

**Research Article**

Predicting key reversal points through Fibonacci retracements

Khalid Mumtaz Khan^{1*}, Waiza Rehman², Osman Bin Saif³

^{1,3}Department of Business Studies, Bahria Business School, Bahria University, Islamabad, Pakistan

²Department of Management Studies, Bahria Business School, Bahria University, Islamabad, Pakistan

*Corresponding Author email: khalidmumtazmail@gmail.com

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ABSTRACT

Anticipation of the key reversal points in trading markets is of key interest to the portfolio managers, investors, researchers, technical Analysts. These points trigger investment or divestment for investors' holdings within the financial markets. Many techniques are used to anticipate these points. Use of Fibonacci numbers has gained significant importance in this context. The tools like 'Fibonacci Retracements' are available to investors; however, another important determinant in the value of an investment is the 'timings' within a certain time frame. This study aims to understand whether such a predictive relationship exists between the Fibonacci time horizons and the modern-day financial markets. For this purpose, two renowned indices i.e., Dow Jones Industrial Average (DJIA) and Dow Jones Transport Average (DJTA) have been taken as the population. Data of these averages, since their inception in 1896, till 2020, has been taken in to account, in order to remove any speculative sentiments, in the long run. The observation periods of data have been classified into daily, monthly and yearly time frames. Charting package, 'meta stocks' version 8.0 has been used to map the Fibonacci sequence against the actual reversal points placed on the data from the first day of trading on DJIA and DJTA. The results reveal striking similarity between the reversal points inferred from Fibonacci sequence, and the actual reversal points. The study concludes with a recommendation to trace this similarity against the technical analysis and charting for further investigation by the future studies. These findings are of significant importance for the portfolio managers, technical analysts, and researchers interested in forecasting the movement of the market index.

Keywords: *Fibonacci Retracements; Key Reversal Points; Fundamental Analysis; Technical Analysis*

1. INTRODUCTION

Determination of key reversal points in the financial markets has been of prime interest for the stakeholders, especially the portfolio managers. An anticipation of these reversal points in the market index allows these stakeholders managers to maximize their returns in addition of maintaining the market balance. Moreover, it allows the investors to decide whether to long or short their holdings in the financial markets (Tien et al., 2021). The securities' analysts use an array of techniques and tools to determine the key reversal points. Fundamental Analysis and Technical Analysis are widely used to ascertain the buy-propositions and the sell-propositions. These propositions primarily are based on the difference between the value and price of any given securities. A buy proposition would be generated for a security whose value exceeds the price. Similarly, a sell proposition would

be suggested where price exceeds the value. The under / overpriced and under / overvalued securities is based on the same (Okumu et al., 2021).

In addition of advising the buy / sell propositions based on the valuation / pricing of the securities, it is important to determine the market direction, i.e., bearish or bullish trend. These trends may not be based only on the financial and economic rationale of pricing securities, but may also include political, social, global, and other factors effecting the financial markets (Ali & Anwar, 2021). Fundamental analysis is based on the fundamental financial information about a security, being more focused at ascertaining the fair price determining the expected price (Dini et al., 2022). While the technical analysis is widely used to ascertain probable direction of the market (Mustafa et al., 2022). Technical analysts believe that Dow Theory by Charles Dow in 1896, provides the underlying principles for technical analysis. These analysts also believe that Elliot Wave theory by Ralph Nelson Elliot 1946, complements the Dow theory in this regard.

Despite of these strong theoretical foundations, analytical techniques, and numerous mathematical and statistical tools in use, investors are still keen for a more reliable set of tools to pre-empt the change in the market trend. In this context the Fibonacci numbers, also known as the golden sequence, presently has gained considerable importance. The market analysts using technical analysis use the 'golden sequence' for determining key retracements and extensions. This study focuses on determining whether key reversal points at Dow Jones Industrial Average (DJIA) and Dow Jones Transportation Average (DJTA) can be predicted using Fibonacci time horizons.

For the purpose of ascertaining the predictive ability of Fibonacci time horizons, DJTA and DJIA have been taken as independent variables, while Fibonacci time horizon has been taken as dependent variable. The data from both the stated averages has been gathered for past one hundred and twelve years, since their inception, i.e., 1896 till 2020. A cross sectional analysis of the gathered data has been carried out. Daily, weekly, and monthly time horizons have been used. It has been found that, at average every four out of five reversal points at DJIA and DJTA could be predicted using Fibonacci time horizons. The predictably has been highest and lowest at monthly and yearly time horizons, respectively. Pertinent to note that in all the predictive capacity does not fall below 78% for all of these time horizons.

'Practitioners', 'analysts', and 'researchers' are expected to benefit from this study, as the ability of one of the widely and informally used 'Fibonacci golden sequence' has been tested for its perceived power to determine the key reversals and extensions in one of the most established industrial and transportation averages, i.e., Dow Jones.

2. REVIEW OF LITERATURE

The intrinsic value for any securities is determined by the amount of assets backing the equity instrument (Li, 2021). Financial statements of the company along with the ratios calculated on the basis of data provided in these financial statements provide the key to determine investment value in any given security (Barauskaite, & Streimikiene, 2021). While the market price is function of its volume demanded by investors and the volume supply

by the divestors. It is heavily influenced by the perceived impressions of various financial and non-financial variables, including hope, guess, fear, events, mood etc. (Alici, & Sevil, 2022). One has a strong reason to argue that intrinsic value may vary from the expected market price (Indahwati, & Agustini, 2022). Fundamental analysis and technical analysis play an important in this regard. determined by the technical analysis.

Technical analysts, contrary to the fundament analysts, focus on information about the variables expected to influence the future price. Technical analysts argue that the market price incorporates all factors determining value, in addition to speculative elements (Kamara et al., 2022). Reflection of 'value' in 'price' varies as the closeness of 'price' to that of the 'value' is determined by the extent of the symmetry in the information as to its homogeneity in extent and timing of availability in concerned. Since the symmetric distribution of information comes just as an assumption in the 'efficient market hypothesis', it becomes imperative to predict the price rather than value, as profit comes from the price, not value.

Murphy (1999), defines technical analysis is the study of market action, primarily through the use of charts, for the purpose of forecasting future price trends. Technical analysis has been widely used to determine the index trends in the modern financial markets. It is action of the market itself rather than the goods in which it deals (Hajkova & Hurnik, 2007). Actual history of trading in certain stock is recorded in graphic form and trends are derived by using statistical tools, to deduce these to an average form. The expected trends inherently remain attached to many probabilities. Pring (2002), explained it precisely as technical analysis deals in probabilities, never certainties. One may argue that technical analysis struggles to provide a literate guess about the movement of prices / trends keeping in view a variety of economic, financial, geographic, psychological, and political factors.

Gehm (1983), questions the reasonableness of the Elloitt wave theory as to its application. In the study 'Who is R.N. Elliott and why is he making waves. He argues that the wave theory depends on number of assumptions that are difficult if not impossible to analyze. It has been further argued that many of the assumption seem unreasonable, hence the theory seems of little or no practical value. This study proposes that shadow theory and Elliott wave theory may be applied to financial markets when read in conjunction with the Fibonacci sequence. Same has been analyzed in this study when the wave like movement at DJIA and DJTA has been analyzed over a time frame of more than a century. It is interesting to observe that the wave like movements in both the averages possess a high degree of confirmation towards Fibonacci sequence.

Chen et al. (2007), incorporate the concept of Fibonacci sequence to the Fuzzy time-series models and propose a new time series model for stock price forecasting. Their study finds the proposed model surpasses the conventional time series models in accuracy when applied to Taiwan Stock Exchange Capitalization Weighted Stock Index. The study supports that the proposed model may be applied in the areas of stock price movements, academic enrollments weather forecasting, etc.

The contribution of Leonardo O. Pisa (Fibonacci) to the history of financial mathematics has been examined by Goetzmann (2004). His study 'Fibonacci and the Financial Revolution',

states that according to the evidence in Leonardo's *Liber Abaci*, Fibonacci was the first one to develop present value analysis for comparing the economic value of alternative contractual cash flows. The study further argues that Fibonacci work in financial mathematics has been stimulated by commercial revolution in the Mediterranean during his life time. His work influenced the evolution of capitalist enterprises in Europe in the times to come. The application of Fibonacci sequence has been extended to soccer game by Archontakis and Osborne (2007). They argue that a betting strategy based on Fibonacci sequence is expected to yields better economic benefits as compared to conventional expectation theory as sports' betting is different to that of financial market prediction (Giusti, 2017).

2.1. THE DOW THEORY

Modern day technical analysts believe the Dow Theory to be the one of initially generalizable proposition for the purpose of forecasting key reversal points and trend movements. The theory was presented for market application by Charles Dow himself in 1896. The theory focused more on the Rail and Industrial averages, than any of the utility composite averages, as the interpretation were based on the Rail and Industrial stocks. Although Dow Jones Averages have been used in this connection, the theory is generalizable to a greater extent to any other similar representative indexes of industrial and rail stocks. Before discussing the predictive capacity of the Fibonacci golden sequence, it is pertinent to discuss basic tenants of the Dow Theory

The averages present a discounted picture of market foresight, as they reflect the combined activity of thousands of market participants (Poplavskaia et al., 2021). Even unpredictable events like natural calamities are appraised upon happening and their consequences are discounted (Bolton et al., 2021). There are primary, secondary, and minor trends in the market. Upwards and downwards movements in the stock prices are usually referred as swing or trend (Dongrey, 2022). Markets tend to swing between the bullish and bearish trends. A bullish market reflects a sentiment of eagerness on the part of investors to invest in securities being traded in the market. A bullish trend exerts a buying pressure in the market (Jindal, & Kumar, 2022). Contrary to bullish, the bearish trend exerts a selling pressure on the market as the investors want to disinvest. The averages of opposing trend must conform to each other as no valid indication can be drawn from any one average. The trends must be backed by the volume. A bullish trend must be backed by orders lined up for buying a specified volume of securities and vice versa (Lee et al., 2022). Side wise movements in trends often referred as lines may substitute secondary trends. Prices of various securities may touch a certain high or low price in a given frame of time (Bahcivan, & Karahan, 2022). Dow Theory takes in to account, the closing prices of securities. It ignores high-low of the prices. Continuation in a trend is assumed to be continued until the time an indication for its reversal has been signaled (Goeyardi, 2021). Dow theory is considered as one of the modern and comprehensive theory explaining the function of wealth creation and contraction (Yusuf, & Samir, 2021).

This study finds out similarity, if any, between the function explained by the Dow theory, to that of an astonishing mathematical anomaly known as the Fibonacci Sequence, in the

context of technical analysis for the trends in secondary security markets. The comparison and contrast between Dow Theory (explaining the growth function for wealth), and the Fibonacci sequence (explaining primal growth function) among living things, is strikingly noticeable.

2.2. THE ELLIOT WAVE THEORY

Market analysts consider Elliot wave theory as a much-needed complement to the Dow Theory. Ralph Nelson Elliott (1871-1948) keenly pursued the movements in stock markets, once relocating to California, came up with 'wave theory', and named after him. Elliott's writing in various financial dailies reveal his theory in parts until 1946, when his book "Nature's Law-The secret of the universe" surfaced, with expanded form of his wave theory.

Kirkpatrick and Dahlquist (2007), describes the Elliott Wave Principle as a wave is a sustained price move in one direction as determined by reversal points that initiated and terminated the move. Wave cycle is composed of two waves – an impulsive wave and a corrective wave. The impulsive wave is in the direction of the current trend and the corrective wave moves against the trend's direction. Elliott believed that markets move in waves, progression and regression, motive and correction. A further discussion about the time period and the frequency of various movements has been extensively discussed in this theory.

Prechter (2005), argued that this is the minimum requirement for, and therefore the most efficient method of achieving both fluctuation and progress in linear movement. The fewest subdivisions to create fluctuation are three waves. Three waves (of unqualified size) in both directions do not allow progress. To progress in one direction despite periods of regress, movements in the main trend must be at least five ways, simply to cover more ground than the three waves and still contain fluctuation. While there could be more than that, the most efficient form of punctuated progress is 5-3, and nature typically follows the most efficient path."

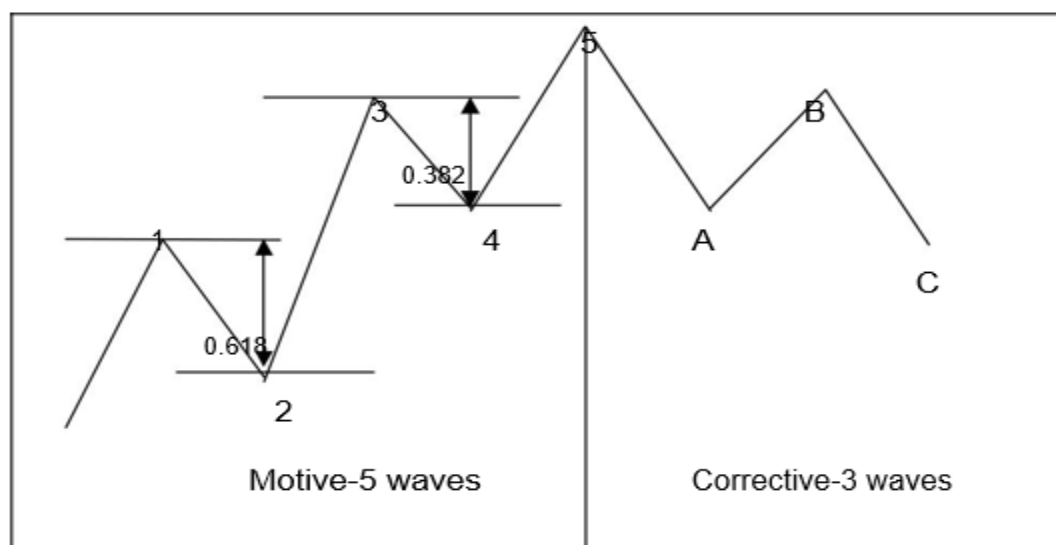


Fig. 1. Graphical presentation of the Elliot Wave Theory

Source: Author

Pertinent to mention that number '3' and '5' are found in Fibonacci sequence. The figure above represents a smaller segment of a bigger wave. The bigger waves, when analyzed in stock markets have been found to form reversal points according to the Fibonacci sequence. Not only this, the ration between smaller reversal points has been observed to the same as derived from the Fibonacci sequence 0.618, 0.382, 1.618, 2.618.

The retracement in the corrective waves has been observed to occur at 38.2%, 50% or 61.8% of the previous wave. A retracement at earlier level i.e., 38.2% may be associated with a corrective action which does not put notable strain on the basic trend. On the contrary retracement at 50% or 61.8% has been to have often been associated with a sharp contrast to the underlying trend. Sharp market incline or decline may take place, when the retracement takes place at higher percentages.

2.3. THE FIBONACCI SEQUENCE

The method or sequence which we know as Fibonacci Sequence today, stands out for its usage by practitioners from various walks of life. From scientists to musicians, and from Greeks, Sumerians, and Egyptians to modern times, this sequence has been used enormously for developing foresight and expectations. The term Fibonacci Sequence" was introduced by a French born mathematician Edward Lucas (1842-1891). In his book 'Liber abaci', he sets out the methods and rules of performing various calculations with the Hindu Arabic decimal positional system using Arabic Numerals Lucas, narrates an interesting experiment in this book. Douglas (2001), explains the experiment as; "a certain man puts a pair of rabbits in a place surrounded on all four sides by a wall. How many pairs of rabbits can be produced from that pair in a year, if it is supposed that every month each pair begets a new pair which from second month becomes reproductive? Same is explained in table 1 and 2.

Table 1. The 'Rabbit Problem' in tabular form

Start of month	Adult pairs	New Pairs	Total pairs
1	1	-	1
2	1	1	2
3	2	1	3
4	3	2	5
5	5	3	8
6	8	5	13
7	13	8	21
8	21	13	34
9	34	21	55
10	55	34	89
11	89	55	144
12	144	89	233
End of month 12	233	144	377

Source: Author

Table 2. Fibonacci sequence

Position	1	2	3	4	5	6	7	8	9	10	11	12
Fibonacci Numbers	1	2	3	5	8	13	21	34	55	89	144	233

Source: Author

A close observation of the sequence reveals the recursive nature of this number sequence can be formulated as

$$X_{n+1} = X_n + X_{n-1} \quad (1)$$

Equation 1 can be rearranged as

$$X_n = X_{n-1} + X_{n-2} \quad (2)$$

2.3.1. The Fibonacci Ratio

Fibonacci ratio also known as the golden ratio may also be derived from the table 2. For first half a dozen numbers the ratio of any number in sequence to that of next number is 0.618 approximately, while for the next number it is 1.168. The accuracy increases as the sequence goes on. Mathematicians typically name these ratios as phi and Phi respectively. Taking square root of 5 and adding 1 for Phi and subtracting the same for phi, and dividing result by 2 gives a more accurate picture of these ratios. Another significant ratio is 0.382, calculated for any given number for a number higher by two positions in the sequence.

Persaud et. al. (2015), argue that phi is the growth-force in the universe, might it be the impulse behind the progress in man's productive capacity. If phi is a symbol of the creative function, might it govern the creative activity of man. If man's progress is based upon production and reproduction in an endless sequence, it is not possible, even reasonable, that such progress has the spiraling form of phi, and that this form is discernable in the movement of the valuation of his productive capacity, i.e., the stock market.

2.3.2. Few Interesting Facts about the Fibonacci sequence and the Golden Ratio

The Fibonacci numbers, sequence and the resultant ratios have found to be extensively used by the architects, musicians, psychologists, scientists, and researchers. The ratios have been applied in the construction of great pyramids, and Parthenon. Modern construction theory makes extensive use of various ratios derived from this sequence. From 'Giotto', 'Da Vinci' too many artists in ancient history and modern times, make extensive use of ratios from the Fibonacci sequence. Even the human body has proven to contain the elements of golden ratio which is the basic building block of the golden spiral, (Douglas, 2001). From the microscopic scale of human DNA double helix to appearance, toe to navel to head, the golden ratio has been observed to be present.

The ratio has also been observed for its presence in the interplanetary synodic period. A synodic period may be defined as the lengths of two planets meet in conjunction, which means revolving 360 degrees to each other (Tattersall, 2013). The division of 360 degrees in to sixtles, squares, trine, and opposition, is used to understand the synodic planetary cycles. The synodic cycles conform to the Fibonacci Summation series (1,1,2,3,5,8,13,21,34,55,89,144...& ratios 0.618, 0.382, 1.618, 2.618...etc.). Space scientists have found striking existence of this sequence and ratios in the solar system. The Wave Theory

of Ralph Nelson Elliott appears to be the missing link between the Dow Theory and the Fibonacci sequence.

2.3.3. Application of Fibonacci number sequence and ratios to market prices

Fibonacci Retracement is not an unfamiliar term the modern financial markets. Elliott wave principle coupled with the golden ratio, provide a meaningful insight to a trend as far its continuation or reversal is concerned. Fig.1 depicts that the corrective wave retraces the previous wave by either 38.2%, 50%, or 61.8% frequently enough to make it a noticeable pattern, which is reversible at various points carry different interpretation as to the retracement of wave is concerned.

Practices adopted by technical analysts in the financial markets support the fact that the tools based on the work of Charles Dow, Fibonacci, and Ralph Nelson Elliott are extensively been used. These tools have been devised with a purpose to determine the price trend of securities being traded in the financial markets. Price of these securities has been given prime significance among many variables determining the trends and reversal points.

The review of relevant literature reveals that two of the important variables, i.e., time and volume, have received relatively little attention of the practitioners in the financial markets. It has been argued that the Fibonacci sequence and golden ration hold significant importance in terms of determining the expected price. Does this sequence and do these ratios have the same significance in determining the expected volume and the time horizon of the securities in the financial markets, has been the focus for this study. The study takes in to account the variable of 'time' only, for the purpose of exploration.

3. RESEARCH METHODOLOGY

Dow Jones Industrial Average (DJIA) and Dow Jones Transportation Average (DJTA), being one the oldest averages in the financial markets, have been tested in order to gauge the predictive ability of Fibonacci sequence and ratios, for the variable of 'time'. Data of these averages, since their inception in 1896, till 2008, has been taken in to account, in order to remove any speculative sentiments, in the long run. Moreover, the data spanning over more than one hundred years has been thought to be sufficient enough to prove the presence or absence of relationship between Fibonacci numbers and major stock market averages, i.e., DJIA and DJTA.

The observation periods of data have been classified into daily, monthly and yearly time frames. Charting package, 'meta stocks' version 8.0 has been used for the purpose of analysis. Once the data has been charted, the Fibonacci sequence has been placed on the data from the first day of trading on DJIA and DJTA. Table 3 in the following section gives a detailed account of the charts and trends developed for the data of more than past one hundred years. The explanation of these charts being cumbersome has been briefly presented in the conclusion a part of this study.

4. RESULTS AND FINDINGS

The results have been expressed in terms of traceability of the Fibonacci retracements with that of the retracements experienced for the daily, monthly and yearly average indices for both DJIA and DJTA. Pertinent to mention that these retracements are based on the Fibonacci sequence based on the number sequence mentioned earlier.

Table 3. Traceability of Fibonacci retracements with periodic averages at DJIA and DJTA

Fibonacci numbers	Traceability of Fibonacci numbers with daily, monthly, and yearly averages at DJIA			Traceability of Fibonacci numbers with daily, monthly, and yearly averages at DJTA		
	Daily	Monthly	Yearly	Daily	Monthly	Yearly
	chart	Chart	chart	chart	chart	chart
1	NO	YES	NO	NO	YES	NO
1	YES	YES	YES	YES	YES	YES
2	YES	YES	YES	NO	YES	NO
3	YES	YES	YES	YES	NO	YES
5	YES	NO	YES	YES	YES	YES
8	YES	YES	YES	YES	YES	YES
13	YES	YES	YES	YES	YES	YES
21	YES	YES	NO	YES	YES	YES
34	YES	YES	YES	YES	YES	YES
55	YES	YES		YES	YES	
89	YES	YES		YES	YES	
144	YES	YES		YES	YES	
233	NO	YES		YES	YES	
377	YES	YES		YES	YES	
610	YES	YES		YES		
987	YES			NO		
1597	YES			YES		
2584	YES			YES		
4181	NO			NO		
6765	YES			YES		
Total	NO=3 (15%) YES=17(85%)	NO=1(7%) YES=13(93%)	NO=2(22%) YES=7(78%)	NO=4(20%) YES=16(80%)	NO=1(7%) YES=13(93%)	NO=2(22%) YES=7(78%)

Source: Author

Contrary to Maclean (2005), who found the Fibonacci timelines to be of little use, or use less at all, the result shown above exhibit that the numbers have been able to match the time horizons at DJIA and DJTA, within a band of 78 to 93 percent, with the highest match in the monthly time line. Data of more than a hundred years from the two most seasoned averages in financial markets shows that the Fibonacci sequence has high rate of predictability for the time horizons.

5. CONCLUSION AND RECOMMENDATION

Based on the findings presented in the previous section, it may be concluded that the Fibonacci retracements have a high degree of precision in identifying the key reversal points at DJIA and DJTA. Though highest degree of precision, i.e., 93% has been experienced

in monthly averages, nevertheless 80% and 78% precision in daily and yearly averages respectively, is a fair precision to attract attention of the stakeholders in determining the key reversal points.

Keeping in view the wide application of Fibonacci sequence and ratios in professions across the globe, it is recommended that its application in predicating the trends, swings, price, volume and timings may be explored further. This study within its scope has attempted to prove the relationship of these numbers and ratios with one of the variables at DJIA and DJTA, i.e., time horizon. The utility of these numbers and ratios may also be extended in finding out the answers to the larger question as to how can these numbers and ratios used to find the high-low points in various trends. It is proposed that the same testing may be carried out in markets other, that DJIA and DJTA, though both the indices are the leading ones within the global financial markets. In addition, more variables may be included for the purpose of exploring the similarity between the golden ratios with the behavior of stock prices.

Author Contributions:

The article has been conceived, conceptualized, and drafted by Dr. Khalid Mumtaz Khan, while Ms. Waiza Rehman has provided the data resources, worked on methodology, and refined the draft along with formatting the article. Mr. Osman Bin Saif has helped with methodology, along with running the data analysis.

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