

THE APPLICATIONS OF THE FIBONACCI SEQUENCE AND ELLIOTT WAVE THEORY IN PREDICTING THE SECURITY PRICE MOVEMENTS: A SURVEY

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ABSTRACT

□ This paper provides a survey of findings describing the use of Fibonacci series (a mathematical sequence that consists of two numbers in the sequence being added together to produce the third number of the series) and its underlying principles to predict future security price movements. The study further describes the details of the Elliott Wavelet theory (to describe the rhythmic regularity which has been observed in the U.S. stock market over an eighty year period) as an application of Fibonacci series. Applications of Fibonacci sequence and the Wavelet theory in the equity market are described to supplement the validity of the argument.

Key Words: Fibonacci Sequence, Elliott Wavelet Theory, Golden Ratio, Impulse and Corrective Waves.

I. THE BACKGROUND

Leonardo Pisano Fibonacci (1170-1250) is known for describing the mathematical sequence that consists of two numbers in sequence being added together to produce a third number. The sequence is 0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, etc. The farther along the sequence, the closer the decimal equivalent of the ratio of two successive numbers in the sequence nears 1.618034. Similarly, the ratio of alternate numbers of the sequence approaches 2.618. According to Erman [3], this ratio can be seen throughout nature and is typified by the arrangement of seeds in a sunflower or the shape in a Chambered Nautilus. The sequence is also found extensively in music and in architecture.

The sequence and the ratio are also being used to predict the stock market swings or oscillations and price targets. Fischer [6], Hartle [9], and Krausz [10], however, concluded against the stand alone use of the sequence. They observed that although the Fibonacci sequence is used as a

technical indicator, it is best used as a tool to supplement other technical analysis methodologies rather than a stand-alone technique. The best use of the sequence is to predict future irregular cyclic moves in a stock which are based on past moves. Fibonacci numbers can be applied to progressions of price support and resistance levels by using an initial price as the first number of a Fibonacci series and then predicting the recurrence of another price support or resistance level. The next Fibonacci number in the series is a predictor of a successor in the series.

Eng [2] and Plummer [13], [14] provided the outline for successfully using of the sequence. In order to use this technique, traders must first identify the phenomenon that they are interested in predicting market bottoms, tops, price support, and/or resistance levels. Next on a pricing chart, the prices are tracked until the first interval has been identified. The first identifiable interval is the first term of the Fibonacci sequence. Traders then can draw a new prediction line equal to the length of the first interval to identify the next interval in the sequence. This process can be continued for as many iterations as are desired. Once Fibonacci lines are established, the professional trader will use other techniques to confirm their predictions before taking a position.

Eng [2] considered that Fibonacci cycles are especially helpful when the markets are irregular and cycles are hidden in the fluctuating activity. In this situation, it is best not to force a fit to the current market activity, but to go back in time to when the market was more predictable and use that time as the starting point. Using the technique of applying the sequence from a stable condition will aid subsequent iterations in the predicting process. The object is to find the most obvious points since they will have the best chance of providing an accurate prediction basis.

Therefore, the use of the Fibonacci sequence is based upon the idea that the market behavior

must be based upon its behavior in the past. The idea runs contrary to the market efficiency argument put forward by numerous researchers. As in music, art, architecture, and nature, the Fibonacci sequence is a numerical abstraction of a pattern of events which depends upon previous events for the future development of the sequence.

The next section describes the underlying principles and the use of Fibonacci series in predicting future price movements. The following section provides details of Elliott Wavelet theory to describe the rhythmic regularity (as obtained from a Fibonacci series) of the past stock price movements. Section four details some applications of Fibonacci sequence and Wavelet theory on the equity market. The last section concludes the discussion.

II. THE PRINCIPLES OF FIBONACCI SEQUENCE

Garland [7] and Prechter and Frost [16] reported that the conceptual predecessor of the Fibonacci sequence is the Golden Ratio. The ratio is formally defined as,

$$\frac{1 + \sqrt{5}}{2} = \lim_{t \rightarrow \infty} \left(\frac{n_{t+1}}{n_t} \right) = 1.618033989 \quad (1)$$

As the Fibonacci sequence is applied over a long sequence of numbers, the ratio of two successive numbers in the sequence approaches a natural limit. The natural limit produces the Golden Ratio.

The Golden Ratio is applicable to any ratio generated from a series as the numbers in the series increase. The preceding or decreasing number in the sequence can also be determined if the inverse of

the ratio is calculated as follows:

$$\frac{2}{1+\sqrt{5}} = \lim_{t \rightarrow \infty} \left(\frac{n_t}{n_{t+1}} \right) = \frac{1}{1.618033989} = 0.618033989 \quad (2)$$

These numbers have been incorporated by several other mathematicians into variations of the Fibonacci sequence. As a variation of the Golden Ratio, the natural limit of the ratio of two alternate numbers approaches 2.618 and the inverse of that ratio approaches 0.382. The natural limit of the ratio of two alternate numbers and its inverse are calculated as follows:

$$\frac{3+\sqrt{5}}{2} = \lim_{t \rightarrow \infty} \left(\frac{n_{t+2}}{n_t} \right) = 2.618033989 \quad (3)$$

$$\frac{2}{3+\sqrt{5}} = \lim_{t \rightarrow \infty} \left(\frac{n_t}{n_{t+2}} \right) = \frac{1}{2.618033989} = 0.381966011 \quad (4)$$

Similar variations of the Golden Ratio can be obtained by calculating the ratios of every third, fourth, or fifth numbers of the Fibonacci sequence. An example of the approximation of the Golden ratio (the ratio of two successive numbers) and its inverse through Fibonacci sequence is provided in Table 1.

Table 1 here

Tribonacci Summation Series: To compliment the analysis of Fibonacci sequence, Prechter and Frost [16] described the principles of Tribonacci series. As a variation of the Fibonacci sequence, the series uses the sequence 0, 1, 1, 2, 4, 7, 13, 24, 44, 81, etc. and adds the previous three numbers

to arrive at the next number in the summation series. As the sequence grows, the ratio of two successive numbers in the series approaches 0.50. Analysis of the markets has shown that the retracements of rallies also approach this ratio in sequencing numbers.

Balan [1], Gately [8], and Murphy [12] reported various financial markets applications of the Fibonacci sequence. The Fibonacci sequence can be used to predict the occurrences in the financial markets but should not be treated as a stand-alone predictor. The markets can send a multitude of signals and there is no one indicator that is infallible in detecting the support and reversal points. A learning curve by the trader can be established as one traces the trends by applying the ratios to either a major market top or bottom (the first day) and then projecting into the future in the second day (2), the third day (3), the fifth day (5), the eighth day (8), the thirteenth day (13), and so forth in the sequence. One can expect from this exercise, with a degree of certainty, to see a reversal in the price action on one of these Fibonacci predicted significant days. On the downward movements of the markets, the application of the Fibonacci numbers can be used to trace retracement moves. Thus, retracements (the bear moves) will demonstrate the ratio of 0.618 of the previous bull move and the bull move will demonstrate the ratio of 1.618 of the previous bear move.

Eng [2] pointed out that Fibonacci cycles work well in markets which seem to have loosely defined but with seemingly unpredictable cyclicality. Fibonacci cycles give useless signals in markets with over-pronounced and very regular cyclicality. They also do not work well in very short-cycle markets, as they need time to build up a train of intervals. Fibonacci cycles are an especially good idea to use with pattern recognition methods, since they attempt to make the kind of predictions which Fibonacci cycles can confirm. In that context, the Fibonacci cycles are an appropriate tool for the Elliott Wave

Theory, where they can be used for local tops and bottoms of the various waves of a cycle or the Dow/Edwards-McGee Theory (details are provided in [4] and [5]) where they can give important confirmation of patterns which predict reversals or breakouts, or of doubtful consolidation patterns.

Krausz [10] pointed out that Fibonacci cycles also have much in common with the Gann Anniversary dates (the procedure is described in detail in [4] and [5]) and can be used profitably as confirmation tools as well. Fibonacci cycles do not work quite as well with methods which rely less on global pattern recognition of price moves, such as point-and-figure, volume-based techniques, or methods which work more with the local breakout rather than tops and bottoms, such as moving averages or oscillators.

III. THE PRINCIPLES OF ELLIOTT WAVELET THEORY

The Elliott Wave Principle was first established by R. N. Elliott in a series of articles in The Financial World in 1939. The basis of the Elliott Wave Theory has been developed from the observation that rhythmic regularity has been observed in the stock market over an eighty year period. It has been further observed that the market moved forward in a series of five (5) waves and declined in a series of three (3) waves (a Fibonacci sequence).

The longest cycle in the Elliott Wave Theory is called the Grand Super-cycle. In turn, each Grand Super-cycle can be subdivided into eight Super-cycles (five Impulse and three Corrective waves), each is then divided into eight cycles or waves. This process continues to embrace Primary, Intermediate, Hourly, Minute, and sub-Minute waves.

Wong [17] and Prechter and Frost [15], [16] described the basic principles of Elliott Wave

Theory. They observed that the theory interprets market actions in terms of recurrent price structures. Basically, market cycles are composed of two major types of Waves: Impulse Wave (denoted by numbers) and Corrective Wave (denoted by letters). For every impulse wave, the structure can be sub-divided into five waves (1-2-3-4-5), while for corrective wave, the structure is sub-divided into three waves (A-B-C). An impulse wave moves in the same direction as the trend of the next larger size, while a corrective wave moves against the trend of the next larger size. In the next stage, the basic patterns of five- and three-wave structures link to form an increasingly larger size (next level) of five- and three-wave structures. An important feature of Elliott Wave is that they are fractal in nature. This implies that the market structure is built from similar patterns on a larger or smaller scale. Therefore, the waves can be counted on a long-term yearly market chart as well as short-term hourly market chart.

Figure 1 describes the impulse and corrective wave patterns of various size classes.

Figure 1 here

Rules for Wave Count: Based on the market pattern (an excellent of the wave count is provided in [19]), one can identify the ‘point of beginning’ in terms of wave count. As the market pattern is interpreted as relatively simplistic, there are several rules for valid counts.

- a) Wave 2 should not break below the beginning of Wave 1;
- b) Wave 3 should not be the shortest wave among Waves 1, 3, and 5.
- c) Wave 4 should not overlap with Wave 1, except for Waves 1, 5, A, or C of a higher degree.
- d) *Rule of Alteration:* Waves 2 and 4 should unfold in two different wave forms.

Wave Forms in Impulse Wave: The basic five-wave structure (1-2-3-4-5) is based on the main trend of the market. If the main trend of the market is up, then wave 3 is higher than wave 1. Similarly,

wave 5 is higher than wave 3 and wave 4 does not correct below the top of wave 1. On the other hand, if the main trend of the market is down, wave 3 is lower than wave 1, wave five is lower than wave 3, and wave 4 does not correct above the bottom of wave 1. There are three major types of wave form in Impulse Wave.

- a) **Extended Wave:** Among waves 1, 3, and 5, only one would be unfolded into extended wave (i.e., the wave further subdivides into five waves). 'Extension' implies that the wave is elongated in nature and sub-waves are conspicuous in relation to waves of higher degree.
- b) **Diagonal Triangle at Wave Five (5):** Sometimes the momentum at Wave 5 is so weak that the 2nd and the 4th sub-waves overlap with each other and evolved into diagonal triangle. The wave is usually a terminal wave (sometimes called a wedge), emanating from the 5th wave and can be subdivided into three corrective sub-waves (a-b-c). Upon completion, there is usually a strong move in the counter direction.
- c) **Fifth (5th) Wave Failure:** In some other circumstances, the Wave 5 is so weak that it cannot even surpass the top of Wave 3, causing a double top at the end of the trend. It further indicates a strong and/or prolonged move in the counter direction.

Wave Forms in Corrective Wave: Corrective wave represents a wave form that moves counter to the direction of the main trend of the market. It subdivides into three smaller waves (A-B-C). Waves A and C move against the market's main trend. On the other hand, wave B moves in the direction of the main trend of the market, but subdivides into three sub-waves (a-b-c). Corrective Wave forms are rather complicated, but basically can be categorized into six major wave forms.

- i) **Zig-Zag:** A corrective A-B-C wave pattern composed of 5-3-5 sub-wave structure. In

this corrective wave pattern, the B wave retraces only a part of wave A and wave C moves below the terminal point of wave A. Waves A and C can be subdivided into five impulse sub-waves, while wave B can be subdivided into three corrective sub-waves (often called a double zigzag).

- ii) **Flat:** A corrective A-B-C wave pattern composed of 3-3-5 sub-wave structure, with 'B' equals 'A' ($B = A$). In this wave pattern, wave B retraces all of wave A, while wave A subdivides into three corrective sub-waves. Wave C may not terminate beyond the terminal point of wave A.
- iii) **Irregular:** A corrective A-B-C wave pattern composed of 3-3-5 sub-wave structure, with 'B' longer than 'A' ($B > A$). In this wave pattern, wave B retraces more than the whole of wave A, while wave A subdivides into three corrective sub-waves. Wave C terminates beyond the terminal point of wave A.
- iv) **Horizontal Triangle:** A corrective five-wave triangular pattern composed of 3-3-3-3-3 sub-wave structure (often expressed by A-B-C-D-E pattern). The pattern often develops after a strong move in the market. In this wave pattern, five successive corrective patterns are further subdivided into three corrective sub-waves.
- v) **Double Three:** This corrective (A-B-C)⊗(A-B-C) wave pattern is composed of any two forms from above and are linked by a ⊗ corrective wave. The form is a prolonged (larger) corrective wave formed by combining two separate corrective waves. The ⊗ corrective wave usually moves in the direction of the main trend and can be subdivided into three corrective sub-waves.

vi) Triple Three: This corrective (A-B-C)⊗(A-B-C)⊗(A-B-C) wave pattern is composed of any three forms from above, linked by two ⊗ corrective waves. The pattern is the largest possible corrective wave that can be formed by combining three separate corrective waves.

The attractiveness of Elliott Wave Analysis lies in its conclusiveness. Three impulse wave forms and six corrective wave forms are conclusive in nature. Once investors can identify which wave form is going to unfold in the future market movements, the prediction of the future market action can be done accurately. However, the knowledge of the market historical wave patterns and experiences in wave count are of paramount importance for accurate prediction. One of Elliott's most significant discoveries is that because markets unfold in sequences of five and three waves, the number of waves that exist in the stock market's patterns reflects the Fibonacci sequence of numbers (0, 1, 1, 2, 3, 5, 8, 13, 21, 34, etc.). It is an additive sequence that nature employs in many processes of growth and decay, expansion and contraction, progress and regress. Because this sequence is governed by a ratio, it appears throughout the price and time structure of the stock market, apparently governing its progress.

The real problem with the Elliott Theory lies with its interpretation and correctly labeling and counting the waves. Indeed, every wave theorist has at some time or another become entangled with the question of where one wave ends and another starts. As far as Fibonacci time spans are concerned, it is extremely difficult to use the principle as the sole basis for forecasting although these periods recur frequently. There are no indications whether time spans based on these numbers produce tops-to-tops, bottoms-to-tops, or something else. The permutations seem to be almost infinite.

The Elliott Wave is clearly a very subjective tool. Its subjectivity in itself can be dangerous to

follow because the market is very subjective to emotional influences. For that reason, the weight given to Elliott interpretations are usually limited by the investor's experience in analyzing Elliott Wave charts of the market. On a positive note, however, an understanding of Elliott waves brings a sense of historical perspective of the securities markets even without using the analysis as a trading technique. The principle reemphasizes the common knowledge that markets never go in one direction forever.

IV. APPLICATIONS OF THE FIBONACCI SEQUENCE AND ELLIOTT WAVE

THEORY: TIMING PREDICTIONS OF THE EQUITY PRICE MOVEMENTS

Analysis of Historical Movement of the U.S. Stock Market

As an application of the Elliott Wave Principle, table 2 shows the historical movement of the U.S. stock market between 1916 and 1976 and indicate that the stock market historical peaks and market bottoms clearly follow Fibonacci sequence. The market experience shows how Fibonacci cycles and Elliott waves can be effectively used to recognize the historical pattern of the stock movements over a long period of time.

Table 2 here

The table shows that the Grand Supercycle waves of historical stock market peaks and troughs follow the eleventh number in the Fibonacci Sequence (55 years). The wave is subdivided into Supercycle waves of 34 years (the tenth number in the Fibonacci sequence). The process continues by subdividing stock market movements into twenty-one years, thirteen years, eight years, and five years respectively. Once the pattern is recognized, similar analysis can be performed to understand monthly, weekly, or daily movements of the stock market.

Analysis of the Value Line Futures

Eng [2] provided an excellent example of setting up and maintaining Fibonacci sequence for trading stocks. The analysis is complimented by strict applications of the Fibonacci ratios to the analysis of the Value Line Futures from October 2 to December 16, 1985. Table 3 provides the results and the predictive accuracy of the strict applications of the Fibonacci Ratios.

Table 3 here

The quick application is based on the following formula:

$$PROJECTION = (X \times R) + S \quad (5)$$

Where, X is the absolute value of the distance covered in one swing, R is the Fibonacci Ratio (0.618, 1.618, 2.618 etc.), and S is the starting point of any major swing. The above formula only shows a representative expression and the formula's variables are randomly selected within the framework of the viable parameters. Therefore, the projected expression is dependent upon the nature of the specific market swing.

Eng [2] described the prerequisites for the traders to utilize the sequence in predicting the equity price movements. To begin using Fibonacci Sequences, every trader needs to have two things already set up, namely: 1) a price chart that has been running for some time, and 2) one or more main trading techniques already in use. Both of these ingredients are necessary, since Fibonacci techniques are used exclusively for the confirmation of signals which a trading system generates. The complete trading is performed in the following five steps:

- 1) Choosing the Market Event to Predict: Traders choose the market (equity, foreign exchange,

futures etc.) they want to predict. This can be any necessary occurring part of a market cycle, usually top side or bottom side reversals or breakouts.

- 2) Two Occurrences of the Event: If the chart has already been started, traders probably already have two occurrences of the phenomenon they are seeking to predict (reversal or breakout). Otherwise, they should wait until they have two confirmed instances of that phenomenon. It is best to wait for four or five days, or whatever interval is necessary so that no amount deviation can make the perception of this occurrence wrong.
- 3) Taking the Interval as Base Interval: Once traders can locate the two events with certainty, vertical lines should be drawn through the exact time instant on the chart where the events occurred. Then the interval between these two lines should be measured. The distance (length) of the interval represents the base interval (e.g., if the interval between two market bottoms is 21 days, then 21 days is the base interval length).
- 4) Calculating and Plotting the Fibonacci Intervals from the Base Interval: The original interval is for twenty-one (21) days and it would be multiplied by one (a Fibonacci ratio) by the traders to get the next interval length. It would make the room for drawing the second line (marking the end of the first interval length just calculated). Using a table of successive Fibonacci ratios (provided in Table 1), the next Fibonacci ratio is calculated as the multiplication of twenty days and the next Fibonacci number (21×1). The third line could then be drawn (marking the end of the second interval length just calculated), 21 days beyond the second one. The fourth line is going to represent 42 days beyond the third line (21×2 , since 2 is the next Fibonacci ratio number) in the series. The fifth line will represent 63 days (42×1.5000) beyond the fourth line

and so on.

- 5) Using the Fibonacci Intervals to Confirm A Main Method: Once a series of interval lines are plotted into the reasonable future, the completed chart is said to be ready for prediction. The idea is to wait until the main method has signaled or predicted the phenomenon as foreseen by the lines. A confirmation of coincidence or near-coincidence of the pattern would signal a strong validation of the predictive power of Fibonacci series.

V. CONCLUSION

The study describes the details of the Fibonacci sequence and the Elliott Wave and their underlying principles. The basic system outlined in this paper is utilized to show the historical pattern of the stock market and how the market tops and market bottoms can be explained through Elliott waves. Using Elliott waves as a tool to predict securities price movements, the trading example indicates how a carefully constructed system can generate profits, even under quite volatile conditions. Most of the losses are generated during the contraction-trend movements, but are kept quite low. The profits generated during the trend are themselves quite large, and more offsetting than any losses.

The example confirms that the profits are likely to be greater, the longer the time-period is used for trading. For the individual investors, greater insights into the markets can be gained just by trying to develop a personalized trading system. It is clear from the example that the profitability is likely to be greater by a genuine understanding of how markets behave, and by the use of the Golden Ratio to determine the price objectives. The analysis, in turn, encourages patience while the natural forces evolve and bring confidence to the investors that the expectations are going to be fulfilled. These are

the primary advantages of goal setting in securities trading. In conclusion, the paper provides a survey of findings in describing the use of mathematical series (Fibonacci sequence and Elliott Wave Principles) and their underlying principles to predict future security price movements. In the period of astronomical stock market rises (as it has been experienced in 1999) and market falls (testimonial to the experience of 2000), a discussion of the use of mathematical series in stock price prediction seems timely and appropriate.

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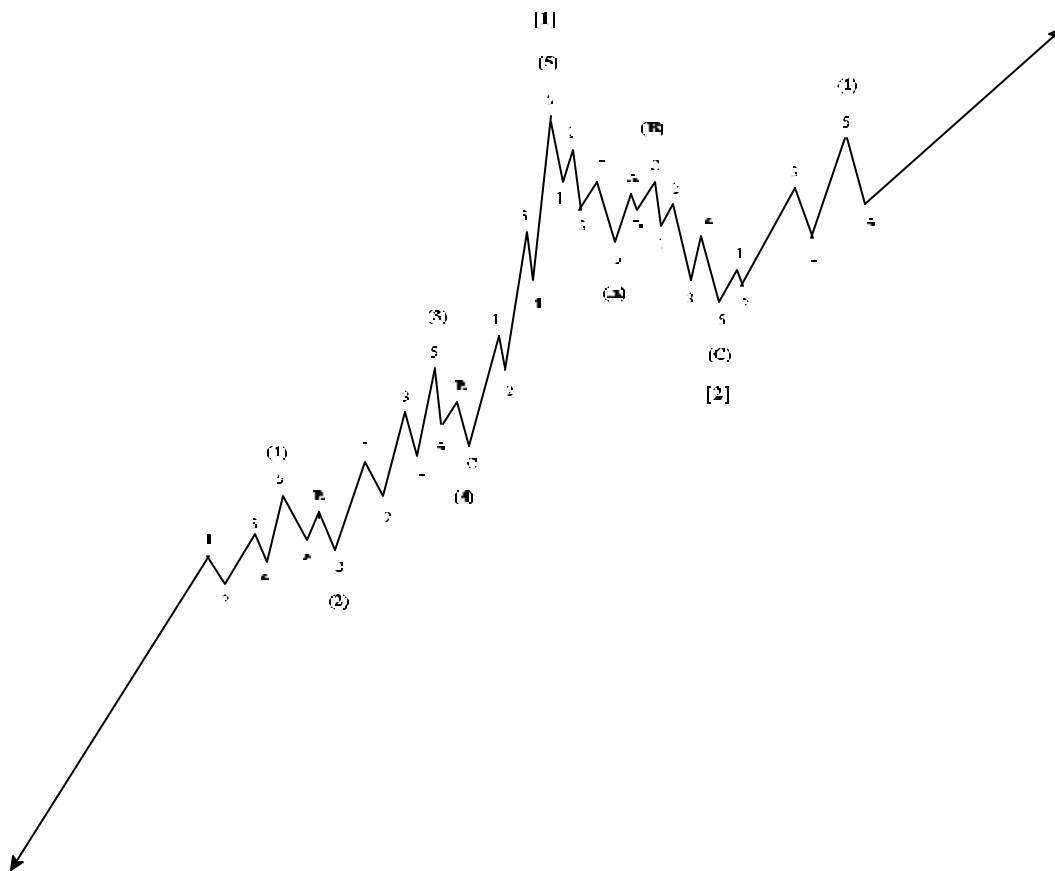
TABLE 1		
Approximation of Golden Ratio and Its Inverse from Fibonacci Sequence		
Sequence Number	Ratio of Numbers $\left[= \frac{n_{t+1}}{n_t} \right]$	Inverse Ratio of Numbers $\left[= \frac{n_t}{n_{t+1}} \right]$
0		
1		
1	1.000000	1.000000
2	2.000000	0.500000
3	1.500000	0.666667
5	1.666667	0.600000
8	1.600000	0.625000
13	1.625000	0.615385
21	1.615385	0.619048
34	1.619048	0.617647
55	1.617647	0.618182
89	1.618182	0.617978
144	1.617978	0.618056
233	1.618056	0.618026
377	1.618026	0.618037
610	1.618037	0.618033

TABLE 2				
Time Spans Between Stock Market Peaks and Troughs (1916-1976)				
Starting Year	Position	Ending Year	Position	Length of Cycle (Years)
1916	T	1921	B	5
1919	T	1924	B	5
1924	B	1929	T	5
1932	B	1937	T	5
1956	T	1961	T	5
1961	T	1966	T	5
1916	T	1924	B	8
1921	B	1929	B	8
1924	B	1932	B	8
1929	T	1937	T	8
1938	B	1944	T	8
1949	B	1957	B	8
1960	B	1968	T	8
1962	B	1970	B	8
1916	T	1929	T	13
1919	T	1932	B	13
1924	B	1937	T	13
1929	T	1942	B	13
1949	B	1962	B	13
1953	B	1966	B	13
1957	B	1970	B	13
1916	T	1937	T	21
1921	B	1942	B	21
1932	B	1953	B	21
1949	B	1970	B	21
1953	B	1974	B	21
1919	T	1953	B	34
1932	B	1966	T	34
1942	B	1976	T	34
1919	T	1974	B	55
1921	B	1976	T	55

Indicators: Market Tops (T), Market Bottoms (B).

TABLE 3			
Analysis of the Value Line Futures (October 2, 1985 - December 16, 1985)			
Projection <i>PROJECTION = (X × R) + S</i>			
Projection (Formula Value)		Actual Value (Date)	
$(a \times 1.382) + 188.65 = 195.97$		196.00 (10-17-1985)	
$(a \times 6.182) + 196.00 = 192.75$		192.70 (10-28-1985)	
$(d \times 4.5000) + 192.70 = 207.55$		207.55 (11-12-1985)	
$-(d \times 0.382^2) + 207.55 = 205.38$		205.30 (12-03-1985)	
$-(d \times \sqrt{0.618}) + 188.65 = 207.54$		207.55 (11-12-1985)	
Actual Swing Tops and Bottoms with Absolute Distance Covered			
Date	High	Low	Distance Covered
10/2/85	193.95		Starting Distance
10/8/85		188.65	- 5.30 (a)
10/17/85	196.00		+ 7.35 (b)
10/28/85		192.70	- 3.30 (c)
11/12/85	207.55		+ 14.85 (d)
12/3/85		205.30	- 2.25 (e)
12/16/85	216.65		+ 11.35 (f)
Note:			
X is the absolute value of the distance covered in one swing.			
R is the Fibonacci Ratio (0.618, 1.618, 2.618 etc.).			
S is the starting point of any major swing.			

FIGURE 1
IMPULSIVE AND CORRECTIVE WAVE FORMS
OF THE SECURITY PRICE MOVEMENTS



{[1], [2]} represent first two of Grand Supercycle Impulse Waves. Each Grand Supercycle is broken down into Supercycle Waves with five Supercycle Impulse Waves {(1), (2), (3), (4), (5)} and three Supercycle Corrective Waves {(A), (B), (C)}. Each Supercycle Wave is further broken down into five Cycle Impulse Wave {1, 2, 3, 4, 5} and three Cycle Corrective Waves {A, B, C}. The process of sub-division can be continued to provide Primary, Intermediate, Hourly, Minute, and Sub-Minute waves.