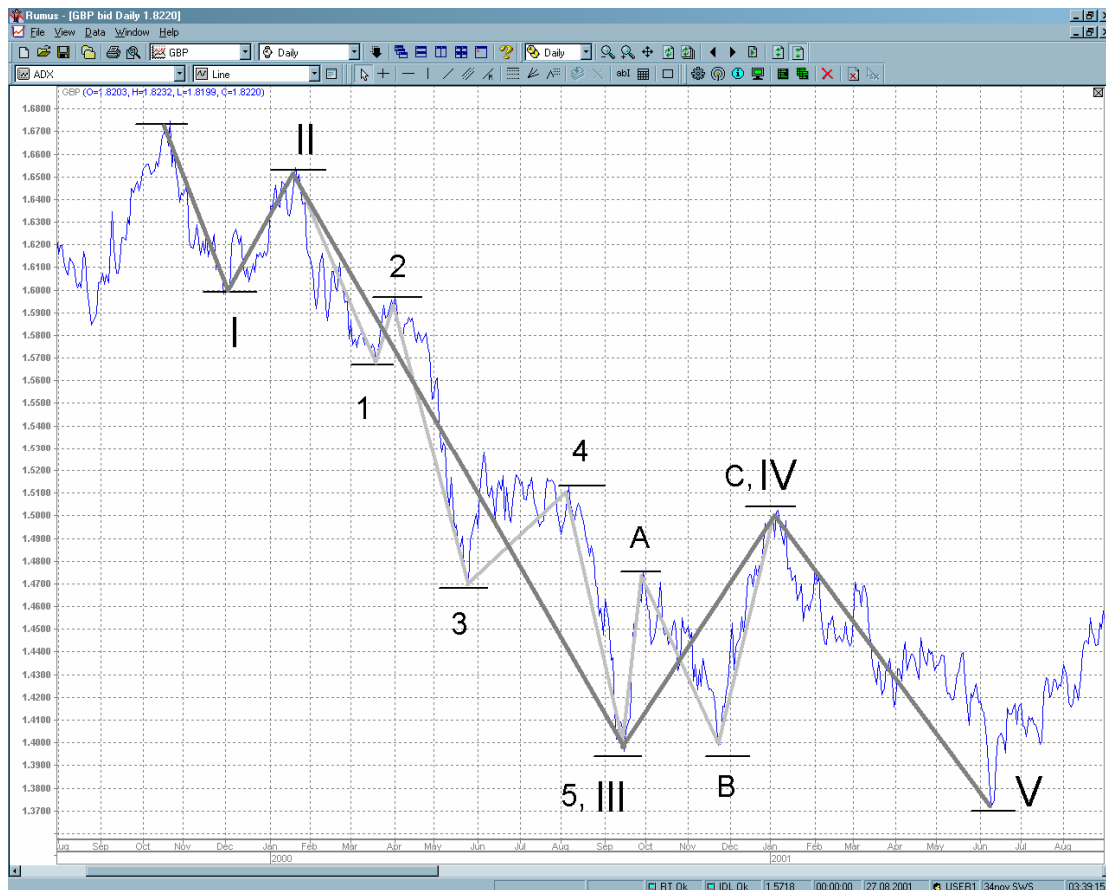
**Fig.6.1.1. Elliott wave structure: wave and sub-waves**

A five wave impulse is always followed by a three wave correction. Any trend will always follow this eight wave cycle. How the waves can be sub-divided depends on their direction in relation to the larger wave they are a part of.

The impulse waves (1), (3), (5), (A), and (C) all divide into 5 sub-waves; and corrective waves (2), (4) and (B) each divide into 3 sub-waves, corrective waves are always shorter than impulse waves.

Bearing these rules in mind, it is possible to discern where we are within the general scheme of things. For example

- If a five wave fall is observed within a general growth trend, we can, with a fair degree of confidence, state that we have observed wave (A) of a three-wave (A)-(B)-(C) fall. We can expect a correction wave (B) and then the fall will continue (C).
- During a bear market a three wave increase in prices should be followed by a renewed trend of falling prices and a revival in five waves is a signal to us that the market is turning bullish.



**Fig.6.1.2. Typical Elliott wave structure: a falling trend.**

### 6.1.2 Properties of Elliott waves, wave by wave

Wave 1: Almost half of all first waves are conceived at the bottom of the market and are nothing other than ‘rebound’ from the lowest levels. The first wave is, as a rule, the shortest of the up waves though sometimes it is very dynamic.

Wave 2: Wave 2 never retraces 100% of wave 1.

Wave 3: Wave 3 usually is the longest and is most dynamic of all 5 impulse waves. Wave 3 passing wave 1’s high is the classic breach and is the signal for opening positions in the direction of the wave. Volumes rise sharply. Wave 3 is never the shortest wave in price movement terms.

Wave 4: This wave has usually has a complex structure. Like wave 2 it is a phase of correction or consolidation. However, it differs in terms of its structure from wave 2 – on wave 4 triangles frequently appear. Important rule: the base of wave 4 never overlaps the maximum of wave 1.

Wave 5: This wave is usually much less dynamic than wave 3. During this wave many indicators (oscillators) lag behind the flow of prices, and negative divergences appear warning the approach of the market top.

Wave A: The most convincing sign of the appearance of this wave is its sub-division into 5 sub-waves, at the same time an increase in volume corresponds to the fall in price.

Wave B: This wave is the ‘rebound’ of prices against the new trend which began with wave A. For wave B low volume is typical. At the same time a ‘double-top’ forms. Sometimes wave B even overlaps the peak of wave 5.

Wave C: Wave C frequently drops much lower than wave A's minimum. A trendline drawn using wave 4 and wave A gives us the classic ‘head-and-shoulders’ chart pattern.

These rules are in no way complete: they are merely the bare essentials. There is a wealth of research on Elliott Wave Theory and, consequently, a wide range of literature including Forex Club’s films and books on wave analysis. Make the most of your opportunities, get on the wave and enjoy the ride that you have worked so painstakingly for.

## **6.2 Fibonacci numbers – the mathematical basis of wave theory**

Elliott conceded that the basis of his theory was a sequence of numbers discovered in the 13<sup>th</sup> century by the great Italian mathematician, Leonardo Pisano (1175-1240). Leonardo often referred to himself as Fibonacci and this is the name most commonly used by historians today. Although Fibonacci was born in Pisa, Italy, his father’s work took him to North Africa and the young Fibonacci enjoyed the benefits of a North African education. It was from the Moors in North Africa that he first came into contact with the Hindu-Arabic decimal system and its system of arithmetic. These are the arithmetical systems that we use today. As Fibonacci grew up he came to realise the decimal system’s vast superiority over the Roman numeral system that was in everyday use in Europe at that time. His book, *Liber Abaci* (The Book of the Abacus, or The Book of Calculation) which was completed in 1202, introduced the ‘new’ number system to European mathematicians. It is difficult to overestimate the role of his book in the development of mathematics and the advancement in of mathematical and scientific knowledge in Europe.

Fibonacci also made another enormous contribution to European mathematics, stemming from some mathematical musings on the breeding powers of rabbits (I kid you not!)

Basically, in chapter 12 in *Liber Abaci*, Fibonacci sets himself this problem. A man has a pair of rabbits in an enclosed place and he wants to know the number of rabbits he can expect in one year. He says that it is in the nature of these animals to have a pair of babies and for that pair to ready to breed then following month. (The mathematics is sound even if the biology is not!)

He then goes on to solve and explain the solution:

In the beginning there is one pair (1) at the end of the first month there are two pairs (2), one breeding pair and one immature pair. And at the end of the second month there will be three pairs (3). Of these three, in the following month two pairs are expecting and one is immature, so at the end of the third month, there are five pairs. He goes on to say that by the tenth month there will be 144 pairs and to these the eleventh month brings a further 89 pairs so there will be 293 pairs at the end of the eleventh month. In the twelfth month 144 have offspring bringing the grand total to 377.

So there we have it: Fibonacci's sequence of numbers:

1,1,2,3,5,8,13,21,34,55,89,144,233,377 and so on and so on to infinity. One special feature of this sequence is that the sum of any two adjacent figures is the following number. Take a look:  $1+1=2$ ;  $1+2=3$ ;  $2+3=5$ ;  $3+5=8$ ;  $5+8=13$  et cetera.

And further: the ratio of any number in the sequence to the following number gradually approaches **0,618**. By this I mean:

$$\begin{aligned}1:1 &= 1 \\1:2 &= 0.5 \\2:3 &= 0.67 \\3:5 &= 0.6 \\5:8 &= 0.625 \\8:13 &= 0.615 \\13:21 &= 0.619 \text{ and so on.}\end{aligned}$$

Notice that the value of the ratios varies around 0,618, and that the spread of fluctuations gradually decreases as the numbers increase.

The ratio of any number to the preceding one is approximately equal to 1,618 (the reverse value of 0,618).

For example:

$$\begin{aligned}13: 8 &= 1.625 \\21:13 &= 1.615 \\34:21 &= 1.619.\end{aligned}$$

The higher numbers, the closer they approach the values 0.618 and 1.618.

The ratio of any number to the number next to it but one oscillates around **0.382** and to the preceding but one around **2.618**. For example:

$$\begin{aligned}13:34 &= 0.382 \\34:13 &= 2.615 \text{ and so on.}\end{aligned}$$

Fibonacci numbers contains other curious ratios (coefficients). But the ones given above are the most important and well-known.

Actually, it may not surprise you to learn that Fibonacci was not the original discoverer of all this. The fact is that the coefficients **1.618** and **0.618** were known to Ancient Greek and ancient-Egyptian mathematicians. They called it "golden

ratio " or " golden section". This knowledge shaped the development of music, fine arts, architecture and biology. For example, the Greeks used the principle of the "golden section" when building the Parthenon and the Egyptians when building the great pyramid at Giza. The properties of "golden ratio" were well known to Pythagoras, Plato and Leonardo da Vinci. But all this begs the question: can they prove useful to us? And if they can how do we use this great discovery?

### 6.2.1 Practical applications

Many technicians use Fibonacci numbers in their Technical Analysis to calculate future price movement after a rebound (known as **retracement** or a **correction**). They can help us determine whether the trend will continue after retracement or whether the retracement is, in fact, the beginning of a new trend. They can also help us identify new levels of support and resistance.

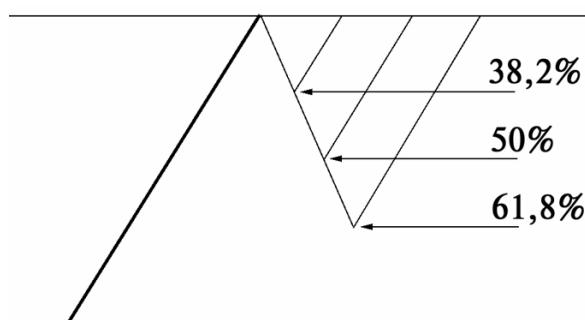
So as I said at the beginning of this section, the basis of Elliot wave theory is the Fibonacci series of numbers. For a start, the number of waves in a trend corresponds to Fibonacci numbers and, very interestingly, values taken from the golden section can help us identify where we are on in the Elliot wave cycle and therefore what will happen to price in the near future.



Fig. 6.2.1. Price chart with Fibonacci levels

Smart people use the simplest method to make use of Fibonacci numbers is during price retracement. Price retracements are simply a pullback, a correction, in price relative to a previous price swing. A bullish retracement occurs as price declines relative to a previous price rally. A bearish retracement occurs as price rallies

relative to a previous price decline. The best trading opportunities occur when price tags one of the more common price retracement levels, usually the 38%, 50%, or 62%. Two of these values are derived directly from the 'golden section': 38% coming from 0.382 and 62% from 0.618. The 50% level is not derived from the Fibonacci sequence, but it has proved itself to be a powerful retracement level and is worth including with the primary Fibonacci retracement levels. These retracement levels are somewhat supported by Dow in his research on the market. According to Dow the most likely levels of retracement occur at 33% (more probable) and at 66% (less probable). If we take into account that other market researchers (for example W.D.Gann) most propose likely retracement levels at around the Fibonacci values. This is why we feel happy recommending Fibonacci retracement levels, remembering to fine tune these levels as the specific circumstances dictate. One thing to bear in mind is the effect that the enormous popularity of Fibonacci numbers: since a large number of traders expect retracement to occur at these levels, it will most probably happen. The mass realises its expectations. It's a disturbing thought, but in this case it is indisputable. Forex Club's charting software, Rumus, allows you to set Fibonacci levels and fan-lines enabling deft and precise levels to be set.



**Fig.6.2.2.The most probable retracement levels**

The simplicity of this method of analysis is very attractive and this simplicity gives rise to the enormous popularity of wave theory. An important point to remember is that retracement occurs on main trends, on intermediate trends and minor trends so it is possible to observe them on monthly, daily and hourly charts, which means that you, me and the whole world of traders have a simple yet effective means of forecast and, in the final analysis, of earning money.

### **6.3 Trend following indicators and oscillators**

Computer technology has opened up the world of mathematics to traders and has brought a wide range of complex methods to hand. These methods process financial data and bring a level of objectivity to the process of trading. This objectivity is invaluable as it takes the individual out of the trade thus helping you

maximize your profits and minimize your losses rather than the other way round, which is what happens when you trade on instinct.

The main tools in the mathematician's tool box are indicators and the two main types of indicators are **trend-following indicators** and **oscillators**.

### **6.3.1. Trend-following indicators: moving averages**

The development of moving averages has brought about a whole raft of trend following indicators. They are designed to identify and track a trend and to signal the reversal of a trend. Trend following indicators are coincident or **lagging** indicators – they turn after trends reverse.

Moving averages are constructed by averaging (smoothing) prices over a period of time. For example a 5-day moving average is the average price over the last five days. The price interval can be chosen by you (5 minute, 10 minute, hourly, daily or monthly: but for the sake of clarity we will refer to day charts). As new price information is processed the oldest price is dropped. Forex club's Rumus software (which can be downloaded free from our site at [www.fxclub.com](http://www.fxclub.com)) allows the traders to set their own time period parameters. If you do this you will see that a moving average with a shorter time period follows the price more closely than a moving average with a longer time period.

The first questions a trader asks himself as he sits down in front of his computer are: "Is the market rising or falling?" and "What trend is on the market now: short-term; medium-term or long-term?" Moving averages can answer these questions: they clearly indicate the direction of the trend and you can compare the trends on five minute, hour day and month charts giving you an insight into the type of trend.

There are 3 basic types of moving average: simple, exponential and weighted.

#### **Simple moving average (SMA)**

The following formula is used to calculate SMA:

$$SMA = \frac{P1 + P2 + P3 + \dots + Pn}{n}$$

Where P is the currency price being averaged.

And n is the number of time periods in the moving average (selected by the trader). In other words a five-day SMA is calculated by the sum of the closing prices of the last five days divided by five.

The simplicity of the SMA is its one big drawback. Each price has the same 'weight' (i.e. importance) so old information is as important as new information. When the price at the end of the day jumps then our SMA jumps, this is good we want our indicator to respond to changes on the market but SMA also jumps when the same price information is dropped from the equation five days later and this has nothing to do with the current state of the market. SMA cries wolf twice, when the wolf is coming and when he is running away.

The most common time periods used with SMA are 3, 5, and 10 to a maximum of 20 days.

### **Weighted Moving Average (WMA).**

A WMA is designed to deal with the drawback of the SMA. Each price is weighted with more weight put on recent data and less weight on past data. The calculations are as follows for a 5-day WMA:-

5-day weighted moving average						
Day #	Weight		Price		Weighted	Average
1	1	*	25.00	=	25.00	
2	2	*	26.00	=	52.00	
3	3	*	28.00	=	84.00	
4	4	*	25.00	=	100.00	
5	5	*	29.00	=	145.00	
Totals:	15			=	406.00	/ 15 27.067

In our example the weight on the first day is 1 while the weight on the most recent day is 5 but you can assign whatever weights you want. Our technical analysis software Rumus devises and charts WMA at the click of a mouse. The main drawback with WMA is that it gets overly complex with longer periods of time and is best used shorter periods.

### **Exponential Moving Average (EMA).**

An Exponential Moving Average is calculated from the formula:

$$\mathbf{EMA = EMA_{(t-1)} + (2/(n+1))*(P_t - EMA_{(t-1)})}$$

Where  $P_t$  = the current price;

$n$  = length of EMA (chosen by trader)

As you can see, each new value of EMA contains information about the preceding EMA,  $EMA_{(t-1)}$ . Consequently, EMA considers price history in its entirety.

Information does not disappear abruptly, but fades away.

EMA can be calculated for any period of time and, of course, Rumus can calculate and chart it in the twinkling of an eye.

So that's three tools in your technical toolkit. But which should you use and when? Like in any other situation you have to choose the tool which fits the job in hand.



**Fig. 6.3.1 Types moving average: 14-hourly SMA, WMA, EMA.**

### **General principles for working with moving averages**

When the moving average is rising one should run with the bulls and speculate for further price rises. The best time to buy is when the price dips near or slightly below the moving average. When this happens, place your stop loss at lower than the recent minimum of prices. If you have already opened a position and placed orders, you can pull the orders upwards in proportion to the price rise. When the MA is falling, one should trade on the short side, opening selling positions when prices rally towards or slightly above the MA. Set your stop loss a little higher than the last peak of prices and the take profit in accordance with your ratio. Lower the stop loss to the break even point as soon as price allows.

The second principle is that when price breaks through MA it is a strong signal for a trend. As we mentioned before, the average ‘lags’ a little behind the price so, for example, when price begins to rise sharply after a long period of decline the price line is forced to cross the MA. There is no magic in this, only simple maths but it’s a signal that prices will continue to rise rapidly.

The third principle is about a turn of MA on a minimum or maximum value. If the MA is running under the price and takes a local minimum while the price is going up then we can read that as a moderate signal to get bullish. If price is not on the up then it is only a weak signal which will need the confirmation of other signals.

Moving averages are the basis for many other indicators namely:

- Moving Average Convergence-Divergence (MACD) and the MACD Histogram
- Rate of Change (ROC)
- Relative Strength Index (RSI)

Let's move on to talk about them.

### **6.3.2 Moving Average Convergence-Divergence (MACD)**

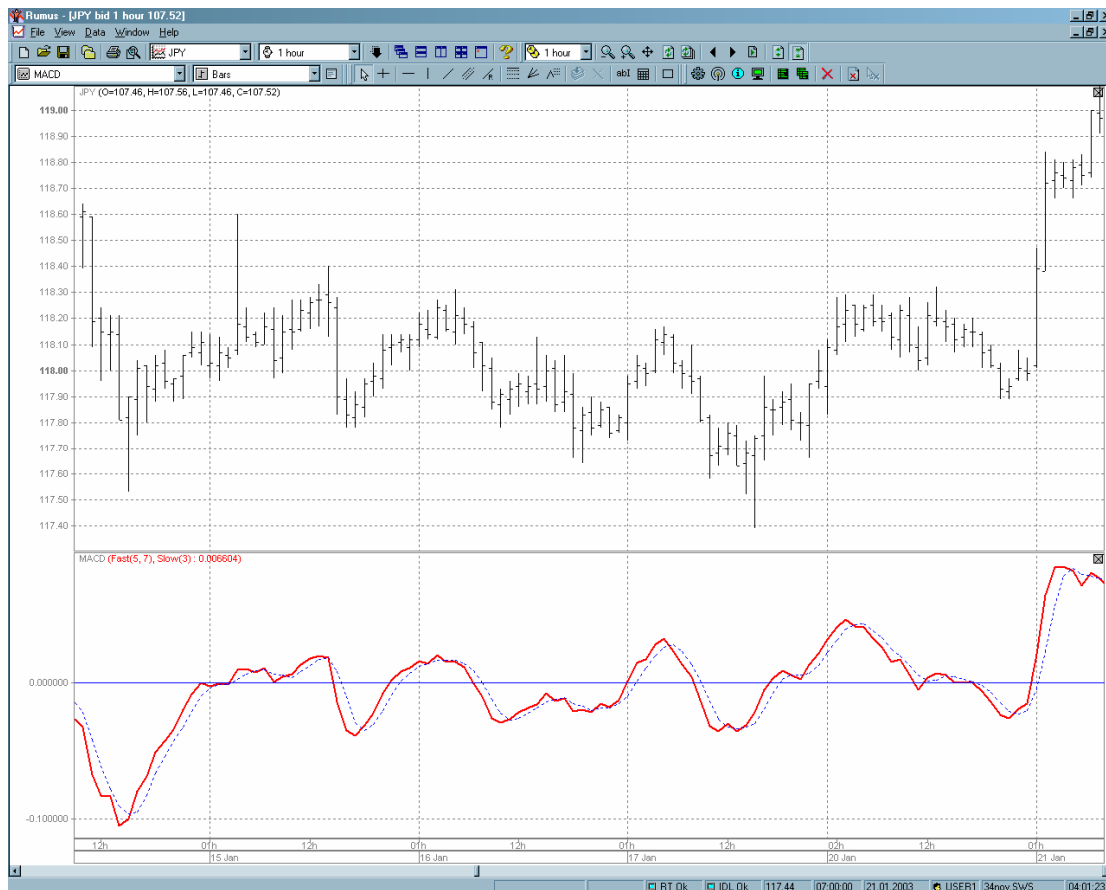
This is a complex indicator based on two moving averages. It is calculated using three EMAs and appears on the chart as two lines. These lines are known as a fast line and a slow line. The fast line is made up of the difference between two EMAs of closing prices at different time intervals and the slow line is an EMA of that difference.

For example, if we want to plot the indicator on the basis of 12 and 26-day EMAs

1. We calculate the 12-day EMA
2. We calculate the 26-day EMA
3. We subtract the 26-day EMA from the 12-day EMA and plot this value as a solid line. This is the fast line.
4. We then calculate a 9-day EMA of this fast line and plot this as a dashed line. This is the slow line.

The slow line and the fast line are so-called because of the speed they react to prices.

But of course, Rumus, our technical analysis software available at no charge from our site, [www.fxclub.com](http://www.fxclub.com), plots MACD automatically. You can change its parameters at the click of a mouse.



**Fig.6.3.2. MACD**

The MACD gives clear and simple signals to buy or sell.

When the fast line crosses the slow line from below and rises above it, we should buy. When the fast line crosses the slow line from above and falls below it, it is a signal to sell.

Analysts frequently employ two MACDs, a daily and a weekly. This gives more reliable signals with the ‘longer’ MACD confirming the ‘shorter’ MACD’s signal.

### 6.3.3 Oscillators

Oscillators are leading or coincident indicators - they often turn ahead of markets. As trend following indicators identify trends, oscillators identify turns of trend. They do this by identifying when a market is over-bought or over-sold. When the market is over-bought it is ready to turn and price has reached a peak and is ready to fall. A market is over-sold when price has reached a bottom and is ready to rise.

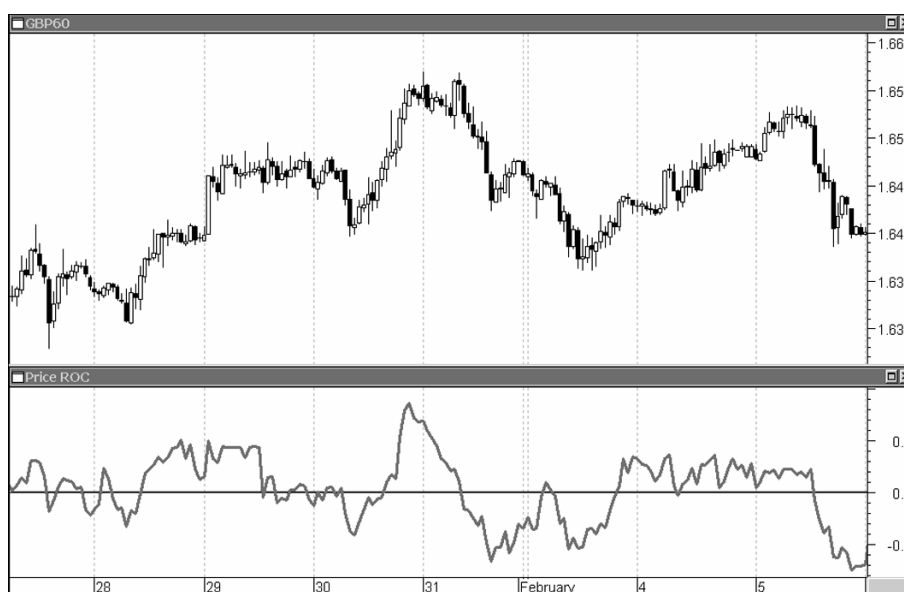
#### Rate of Change in price (RoC)

Rate of Change in price is calculated using the following formula:

$$\text{RoC} = (V / V_n) * 100$$

Where V is the latest closing price; V<sub>n</sub> is the closing price n days ago and 100 gives us a value connected to a central line of 100. This central line value is merely

for convenience as multiplying  $V/V_n$  by 100 means that our RoC will be a whole number and most people prefer to work with whole numbers.



**Fig. 6.3.3 RoC (Rate of Change in price) on GBP**

Referring to fig.6.3.3 we can see RoC oscillating around the central line which corresponds to the price level of , for example, 10 days ago (if  $n=10$ ).

When RoC is on the central line then there is no difference between the price ten days ago ( $V_n$ ) and the price today ( $V$ ). When RoC is above the line,  $V > V_n$ ; and when RoC is below the line,  $V < V_n$ .

When RoC is rising and is above the line;  $V > V_n$  and the difference between the two values is increasing. When RoC is falling and is above the line,  $V > V_n$  but the difference is decreasing.

When RoC is falling and is below the line then  $V < V_n$  and the difference is increasing. When RoC is below the line but rising, then  $V < V_n$  but the difference is decreasing.

RoC gives reliable signals when it signals against the trend. When prices reach a new low but RoC is on the up then we have what is known as a bull divergence. In this situation the bears are losing power, price is falling through inaction and the bulls are ready to take the market. RoC is signaling a new bottom, a turn in trend and a time to buy.

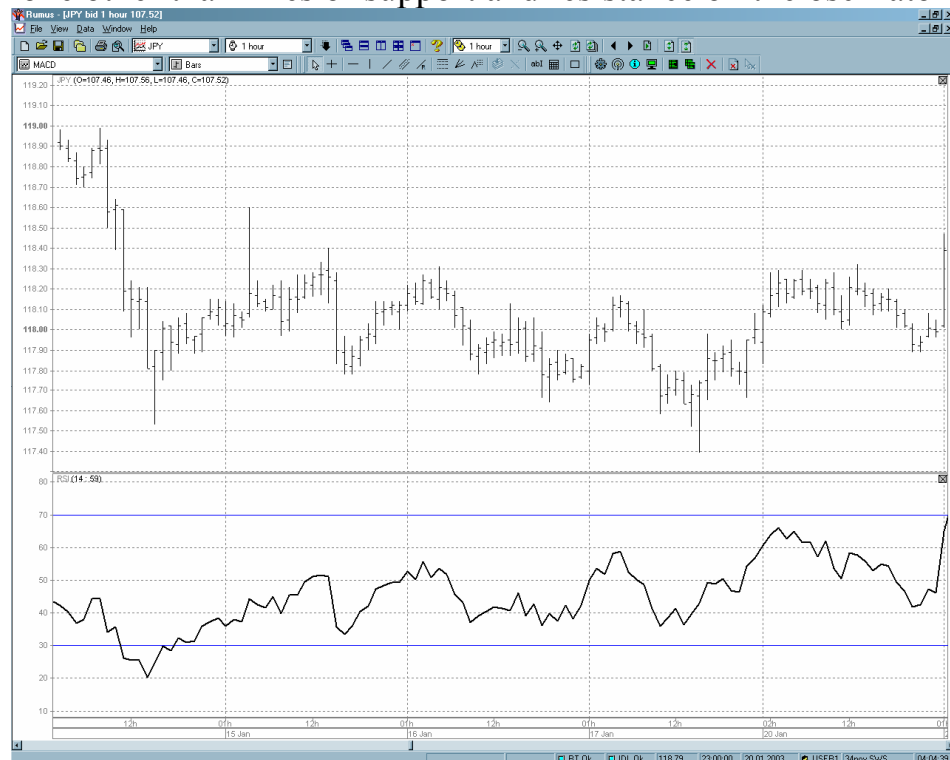
Conversely, when prices rise to new heights but RoC is falling, the bulls are losing ground and the bears are gaining the upper hand. It's time to close long positions and go short.

### **Relative Strength Index (RSI)**

This oscillator measures the internal strength of an instrument against the situation as a whole and does not measure that instrument's strength relative to another market tool.

RSI (like other oscillators) gives us an insight into the emotional state of the market participants by looking for points where market optimism or pessimism is becoming fragile.

In practice over-sold and over-bought zones are marked out on the oscillator chart by horizontal lines. The curve of the oscillator should go into these two zones only 5% of the time at most. Often these lines are set at values 30 and 70 on the RSI scale. This is the default setting for the RSI on our software Rumus. This can, of course be altered and many traders play it safe and set the horizontal lines marking the border of the zones at 80 in 20. My advice is to follow the 5% rule and set each line to mark the border where RSI has spent less than 5% of it's time in the last 4 months and to rest these reference lines every three months. These lines are basically none other than lines of support and resistance on the oscillator chart.



**Fig 6.3.4 Oscillator RSI**

RSI is a momentum oscillator and considers changes in closing prices of a market tool and compares the upward moving closing changes with the downward moving closing changes over a specific period of time.

Here is the basic formula:

$$\mathbf{RSI = 100 - [100 / (1 + U / D)]}$$

Or with the same result like this:

$$\mathbf{RSI = 100 * [1 - D / (D + U)]}$$

Where U = average value of upward price changes for 'n' time periods

And D = average value of downward price changes for the same 'n' periods.

So if you wanted to manually calculate RSI for a 14-day period, what you have to do is:

1. Obtain the closing prices for the last 14 days.
2. Take all the days when the market closed higher than the day before, add up the amount of the increases and then divide the total by 14 to get the average upward price change.
3. Take all the days when the market closed lower than the day before, add up the amount of the decreases and then divide the total by 14 to get the average downward price change
4. Put your U value and D value into the formula, calculate and voila! You have one point on your RSI line.

Of course, once again, with Rumus you need only to select the number of time periods you require and our software does the rest. I have only gone through the calculations for these indicators in order to help you understand what they are.

As an oscillator, RSI identifies a market tools overbought and oversold zones. It should be remembered that a tool can stay over-bought or over-sold for some time. It's a bullish signal when RSI leaves the over-sold zone and then rallies above it and it's bearish when it falls out of the over-bought zone. Other analysts suggest heeding daily bullish and bearish signals when the weekly trend is up (for bullish signals) or down (for bearish signals). Look for divergences. Because RSI is a leading indicator it can often signal the reversal of a trend. A final tip is to keep your eye on the centre reference line. Generally a reading above 50 tells us that average gains are higher than average losses and that RSI below 50 indicates the reverse is true. Some traders see a move above or below 50 as a secondary (confirmation) signal.

Here are just a few of the many indicators available to the trader. With Rumus, you can even devise your own indicators, using Rumus' in-built language RuLang. My advice here though is "let's learn to walk before we start trying to run". In the near future Forex Club Financial Company will be publishing a book dedicated to the use of indicators in technical analysis. As for which indicators to use, I can only advise experimentation and then selection. The old adage that one man's meat is another's poison is as true here as elsewhere.