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## Copper Price Prediction using Wave Count with Contribution of Elliott Waves

R. Sattari<sup>1</sup>, A. Akbari Dehkharghani<sup>2\*</sup> and K. Ahangari<sup>1</sup>

<sup>1</sup>-Department of Mining Engineering, Science and Research Branch, Islamic Azad University, Tehran, Iran

<sup>2</sup>-Department of Petroleum, Mining and Material Engineering, Central Tehran Branch, Islamic Azad University, Tehran, Iran

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### Keywords

*Copper*

*Metal price prediction*

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### Abstract

Within the last few decades, copper has been identified as one of the most applicable metals by many researchers. These researchers have also been enthusiastic to predict the price of this valuable metal. These days, the available technical analysis methods have been highly applied in the financial markets. Moreover, the researchers have used these methods to predict the suitable price trends. In the present work, some technical analysis tools including the Fibonacci series, Elliott waves, and Ichimoku clouds were practiced to scrutinize the price changes and predict the copper price. All copper prices from 2008 to 2016 were considered. Regarding the fractal property of these methods, the relations among prices were obtained within an eight-year time sequence. Since 2016, the copper price has been gradually deviated from its previous trend. Using the wave count and Elliott waves has specified that the wave number 1 and wave number 2 have been completed. Now, the time has come to develop the wave number 3. According to the relations introduced by the Elliott waves and the clouds made by Ichimiku, it was determined that the copper price would be almost \$16000 per ton in 2022.

### 1. Introduction

Copper is one of the oldest metals that the human has been able to find. The researchers have paid high attentions to it for the sake of its various applications. Within the last few decades, the sharp increase in the copper price has led to several research works on the specifications of this metal. The technical analysis methods have been identified as one of the methods practiced to deem the price of time series. These methods are mostly utilized in the financial and stock markets. The Elliott wave count has been counted as one the most prominent technical analysis methods. Since the twentieth century, some researchers have applied these techniques in other sciences. In 2011, Atsalakis *et al.* mulled over a four hundred-day period, and realized that using the Elliott wave theory along with fuzzy logic could be directed into a more suitable and precise prediction of the stock market [1]. In 2012, Tirea *et al.* wielded a multi-function system based on the Elliott wave theory, and could

make a model to foretell the signals and selling and purchasing trends. Some functions including the Elliott wave theory, nervous system, and technical analysis contributed to this model to get connected to the core and central relations [2]. From 2008 to 2011, Magazzino *et al.* contemplated the price data of the S&P500 index and illustrated that the technical analysis and the Elliott's theory accurately reflected the realities of the intermittent financial markets. In fact, the Elliott's theory, as an analytical tool, can present the profitable opportunities in disturbed stages [3]. Volna *et al.*, in 2013 and 2016, used the nervous network along with the Elliott's theory, and found that whenever the impulsive phase of the Elliott waves was identified, a downward trend was foreseen. In case the modified phase of the Elliott or the triangle patterns are specified, an upward trend is predicted [4-6]. In 2016, Ilalan pondered the Nikkei 225 index by the Elliott waves and Brownian

✉ Corresponding author: [afshinkr@gmail.com](mailto:afshinkr@gmail.com) (A. Akbari Dehkharghani).

fraction, and demonstrated that this index held the Hausdorff dimensions less than 0.5 and equal to 0.176 [7]. In the same year, Vishvakshenan *et al.* deliberated moments in the short time units of cell phone wireless network signals along with the Elliott waves. Indeed, they could make predictions for these signals within long time durations [8]. In 2017, Vantuch *et al.* could present an algorithm, predicting the price of gold and silver and the ratio of Euro to Dollar. In 2018, they developed it and achieved better results from the financial markets [9, 10]. In 2018, Marañón *et al.* employed the Elliott wave theory and Mont Carlo simulation to interpret the commercial cycle of metals. Thus they declared that the Elliott wave theory could be practiced for some items like gold and silver that have an enormous market and follow psychological movements.

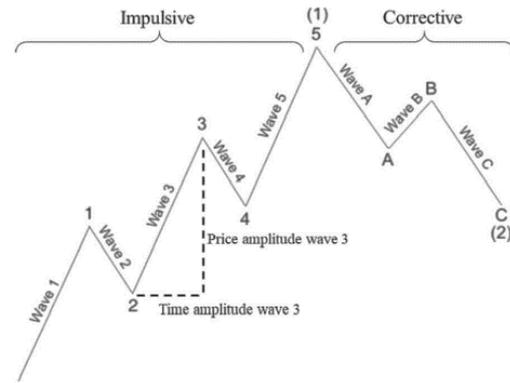
## 2. Methodology

### 2.1 Elliott Waves

In the 1930s, Ralph Nelson Elliott introduced the Elliott wave theory. He presented two principles in his theory to control the markets. The first one is the patterns by which the markets are expanded, and the other one is associated with the psychological motifs that occur accordingly. The Elliott's theory has been founded on the concept that the markets are managed by the mass of psychological motifs and are repeatedly expressed in the wave frame. Consequently, the markets reflecting the social spirit are developed through putting the two aforementioned patterns together suggested by Elliott as motive, impulsive or corrective waves [11]. The Elliott wave theory divides the waves into two categories. The first category includes the motive or the impulsive waves, and the second one holds the corrective waves. This theory defines that a motive wave is always accompanied by a corrective one. Thus complete changes in price are initially indicated as a motive wave. Then the markets require a return or price correction, which is done by a corrective wave [12].

As observed in Figure 1, each motive wave is divided into five micro-waves called 1, 2, 3, 4, and 5. The waves 1, 3, and 5 are always directed toward the motive wave. The waves 2 and 4 play a corrective role in the motive wave section and move in the opposite direction. The second section is involved with corrective waves including three micro-waves called A, B, and C. In this section, the waves A and C are in the same direction with the corrective wave, while wave B is directed toward the motive waves. In a complete cycle, the Elliott wave is obtained from a motive wave (5 micro-waves) and a corrective wave (3 micro-waves), and there are also 8 micro-

waves. The next waves are made by the repetition of these two waves.



**Figure 1. Corrective and motive waves in one motive wave and one corrective wave [12].**

Elliott emphasized that he could consider these patterns regardless of the time pattern. This allowed him to direct the impulsive corrective pattern to all-time measurements and provide the fractal specifications of his theory. Furthermore, he believed that the human nature did not change. He repeated that an activity led to a prediction. As a result, fractal paves the way that the theory that is independent from time measurement becomes valid for the market. Due to this concept, fractal can be applied to the model markets and commercial cycles [12].

According to the fact that these waves have fractal properties, the repetition of these micro-waves exists in all micro-waves. The waves 1, 3, 5, A, and C are made up of 5 micro-waves called 1, 2, 3, 4, and 5. Additionally, the waves 2, 4, and B include 3 micro-waves known as 1, 2, and 3 [12].

Elliott considered numerations for the higher and lower layers and degrees as well as micro-waves based on the standard illustrated in Table 1. In this table, there are different names for the impulse and corrective waves. The upper-level waves are count with numbers or capital letters that are separate with brackets or parentheses or none of them. The sub-level waves are differentiate with the roman numbers or lowercases letters, and in this case, again the layers are differentiate with brackets or parentheses or none of them. This procedure is continuously repeated for any layer until counting the waves is ended.

In case the waves are completely separated and divided into the related micro-waves, there are only two waves (the motive and corrective ones) in the first cycle (Figure 2). As a consequence, it can be observed that a complete cycle holds 8 waves in the second stage of analysis, 34 micro-waves in the third stage, and 144 micro-waves in the fourth stage [12].

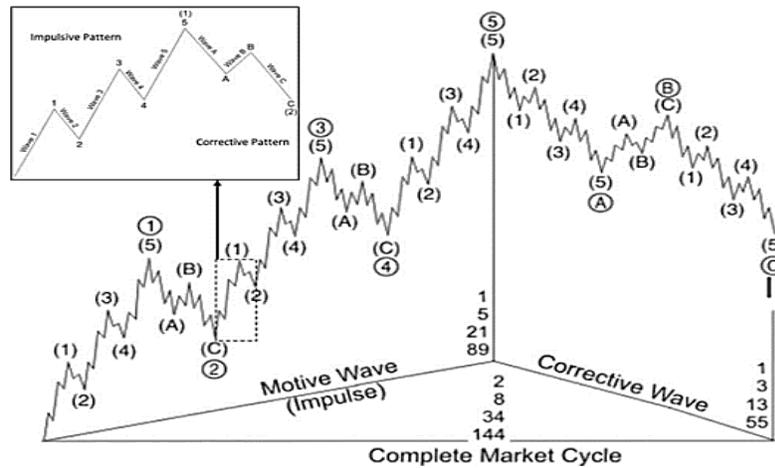


Figure 2. A fractal cycle of Elliott waves (12).

Table 1. The numbers and names of waves in different layers and degrees (13 and 14).

Wave degree/cycle	Impulse pattern (5 waves)	Corrective pattern (3 waves)
Super-millennium	[1] [2] [3] [4] [5]	[A] [B] [C]
Millennium	(1) (2) (3) (4) (5)	(A) (B) (C)
Sub-millennium	1 2 3 4 5	A B C
Grand supercycle	[I] [II] [III] [IV] [V]	[a] [b] [c]
Supercycle	(I) (II) (III) (IV) (V)	(a) (b) (c)
Cycle	I II III IV V	a b c
Primary	[1] [2] [3] [4] [5]	[A] [B] [C]
Intermediate	(1) (2) (3) (4) (5)	(A) (B) (C)
Minor	1 2 3 4 5	A B C
Minute	[i] [ii] [iii] [iv] [v]	[a] [b] [c]
Minuette	(i) (ii) (iii) (iv) (v)	(a) (b) (c)
Subminuette	i ii iii iv v	a b c

The most significant property of these waves is that the motive wave can form a downward shape, whereas the corrective wave can have an upward trend. Elliott believed that the market was affected by the motive wave. Hence, this model could be practiced at specific time intervals and transient analyses.

Elliott supposed that the people's psychological and emotional factors directed the market. Therefore, each one of the eight waves of one cycle (whether it is a huge one-hundred, some-hour or even some-minute cycle) features out the public emotional and psychological motifs. Moreover, the psychological motifs of the society can contribute to predict various industrial indices like Dow Jones, while it is not possible to precisely predict them through average indices or the average of an individual's property.

Wave 1: It is usually hard to find wave 1, and it can emerge when the expectations are the least for the sake of investment thoughts and lack of information and news while being formed. In other words, only some major investors can revolve the market by their huge investment in wave 1.

Wave 2: This wave starts correcting in the next phase of price movement from wave 1, which has moved a huge wave of market. Thus there is much supply in the market. Nonetheless, this sale trend reduces the negative expectations and also decreases the temptation of returning to the previous price. This wave has resulted from those who have highly benefited from wave 1 and removed their capital because it is not possible for them to keep on taking risks.

Wave 3: This wave is reinforced to grow price. However, good news can strengthen the public optimism. In fact, it brings about a better income for other investors. A stable and reinforced market improves investment, and it is lucrative for them. Most experts believe that wave 3 of the stock market is the most intensive one [16].

Wave 4: After an optimistic period, questions about the fundamentals of this reconstruction are started. It is a period in which there are disagreements among the participants in the market. Some of them tend to leave, while some others bet on price increasing. Since this weak market is not confirmed, the bases are founded to increase prices in the next wave. The

experts usually believe that this stage might be lengthy due to market disorientation [12].

Wave 5: After a weakness is observed in wave 4, lots of concerns are removed and the price restarts increasing.

However, the experts think that the growth of this wave is less than that for wave 3. Besides, this period is affected by a significant ambiguity that rests on a delay in the action of so many participants of the market. Suddenly, they want to use the neglected opportunity. It means that the third phase of public investment has begun. At this point, there are lots of news on this issue.

There are three main principles for the Elliott waves that should always be followed:

Wave 2 can never correct wave 1 100%.

Wave 4 can never reach the peak of wave 1.

Wave 3 is the shortest wave.

On the other hand, according to the fractal nature of the Elliott waves for corrective wave, the rules are the same as wave 2; in fact, the first corrective wave for the first impulse wave is completed with another impulse wave named wave 3. For an additional information, the user must know that the corrective wave includes 3 waves that do not get to each other (waves a, b, and c).

## 2.2 Fibonacci Ratios

Elliott did not initially present a logical system to estimate the wave time and price range. He used the Fibonacci ratios (FRs) in his second work, and developed some principles for his motive and corrective forms [15]. FRs are attributed to Leonardo Fibonacci Da Piza, an Italian mathematician in the thirteenth century. FSs is commenced by two primary parameters with amounts of 1 and 1. In FS, the next number is obtained from the sum of the two previous consecutive numbers.

$$1 + 1 = 2, 2 + 1 = 3, 3 + 2 = 5, 5 + 3 = 8, 8 + 5 = 13 \quad (1)$$

The general relation of Fibonacci is defined as  $S_{n+2} = S_{n+1} + S_n$ . The relation  $R(\text{ratio}) = \frac{S_{n+2}}{S_{n+1}}$  should be followed to achieve the golden ratio of FS. Thus it can be concluded that:

$$\frac{S_{n+1}}{S_n} = 1 + \frac{S_{n-1}}{S_n} \quad (2)$$

By substituting the mentioned items in Equation 2, it can be concluded to be  $= 1 + \frac{1}{R}$ . The answer to this

equation is  $R = \frac{1+\sqrt{5}}{2} = 1.618$ . This ratio is for two consecutive numbers in FS. In case the ratio of  $\frac{S_{n+2}}{S_n}$

is obtained, the answer is 2.618, and the difference between the two numbers will be 4.236. As this method keeps on, more ratios of this series are obtained [15]. The reverse ratios achieved from the following relation are 0.23, 0.38, 0.618, and 0.768, which are the significant ratios of the series.

Elliott started studying FS and the ratio extracted out of it. At first, he realized that the number of waves were related to the number of the complex. Thus FS controls the number of waves in the market. Eventually, Elliott figured out the concept of his theory and illustrated that the waves were connected to one another by the golden ratio of FR and other frames. He found out that these ratios relied on time and the range of prices in some items. These findings led Elliott and other researchers to conclude that the Elliott waves were managed by FS and FR. Today, it is identified as a pioneering method in a technical analysis that is known as Fibonacci Analysis (FA).

The FA results are vital for the Elliott's theory because they are regarded as the prediction base. Considering the Elliott's theory, the consecutive waves are connected by FR. Therefore, when the right wave is identified (especially wave 1), the following waves can be predicted by FR using the time range and the price of the previous waves. That is why FA depends on the correct numeration of waves. Moreover, the applicants consider that it is essential to experimentally specify the probabilities in relation to the development and correction of one wave to one special Fibonacci ratio.

## 2.3 Ichimoku Clouds

The theory of Ichimoku clouds was first suggested by Giochi Hosoda in 1969 in Japan. The complete name of this theory is Ichimoku Kinokuhew, which means the horizontal graph in one glance. This theory consists of 5 graphs, as follow:

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$$\text{-Tenkan-sen (Conversion line): } (9\text{-period high} + 9\text{-period low})/2 \quad (5)$$

$$\text{-Kijun-sen (Base line): } (26\text{-period high} + 26\text{-period low})/2 \quad (6)$$

$$\text{-Senkou Span A (Leading span A): } (\text{Tenkan-sen} + \text{Kijun sen})/2 \quad (7)$$

$$\text{-Senkou Span B (Leading span B): } (52\text{-period high} + 52\text{-period low})/2 \quad (8)$$

-Chiku span: it can be obtained by transferring the price to the previous 26 periods.

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The technical analysis results achieved from the Ichimoku clouds are much extended and are different from the personal tact. Most experts agree that when the Komu cloud gets thin, the price channels can pass through them. When the cloud gets thick, it is hard to pass through them, and it requires very strong channels. It is noteworthy that all the lines act as the resisting and supporting ones. Figure 3 features out a sample graph with the Ichimoku clouds.

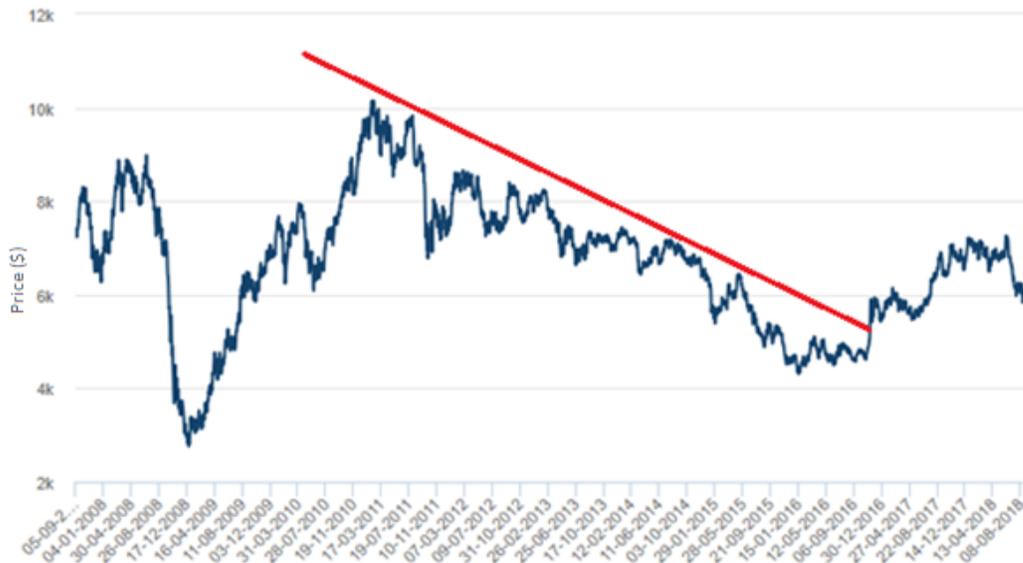
**3. Discussion**

**3.1. Predicting Copper Price**

As it can be observed in Figure 3, the price trend that has recorded the lowest price rate within the last decade has reached the highest price in 2010. From 2010 to 2016, the global price of copper has not

changed much. The price has only moved through its corrective canal, and the price has never reached the price in 2010. The line illustrated in Figure 2 expresses that the price has never been beyond it, and this line acts as a resisting one. However, the price has been remarkably changed from 2016 onward. Thus it can be assumed that the price has changed its changing trend. Moreover, it has removed from its previous trend and has commenced a new one.

The resisting and supporting lines are the lines that totally cover the price, and the price does not move above or below these lines. The price approaches for several times to these lines but cannot cross them; this means that the resisting and supporting lines are unique lines, and the user must draw them.



**Figure 3. The copper price graph from 2008 to 2018 with the resisting line (18).**

From the beginning of 2016, copper price has reached its lowest one from the second half of 2009. Clearly, copper price has never experienced a price less than the price of the beginning months of 2016 from the second half of 2009 to 2016. Notably, it has moved to its next wave by breaking the resisting line. Through removing the prices before 2009 and after 2016, it can be concluded that wave 1 develops a strong upward trend for more than two years and carries on a price almost \$2800 for each tonne at the beginning of 2009, and in the second month of 2001 at a price around \$10000/tonne. Due to the Elliott wave theory and breaking the resisting line, wave 2 starts from the end of wave 1 and reaches \$4300 for each tonne after 4 years. According to the Elliott wave theory, wave 3 originates from the end of wave

2, and it should be more than the wave price due to the rules of the Elliott waves.

In this research work, the waves 1 and 2 were divided into the related micro-waves. Finally, the ratio of all the divided micro-waves was obtained from the higher range waves based on the fractal property of these waves. All the waves from 1 to 5 were divided into 67 micro-waves. Totally, 335 micro-waves were made.

The ratios of all micro-waves from 1 to 5 have been diverged from the waves 1, 3, 5, a, and c. These 67 ratios were analyzed by SPSS, and the Boxplot software was practiced to determine all the outliers. Two numbers were removed from the outlier data of ratios for wave 1, two numbers were eliminated for the ratios of wave 2, and five numbers were detached for the ratios of wave 4. Then the average data was

estimated by the average method. The ratios of each wave from the primary motive wave were obtained and presented in Table 2.

As indicated in Table 3, if we consider a motive wave 100, on average, 34% of its movement belongs to wave 1, 16% of it is the corrective one, which is related to wave 2, 57% is for wave 3, again 14% of correction is associated with wave 4, and finally, 39% is related to wave 5, where a 100% motive wave can be completed.

Figure 4 displays the separated price lines of the wave numbers 1 and 2, which are counted until a minor degree. The degree of counting follows the Table 1 rules.

SPSS was applied to calculate the data dispersion and the distribution of the waves 1 to 5. The description

of appendix 1 illustrates the quartiles of the wave ratios after removing the outlier data. Appendix 2 shows the data histogram of 61.8% of wave 1 due to the Fibonacci theory before eliminating the outlier data. As wave 2 was able to get completed, the rest of the waves 1, 2, 3, 4, and 5 were defined as a matrix, and their time amounts were determined.

$$a = \begin{bmatrix} w2 & w3 & w4 & w5 & 1 \\ w1 & 0 & 0 & 0 & 1 \\ 0 & -w1 & 0 & 0 & 1 \\ 0 & 0 & w1 & 0 & 1 \\ 0 & 0 & 0 & -w1 & 1 \end{bmatrix}$$

$$b = [0 \ 0 \ 0 \ 0 \ t3]$$

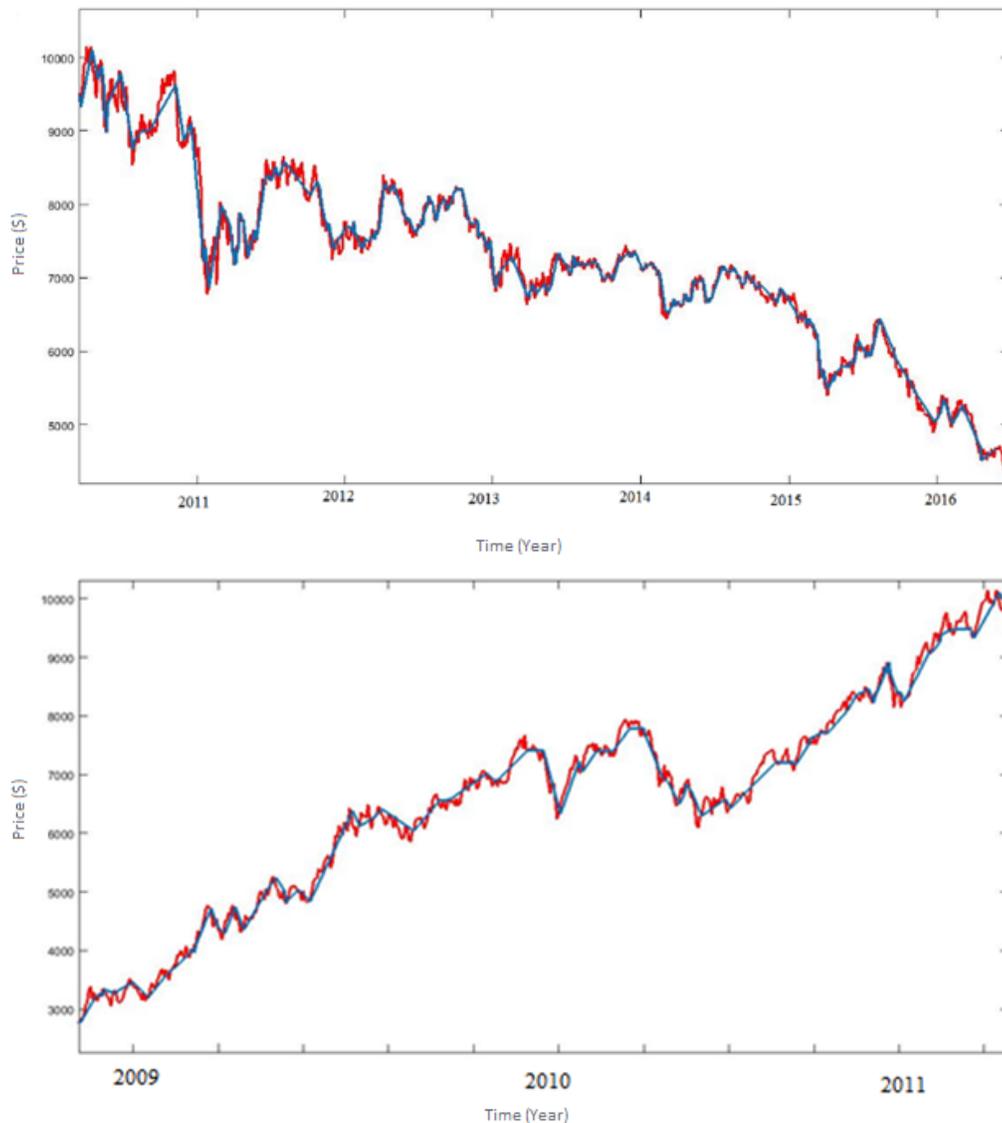


Figure 4. The micro-waves obtained by Elliott waves (copper price that is in red and blue indicates the micro-waves made by wave counting using the Elliott waves).

**Table 2. The average of the extracted wave ratios to their parent wave.**

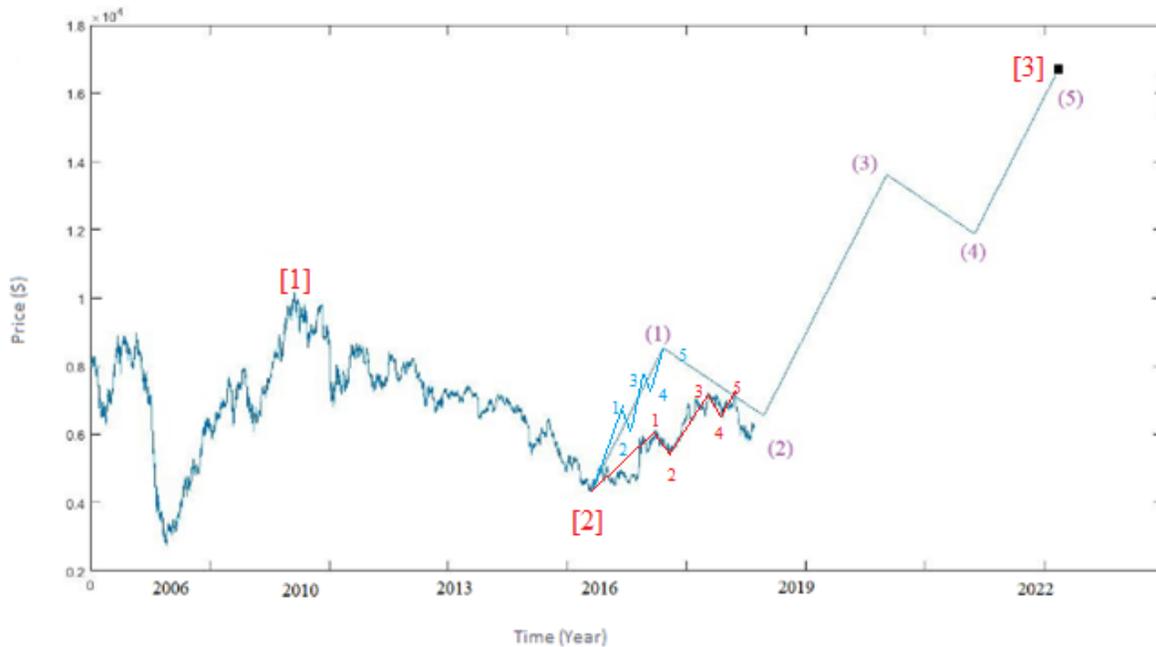
	Wave 1	Wave 2	Wave 3	Wave 4	Wave 5
Ratio to parent	34%	16%	57%	14%	39%

in which W1 to W5 are the ratios taken from the ratios of waves. The t3 value indicates the time and it is after X waves are obtained from  $t3 = t1 * \frac{w3}{w1}$ , and t1 is the total time passed by wave 1. Eventually,

matrix T can be obtained by solving b/a, which is the time predicted for each one of the waves.

$$T = [25 \ 12 \ 42 \ 108 \ 29]$$

Figure 5. Divulges of the copper predicted prices based on the information.



**Figure 5. The copper price predicting graph up to 2022 using the Elliott waves.**

According to Figure 5, in this prediction, wave number (1), after wave number [2], which is completed in \$4100, reaches \$8100 per tonne but the real price is about \$7000. For the corrective wave number (2) the predicted price is about \$6500 and the real price is about \$6000. In the Super-millennium or Millennium degree, there is a long term trend between the predicted and real prices. Hence, for more consistency, it is required to correct the wave counting by everyday counting in Intermediate, Minor or Minute wave degree.

In another phase of this work, when the copper graph is depicted with the Ichimoku clouds, as show in Figure 6, the black line is the copper price, the red line is the Tenkan-sen line, the blue line is Kijun-sen,

the purple line is the Chiku span, and the green and yellow area is the Senkou span (clouds). The green line is the resisting line for the copper price.

There are a lot of technical analyses by the Ichimoku clouds. In this work, only the Senkou span section was used. It can be observed that the strong Ichimoku cloud has been placed opposite to the price within the next 25 to 30 months. Thus there will be an upward trend, and it confirms the model presented in the previous figure. Figure 6 displays the copper price graph with the Ichimoku clouds, in which the seasonal prices of copper have been used because 26 clouds are drawn in the daily time frame and again 26 clouds are depicted in the yearly time frame.

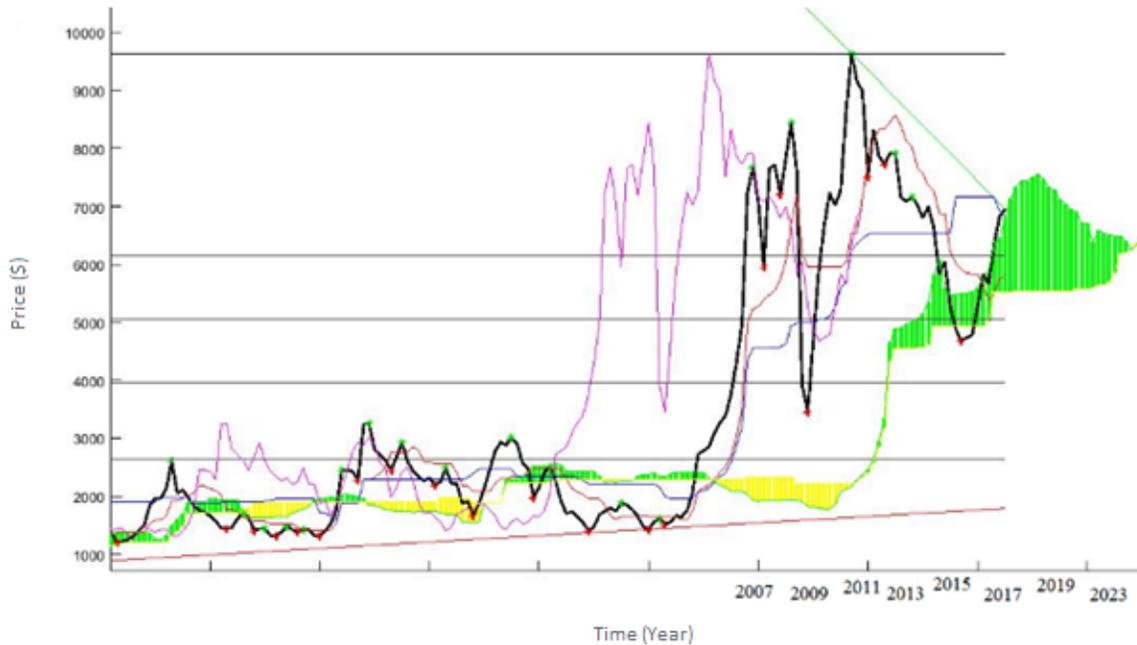


Figure 6. Graph of copper price with the Ichimoku clouds.

#### 4. Conclusions

Using the Elliott's theory in a long term and with a high concentration can lead to positive results. The current work aimed at predicting all the possible phases and eliminating the unachievable results. All the principles governing the Elliott waves have affected the two aforementioned waves (waves [1] and [2]). The ratios 34, 16, 57, 14, and 39 were obtained for waves (1) to (5) in the Millennium degree.

In this work, the wave number (1) comes to about \$7000 and is corrected with a corrective wave called number (2) at the end of 2018 to about \$6100. After that, the price raises up with wave (3) to about \$14000, and after another wave correction with wave number (4) comes to less than \$12000. Finally, for completing the Supermillennium wave, the price goes up to more than \$16000 with wave number (5). The depiction of wave 3 determined that the copper price could reach \$16000 per each tonne in 2022.

The composition of the Elliott waves and the Ichimoku clouds show that the copper price has a stable future and has a growing market in at least half a decade. While the Elliott wave's Supermillennium wave in number 3 raises up for several years, a huge cloud is available in these years by the Ichimoku clouds result.

For better results, the user must check and count the waves in a short time (such as Intermediate, Minor or Minute wave degree) interval and modify every fluctuation. The short time fluctuations cannot be affected in a long term planning but it takes a drawn

counted wave closer to the real price in the Supermillennium wave.

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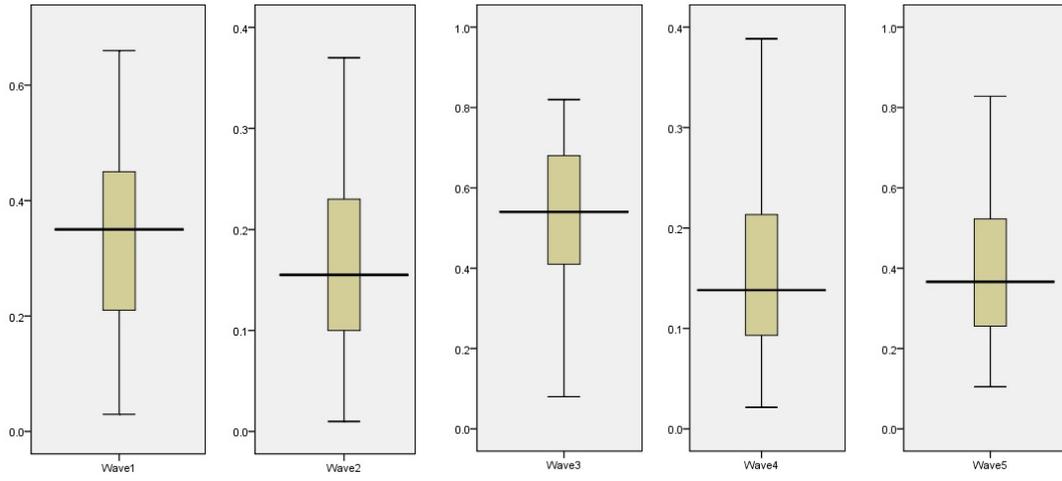
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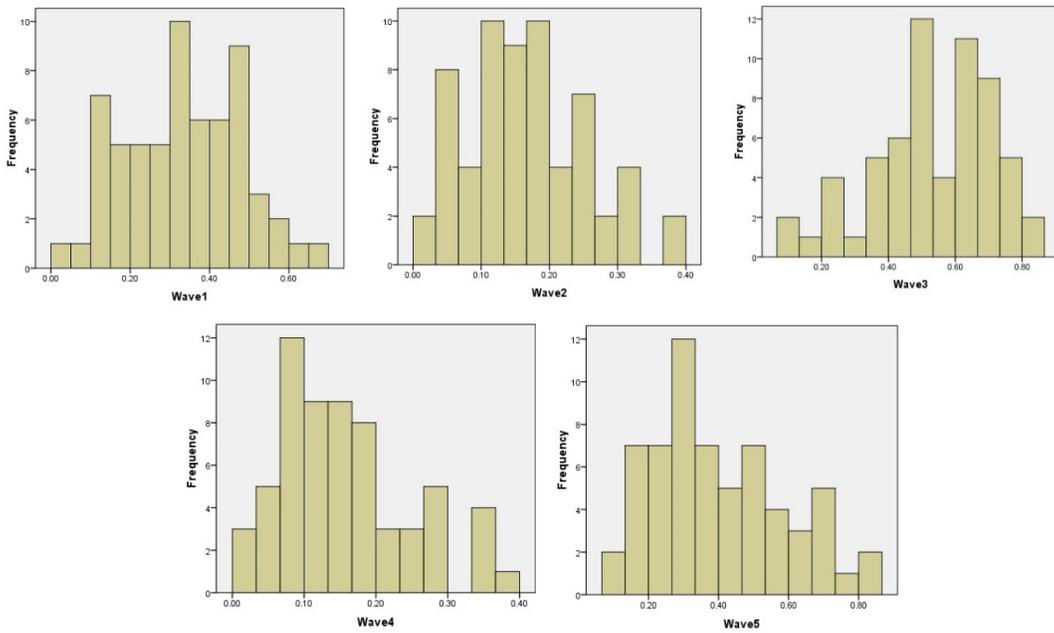
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Appendix 1



Appendix 2



## پیش بینی قیمت مس با استفاده از موج شماری به کمک امواج الیوت

رامین ستاری<sup>1</sup>، افشین اکبری دهخوارقانی<sup>2\*</sup> و کاوه آهنگری<sup>1</sup>

1- گروه مهندسی معدن، واحد علوم و تحقیقات، دانشگاه آزاد اسلامی، تهران، ایران

2- گروه مهندسی نفت، معدن ومواد، واحد تهران مرکزی، دانشگاه آزاد اسلامی، تهران، ایران

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\* نویسنده مسئول مکاتبات: afshinkr@gmail.com

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### چکیده:

مس به عنوان یکی از پرکاربردترین فلزات در دهه های اخیر مورد علاقه محققین زیادی واقع شده و پیش بینی قیمت این فلز ارزشمند، یکی از گزینه های مورد علاقه پژوهشگران میباشد. امروزه استفاده از روش های تحلیل تکنیکال در بازارهای مالی رونق زیادی یافته است و محققان به کمک آن به پیش بینی روندهای قیمتی مناسبی دست پیدا می کنند. در این پژوهش به کمک استفاده از ابزارهای تحلیل تکنیکال با نام های سری فیبوناچی و امواج الیوت و ابرهای ایچیموکو به بررسی تغییرات و پیش بینی قیمت مس پرداخته شده است. تمام قیمت های مس از سال 2008 تا 2016 مورد بررسی قرار گرفت و با توجه به خاصیت فرکتالی روش این پژوهش، روابط بین قیمت در سری زمانی 8 ساله بدست آمد. قیمت مس از سال 2016 شروع به خروج از روند قبلی خود داشته است و با موج شماری به کمک امواج الیوت مشخص شد موج شماره یک و دو کامل شده و حالا نوبت ایجاد موج سه می باشد. با توجه به روابط ایجاد شده توسط امواج الیوت و ابرهای ایجاد شده توسط روابط ایچیموکو مشخص شد که قیمت مس در اوایل دهه بعدی میلادی یعنی سال 2022 به قیمتی در حدود 16000 دلار به ازای هر تن خواهد رسید.

**کلمات کلیدی:** مس، پیش بینی قیمت فلزات، امواج الیوت.

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