FIBONACCI AND GANN APPLICATIONS IN FINANCIAL MARKETS

Practical Applications of Natural and Synthetic Ratios in Technical Analysis

George Alexander MacLean

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Contents

For Angus and Jenny for all the skills and encouragement and to the Great, the Good and the Gurus for the knowledge

Cuimhnichibh air na daoine bho' n d' thainig sibh
(Gaelic proverb)

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Preface

Technical analysis is not a difficult subject for study, but it does suffer from a bad press from time to time. It attracts strong personalities, as it is a very small pond and strong characters tend to stand out more and get heavy coverage in the media; we can suffer from the bad press by having far too many technicians saying they forecasted various key corrections in the past. These boasts have to be taken with a pinch of salt. Publicity for technical analysis in the media is a good thing as technical analysts are not shy and tend not to hide under bushels. However, within our own community the real stars are the quiet ones who do sterling work and research day in, day out with little or no acknowledgement.

These are the experienced analysts who take time to dispense their accumulated knowledge of market analysis and strive to further the bounds of technical education and study. Market understanding has fallen out of favour in recent years as traders shrink the timeframes necessary for a profitable trade. However, that was fine in the bull market times, but is much more difficult in choppy bearish ones. Anyone can catch the trend from simply looking at a screen, but it takes a trained eye to spot when an asset price is running out of steam and indeed looking risky.

It is in such situations that the skills of a good technical analyst come to the fore. In the last 20 years the study of technical analysis has become more formalised. In the past, charting and interpretation skills were passed on from individual to individual or perhaps even picked up from the plethora of business biography books available. However, this is not an ideal situation and a more formal approach is needed. It has been with the networking of analysts regionally and globally that has seen the development of training courses, seminars and even television training. It is to this corpus of information that this book hopes to add.

When I started out as a trainee technical analyst I was never allowed to act on any of my analyses until I had proved myself with a professional qualification in technical analysis, so my learning was bookish and dry and suffered from lack of practical

application. However, subsequent employment opportunities gave me practical skills that cannot be found in any of the more traditional textbooks. Practical technical analysis is quite different from a bookish one – the sheer volume of instruments that have to be analysed on a daily basis, coupled with constraints on time, which mean that not all studies have the time to be drawn, means that the contemporary technical analyst has to be knowledgeable as to when to cut corners, and more importantly when not to.

Traditional paper charting days are gone, as is the gentle skill of taking time to look at trend, pattern and Point and Figure charts and taking a measured long-term view. It is not uncommon for a technical analyst today to consider the long-term view as being until lunchtime. Screen-based charting and price information have allowed this shortening in timescales to develop, but not without some cost. Long-term studies of any financial market are few and far between.

It is only through continued practice and study of new techniques and reviews of old long-learned ones that technical analysts will improve their skills. Technical analysis is not a Dark Art practised by very few acolytes; it offers skills and opportunities to look at markets from both a scientific and an artistic bias, as true technical analysis is a porous membrane between science and art and both skills are needed if the technical view is to be successful.

This book looks at the application of two of the more 'obscure' techniques, Fibonacci applications and Gann theory. Both of these techniques have a long and glorious application history, but it is the careful application of these techniques that has been overlooked now that many charting packages conveniently draw the various patterns on a screen. This book looks at the drawbacks of this convenience and points the student of technical analysis in the right direction and hopefully encourages good technical practice.

While it can be enough to take positions on Fibonacci and Gann analysis alone, it would be seriously wrong to overlook other technical tools. There is a chapter that looks at 'Total Analysis' (Chapter 8) where a sequence of analysis tools, which give a better understanding of the outlook, is suggested.

Contemporary technical analysts stand on the shoulders of giants in our field, and I am fortunate to have met and studied and practised under some of the greats. Bronwen Wood FSTA started me off in this field and her lectures were inspirational. She is greatly missed. Tony Plummer, who turned me from technical analysis of equities to Gilts, can take the blame for my subsequent career. Thanks are also due to Gerry Celaya for showing me how not to be frightened by either intraday charts or Fibonacci tool attack and my fellow board members of the Society of Technical Analysts, especially John Cameron FSTA for encouragement.

Finally, to the stars and giants of the future, this book is addressed to you.

George Alexander MacLean
London

1
Introduction to and History of the Fibonacci Sequence

A brief look at mathematical proportion calculations and some interesting facts about this ratio.

The origins of the Fibonacci sequence are well known to architects, artists and technical analysts, but knowledge of the importance of the Golden Section was known further back in ancient history, definitely as far as the Greeks and, depending on which source is read, as far back as ancient Egyptians and Sumerians. However, evidence for understanding and usage in ancient Sumer is tenuous at best.

Taking a line of any length, the ancients discovered that there was a point on the line where the proportions of the whole to the larger section was the same proportion of the smaller section to the larger section. This point on the line is called the Golden Section.

Knowledge of irrational numbers was known in antiquity, and for the Greeks, especially the Pythagorean school, came as a shock. In ancient times, rational numbers (1, 2, 3, etc.) were believed to have the secret of all knowledge and that any length could be measured using whole number units only; e.g. 9.65 was actually 965 units of some smaller measure. The discovery of pi (π) came as a surprise to the Greeks looking at the relationship between the diameter of a circle and its circumference, as the multiplication factor to find the circumference was not a whole number. Imagine the additional shock of discovering that in a square of side one unit the diagonal was not a whole number that could be counted? That is to say, within the line section that gives the Golden Mean, there is no measure, no matter how small, that will give the result that one part of the line section is a whole number of measuring

units and the smaller is also a whole number. The inability to find common measures that will give whole numbers for the two sections means that the proportion is incommensurable.

This meant that there was no number representing the hypotenuse of the triangle of sides equal to one, or within the line section, that could be seen as the product of two others, no matter how they searched. That was just the start as more and more of what we now call irrational numbers were discovered. It is into this group that the Golden Section belongs. The Golden Section is an incommensurable number, i.e. it cannot be represented as a fraction, and was represented by the Greek letter τ (tau), being the first letter of the word for 'the cut', τομη (to-mi) in Greek. Contemporary symbolism for the Golden Section is 'ϕ', which was suggested in the early 20th century by Mark Barr, an American mathematician, as a homage to Phidias, the classical Greek sculptor and builder of the Athenian Parthenon and of the Temple of Zeus at Olympus. What greater honour could there be?

Much later, in the 15th century in Pisa, Italy, Leonardo de Fibonacci constructed a simple series after observing the population expansion of a pair of rabbits. He noted that it took one generation before each new pair reached sexual maturity and the population exploded. The total number of pairs (breeding and immature) was noted down. In Figure 1.1, taken from data in Table 1.1, the normal notation from biological science is used, where F_n is the filial generation and n is the number of

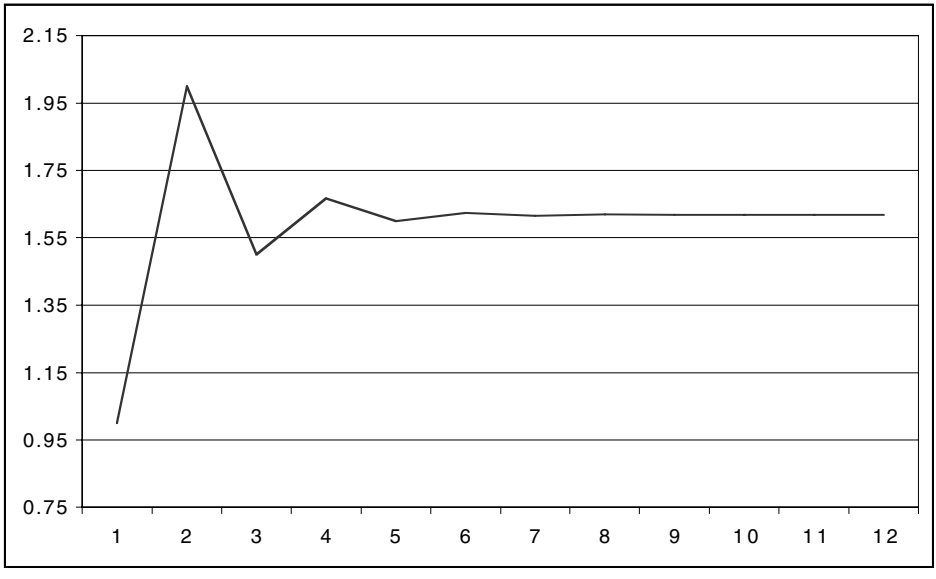

Figure 1.1

Table 1.1

n	1	2	3	4	5	6	7	8	9	10	11	12	13
F	1	1	2	3	5	8	13	21	34	55	89	144	233
		1	2.000	1.500	1.667	1.600	1.625	1.615	1.619	1.618	1.618	1.618	1.618

that generation. Taking this series (1, 1, 2, 3, 5, 8, 13 and so on), each subsequent filial generation is seen as the sum of the previous two generations as follows:

$$F_n = F_{n-2} + F_{n-1}$$

This is an infinite series without limit.

An interesting corollary of this series is that there is a relationship between each filial total. Taking

$$\frac{F_n}{F_{n-1}}$$

the series

$$4.236, 2.618, 1.618, 0.618, 0.382, 0.236, 0.146$$

very quickly tends to 1.618, as represented graphically by Figure 1.1. Further relationships are found by taking F_n with F_{n-2}, F_n with F_{n-3}, etc., resulting in the limits given in Figure 1.2, taken from the data in Table 1.2. These are important values for the technical analyst, for from these our 'common or garden' Fibonacci ratio of 61.8% is derived.

Reversing the ratio will give similar limits, with 0.618, 0.382, 0.236 as key here. These are the main ratios used in technical analysis and a discussion and application chapter follows later in the book. The table of Fibonacci ratios is

$$1.618, 2.618, 4.236, 0.618, 0.382, 0.236 \text{ and } 0.146$$

Normally in technical analysis, these are expressed as percentages:

$$161.8\%, 261.8\%, 243.6\%, 61.8\%, 38.2\%, 23.6\% \text{ and } 14.6\%$$

The interesting number of 1.618 is also derived from the following infinite fraction:

$$1 + \cfrac{1}{1 + \cfrac{1}{1 + \cfrac{1}{1 + \cfrac{1}{1 + \cdots}}}}$$

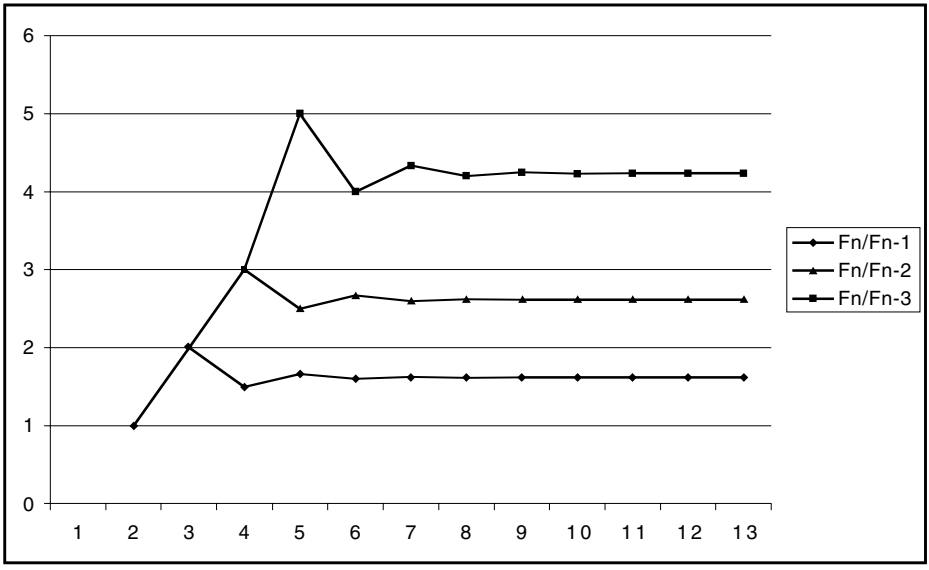

Figure 1.2

Table 1.2

n	1	2	3	4	5	6	7	8	9	10	11	12	13
F	1	1	2	3	5	8	13	21	34	55	89	144	233
		1	2.000	1.500	1.667	1.600	1.625	1.615	1.619	1.618	1.618	1.618	1.618
			2.000	3.000	2.500	2.667	2.600	2.625	2.615	2.619	2.618	2.618	2.618
				3.000	5.000	4.000	4.333	4.200	4.250	4.231	4.238	4.235	4.236

Although this looks complicated, making the above equal to x, it breaks down to

$$x = 1 + \frac{1}{x}$$

resulting in $x^2 = x + 1$ once both sides are multiplied by x. Therefore, using the quadratic solution of

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \qquad \text{with } a = 1,\ b = -1 \text{ and } c = -1 \text{ (from } x^2 - x - 1 = 0)$$

gives

$$x = \frac{-(-1) \pm \sqrt{(-1)^2 - 4.1(-1)}}{2.1} = x = \frac{1 \pm \sqrt{1 + 4}}{2} = x = \frac{1 \pm \sqrt{5}}{2}$$

which results in $x = 1.618\ 033\ 9$ (ϕ) and $-0.618\ 033\ 9$, which is $-1/\phi$.

There are many volumes that look at the interesting properties and occurrences of this ratio in nature. Some key examples of this are the famous nautilus shell chambers, the sunflower head seed pattern and the spiral in a galaxy, and in architecture the ratio of the length to the width of the Parthenon of Phidias, which is seen as the epitome of classical proportion. In other art forms such as fresco and oil painting, the proportions of the setting are often seen in the above ratio, especially in the work of Leonardo da Vinci and in the 20th century in the religious art of Salvador Dali. Closer to home, the human ear length needs to be 1.618 greater than the width to be said to be 'in proportion', as are the relationships between limbs and the ratio of the navel to the feet and total height, as in the work of Le Corbusier (Charles Edouard Jeanneret), in *The Modulor: A Harmonious Measure to the Human Scale Universally Applicable to Architecture and Mechanics* and *Modulor 2* (*Let the User Speak Next*) with the Red and Blue scales of proportion. However, Le Corbusier had to force his proportion system to appear as the Golden Ratio, given that his original premise was that the male figure in his drawings had to be British and not French in order to get the height of the figure with arm outstretched above equal to 220 cm.

The human eye sees proportion in interesting ways: what is pleasing to the eye generally is seen as beauty. It does not take long to see that something is 'out of proportion' in nature, and no more so than the frequent occurrences of the ratio on and within the human body. Artists and architects have used this relationship, often called the 'Golden Mean', for centuries to produce work that is pleasing to the eye.

The following derivation of the Fibonacci spiral contains some very basic algebra which I hope will not confuse the reader so early on in this general work.

Beginning with a square of side unit equal to 1, one of the sides is extended so that the ratio of the new line to the old side of the square is in the Golden Mean, i.e. the new total length is ϕ, being the original size of the square edge + the new line ($\phi - 1$). Now, completing a new square adjacent to the original, this will have a side of length $\phi - 1$. Again extending the side of this square so that the new length equals that of the original square, i.e. size = 1, the length of this addition is calculated from

$$1 = x + (1 + \phi), \text{ where } x \text{ is the length of the line extension}$$

Solving gives $x = 2 - \phi$. Repeating this process, the next line extension will join back to one of the corners of the original square.

This unknown (y) can be calculated from some of the previous lengths as follows. The initial extension line was of size $\phi - 1$ and part of that is the x found above. Therefore,

$$\phi - 1 = x + y = 2 - \phi + y$$

and so

$$y = \phi - 1 - 2 + \phi = 2\phi - 3$$

Again repeating this move, a square is formed with sides equal to y and an extension line z is drawn. This can be calculated as $y + z + \phi - 1 = 1$ (the side of the original square):

$$z = 1 + 1 - \phi - y = 2 - \phi - (2\phi - 3) = 5 - 3\phi$$

Again a square is completed, now with side z, and an extension line is also drawn. The length of this extension line is calculated from the knowledge gained before: $\phi - 1$, the initial extension line length, is equal to $x + z + q$, where q is the new length. Thus

$$\begin{aligned} q = \phi - 1 - x - z &= \phi - 1 - (2 - \phi) - (5 - 3\phi) \\ &= \phi - 1 - 2 + \phi - 5 + 3\phi = 5\phi - 8 \end{aligned}$$

Continuing this process, the next line length is r. As we know that $r + z = y$, then

$$r = y - z = 5 - 3\phi - 5\phi + 8 = 13 - 8\phi$$

The natural occurrence of the Fibonacci ratio is most famously seen in the developing chambers of the nautilus shell. Here each new chamber is 1.618 greater than the previous one as the crustacean grows in size.

In addition, the pattern of seeds in a sunflower head also show this relationship. Here two concentric spirals compete and grow as the flower head develops. The spirals increase in size as the flower grows and the spiral increases at 1.618 as well. On a grander scale, the spiral galaxy also grows at this rate.

These proportions also exist in human anatomy. Taking the unit as that distance from the navel to the feet, the distance from the navel to the top of the head is 0.618. Similar relationships are seen within this position within the body itself, e.g. from the total arm length and the shoulder to the elbow.

It is a simple step to link all these occurrences together and from there to suggest that 'natural' systems of growth should show this relationship in some form or other. Mathematically, the Golden Ratio displays interesting characteristics. Taking $\phi = 0.618$, the following becomes clear:

$\phi^2 = 0.618 \times 0.618 = 0.382$, a Fibonacci retracement level (see Chapters 3 and 5)
$\phi^3 = 0.618 \times 0.618 \times 0.618 = 0.236$, a Fibonacci retracement level (see Chapters 3 and 5)

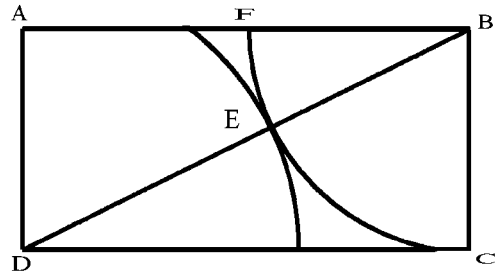

Figure 1.3

$1/\phi = 1/0.618 = 1.618$, a Fibonacci extension level (see Chapters 3 and 5)
$1/\phi^2 = 1/(0.618 \times 0.618) = 2.618$, a Fibonacci extension level (see Chapters 3 and 5)

It can therefore be seen that adding a unit to ϕ is the same as multiplying by ϕ.

A further method of constructing the Fibonacci ratio comes from simple geometry (see Figure 1.3). Take a rectangle with two sides of one unit and with two others of two units. The diagonal of this shape has the value $\sqrt{5}$. Taking an arc from one corner of radius 1, the diagonal is cut as shown. Then using an arc from the opposite corner with a radius measured along the diagonal to the previous cut, curving this to the long side gives the following:

Side AB:AF = AF:FB

These are exactly the proportions necessary to complete the Golden Section mentioned above. It can be seen from the above various derivations that the Golden Section, ϕ, is very important. It is the 'naturalness' and frequency of occurrence that gives the proportion to financial market analysis, as technical analysts believe that 'price' is the physical outcome of a natural system at any point in time, the natural system being the result of the action between buyers and sellers. This is covered in more depth in the next chapter.

2
Application to Financial Market Analysis

What does a Fibonacci retracement look like? What are the particular values of retracements and extension? How is this ratio used in forecasting?

Before looking at the standard application of Fibonacci retracements and extensions, a brief philosophical and psychological detour is made. Market technicians rely on accurate and timely price information in order to complete their task, so what is 'price'? Group theory informs us that the current price is the direct result of the attrition between 'buyers' and 'sellers' at any particular time. As the trading universe is a dynamic system where some members join the group, some leave, some stay, some wait, this universe is ever-changing. There are two main forces driving market action: fear and greed. Some participants in the search for fair-value are frightened of either being left at the top of a market move or of being slow to notice a change in direction and miss out on an improved market action. Some others are greedy and see a positive move as the ideal time to join the herd and make easy money. However, is it as simple as that? Approaching the bottom of a perceived slide in prices, the general consensus changes subtly from those with 'news' starting to anticipate a recovery and those who are not afraid to lose a little in order to maximize an impending gain. Thus the herd of bears loses some members who move to a slightly bullish position. This is often reflected in a change in volume and in an increasingly oversold stochastic.

Many years ago an exponent of Elliott wave theory pointed out that the start of a small five-wave move signalled that readers of the heavyweight financial press/research were looking at reversal and would be pleased to see slightly increased risk to the downside in order to be facing the right way in a recovery. It would be some

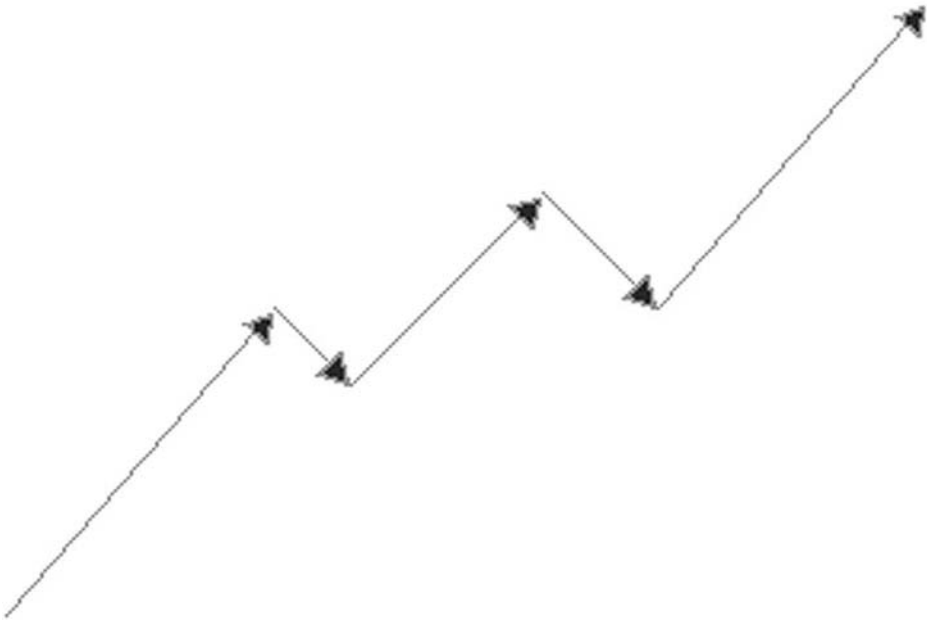

Figure 2.1

time before the next wave of positive investors joined in and even longer before the tabloid readers did so in the way shown in Figure 2.1.

Returning to the discussion on price, novices to the investment world are always amazed that for every person who thinks something is cheap and liable to rise there is someone who believes it still has some way to fall. That is the nature of an efficient matched market and despite the proliferation of research, up-to-date distributed news and instant communication methods, this is still the case. While each potential investor may be looking at the same direction as some other, all have different needs and it is these individual needs that are key to the development of a rally (or a fall) as the dynamic of the herd has to change over time as the final goals of the individual within the group are met – or refuted. This is clear from the herd mentality observed within the trending market, but participants have different goals and timeframes. The short-term bull may see the price objective as ambitious, and if it is not met within a particular timeframe then a reversal position may be triggered as this bull fails to attain the particular goal. However, a longer term bull may be able to weather the storm of the goal not being reached in that timeframe, and indeed not be overly panicked by shorter bulls reversing their position. This is one of the most interesting elements of technical analysis. Although the long-term objective may still be valid, shorter, perhaps opposite, positions may be of particular interest and it is the task of

a good technician to maintain the longer-term goal while taking a shorter-term financial opportunity when it does arise.

It is my firmly held belief that price has to be at the forefront of everything to an analyst. Any studies that remove the intrinsic value of the price from any investment decision have to take secondary place to any triggers or moves that the price may make throughout the developing behaviour. This means that penetration of a congestive area of support, a trendline penetration, a price piercing of the moving average is much more important than a change in a momentum indicator, such as the Relative Strength Index (RSI) or Stochastic. The technical analysis use of the term RSI is quite different to the Relative Strength used in other forecasting, such as a comparison of equity relative to an Index or Sector performance. Technical RSIs compare current price with the range of closes over the last *n* periods, e.g. 14 days. While having the ability to calculate and plot daily, hourly or more short-term momentum values on evermore powerful computers is undoubtedly helpful, analysts have to remember that for over 100 years in the West and even longer in the East, successful trades continued to be made with only the more traditional tools available at the time, such as trend, pattern and wave. I cannot emphasise enough that price behaviour is critical to the overall outlook. To simply use the buy and sell signals from indicators to the detriment of all other techniques is as dangerous as a technical analyst avoiding approaching economic news and data. Although a traditionalist technical analyst may disregard fundamental news in its entirety, I think it is wrong not to be aware and careful of violent swings in price data on an announcement of great fundamental news, such as an inflation number. Such economic data may come out worse/better/as expected, but each of these outcomes will have a different effect on the market. An 'as expected' value corresponds to the traditional axiom of technical analysis: that all information is known to the market at the same time and is reflected in the price. However, a 'worse' or 'better' number will act as a shock to the market and price action will move to adjust to this particular information. It is interesting to see the price action as key economic data come out. This is best seen in Forex and futures markets where the price will move sharply in the seconds and minutes following news, then pause and then continue to move or reverse initial positions. The reason for this is shown in Figure 2.2. It has to be remembered that this all happens very quickly and more often than not the reaction

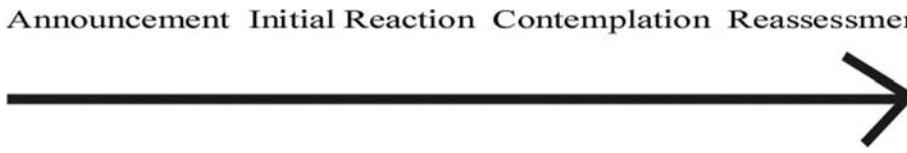

Figure 2.2

phase can reverse what directional move there was in the Initial Reaction phase as knowledge and explanation are digested by the trading community.

When I started out as a technical analyst it was seen as trendy to suggest reading Sun Tsu's treatise *The Art of War* and I am sure that most who said they had read it had not. I found the graphic novel version easier going! This is an early management book and looks at crowds and behaviour in interesting ways. Much can still be learned from this little book and with the more modern *On the Madness of Crowds* by le Bon, which has been superseded by excellent contemporary writings such as Tony Plummer's *Forecasting Financial Markets: The Truth Behind Technical Analysis*, which has an excellent chapter on the cycles prevalent within the UK Gilt Market, which is very useful for students of cycle theory.

Remembering that price is the outcome of attrition, i.e. the result of physical actions of buying and selling, it is only a short step to suggest that price is the result of a natural system, similar to apples being the result of the natural system of pollination, gestation and fruition.

In the previous chapter the derivation of the Fibonacci sequence, Fibonacci ratio, and Fibonacci number was described. Market technicians use some but not all of the ratios and look especially at 0.618, which is more commonly given as a percentage 61.8%, and 38.2%, which is simply 61.8% of 61.8%, and sometimes 24.6%, which is 61.8% of 38.2%. We shall use these in this chapter.

Taking a move in a commodity from a significant start and putting the end of the move at the high gives the primary move. This is of course equally true of a downmove. Once the top is confirmed and lower moves are gathering pace, it is safe to apply the Fibonacci retracement function of a screen-based package to the chart. Before the advent of screen-based packages, proportional dividers (commonly known as 'Fib tools') did the same job. The end result looks like Figure 2.3.

Most charting packages give defaults as 38.2%, 50% and 61.8%, but I prefer to add in the 23.6% retracement as well if I am looking at futures markets where the underlying instrument is an interest rate or a government bond. The very nature of these instruments means that sudden moves are uncommon and price action tends to be range-bound for extended periods of time. A move to 38.2% of a primary move would be substantial and if waiting for a move there, much potential profit could be lost. Smaller moves such as the 14.6% level I have found to be of little importance. They are often triggered in error, especially within markets showing fairly decent trading volatility.

INTERPRETATION

The initial Fibonacci theory states that reversing from the extreme of the move will encourage price activity to slide towards the first retracement (here 24.6%) and then if there is no support at that zone to slide to the next (38.2%) and then towards 50%

Figure 2.3

and then 61.8% before the 100% retracement at the origin of the move. While 100% retracements are possible, penetration of that level does not happen as often as probability would suggest. In cases of penetration of the 61.8% retracement support level, other market knowledge should be applied, whether of market technicals or 'technical' (analysis). A move of this size suggests major changes in the way the market is viewing new news and conditions and a better forecast of a price target could be possible using other more traditional techniques. Whenever I have come across a break in the 100% retracement level I have interpreted this as a global change in the price pattern and given it higher priority than, say, a break of 50%. In many cases a 100% retracement from an explosive extension move, as seen in the chart below, signals a balancing operation; i.e. the price will move significantly below the 100% retracement level in order to balance out that initial price move, which could now be seen as too steep relative to previous bullish moves or indeed overextended. This is most prevalent in market action where the move has been part of an extension into 'clear sky' where there has been no price history in the past. However, it has to be remembered that this balancing move will have a long way to go before calling a correction, as in many cases once the price trend has been balanced the primary move will restart, this time using previous price levels as encouragement to extend further. Figure 2.4 shows that effect very well.

Experience shows that if the retracement is near or at a quarter price then it has increased strength and should be considered a zone with both 'belt and braces'! This would mean that a break of support becomes significant and would normally see a