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## An Optimization Method on Hyperbolic Indicator

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### ABSTRACT

Forex indicators are one way of examining market data. One of the best methods is using approximations of quadratic curves. For example, the Parabolic SAR indicator is an indicator that approximates the trend by a parabola. Of course, not all indicators necessarily map the direction of the trading trend with a curve, but discovering a clear curved path for the trading trend is definitely the dream of many great analysts. The problem that we are dealing with here is actually trying to generalize the idea of approximating the direction of the trading process by using hyperbolic functions. Suppose there are two fixed points in the movement of the financial market and the path length between these two points is also a fixed number, using numerical approximation methods, we try to calculate the maximum and minimum amount of financial market movement. The main idea that is in our minds is the approximation of financial market trends by using hyperbolic functions. We approximate the path between these two points with a hyperbolic sine function. Finally, we try to find the maximum or minimum points of this hyperbolic sine function numerically.

## 1. Introduction

When the finance industry looks at past market data to make predictions about future performance, this study is known as technical analysis. Technical analysts use these technical indicators to make sense of price movements, predict time frames, and try to make sense of the markets' volatility. Chart patterns can give us clues to how certain financial products will perform. It's a type of active management designed to give advisors the information they need to make decisions for their clients, organizations, and themselves. The more correct technical analysts are about future price changes, the better we can manage wealth.

Note everyone is convinced of the power of technical analysis. In the past, data showed that those using past information to predict future closing prices, in the short term or long term, weren't much better than simply guessing. Now, we have the power of computers capable of enormous processing power, which could help us get closer to those right numbers. Forex indicators are one way of examining market data. By examining

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historical data, such as currency price, volume and market performance, indicators seek to predict how the market will behave in the future and which patterns are likely to be repeated. Recently, various researches have been done in this field [1, 3, 4, 5, 6, 7, 9, 11, 12, 13, 14, 16, 17].

One of the best methods is using approximations of quadratic curves. For example, the Parabolic SAR indicator is an indicator that approximates the trend by a parabola. The Parabolic SAR is a technical indicator developed by J. Welles Wilder to determine the direction that an asset is moving. The indicator is also referred to as a stop and reverse system, which is abbreviated as SAR. It aims to identify potential reversals in the price movement of traded assets. It can also be used to provide entry and exit points. The Parabolic SAR mainly works in trending markets. Wilder recommends traders should first establish the direction of the trend using the parabolic SAR and then use alternative indicators to measure the strength of the trend. J. Welles Wilder Jr. (June 11, 1935 – April 18, 2021) was an American mechanical engineer, turned real estate developer. He is best known, however, for his work in technical analysis. Wilder is the father of several technical indicators that are now considered to be the core tenets of technical analysis software. These include Average True Range, the Relative Strength Index (RSI), Average Directional Index, and the Parabolic SAR. When graphically plotted on a chart, the Parabolic SAR indicator is displayed as a series of dots. If it appears below the current price, the parabolic SAR is interpreted as a bullish signal. When it is positioned above the current price, it is deemed to be a bearish signal. The signals are used to set stop losses and profit targets. Figures 1 and 2 are examples of the performance of this indicator.

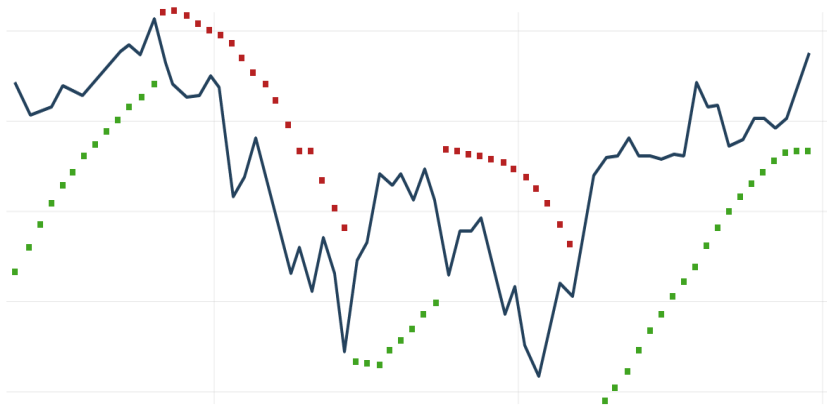


Figure 1: Parabolic SAR indicator

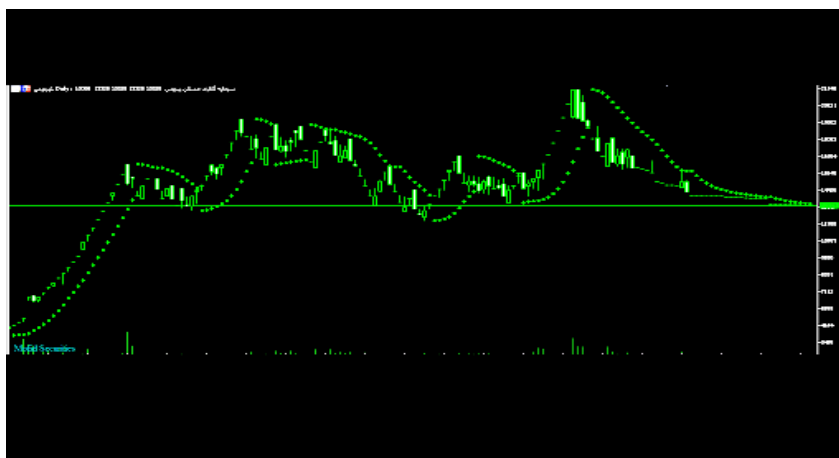


Figure 2: Parabolic SAR indicator

A parabola below the price is generally bullish, while a parabola above is generally bearish. A parabola below the price may be used as support, whereas a parabola above the price may represent resistance.

Recently, in [2], authors conducted a study on the automatic adjustment of the Parabolic SAR by using the Fuzzy logic. This paper proposes the possibility which the fuzzy theory can be used to improve the performance

of the parabolic SAR (Stop-And-Reverse) indicator in the trading systems for stock market. The simulation results with data of the KOSPI 200 future show that the occurred number of trading signals and the false signals in the proposed fuzzy SAR indicator is less than that in the conventional SAR indicator. In the conventional SAR system, the incremental value of the acceleration factor is usually set as 0.02 and the maximum value of the acceleration factor is usually limited as 0.2. But in the proposed fuzzy SAR system, the incremental value and the maximum value of the acceleration factor are automatically adjusted by using the fuzzy rules, which are designed based-on the difference between short-term moving average and medium-term moving average and also based-on the slope of short-term moving average.

Also, in [10] a new research has been done on this indicator. The evaluation is based on application of the Parabolic-SAR indicator for four currencies namely EURUSD, GBPUSD, USDCHF and USDJPY individually to identify effectiveness of the indicator regarding to the amount of profit generated, using hourly data of market stretch from January 2001 to December 2010. Virtual Historical Trading Software (VHTS) is developed for the purpose of computing the indicator based on its original formulas and interpretations; for applying the assumptions; for trading based on buy and sell signals generated by the Parabolic SAR (P-SAR) indicator. Trading in foreign currencies began in 1973 following the collapse of the Bretton Woods agreement under which gold held by central banks underpinned currency values. Forex is a free market in which currency prices are based on supply of and demand for a particular currency. The Forex market has several distinct advantages over other financial markets, such as: operation on a 24-hour basis 5 days a week, no fixed location, and an over-the-counter market. Besides, Forex market currently generates a daily volume of over USD 3.2 trillion thereby making it the largest financial market. Any currency can be traded as long as there is no restriction by central banks issuing the currencies.

Only quadratic polynomial functions are not used to approximate financial market charts. Figure 3 is an example of an indicator type that approximates the market trend using the ellipse.



Figure 3: Ellipse and Tether chart

The main idea that is in our minds is the approximation of financial market trends by using hyperbolic functions. Due to the difficulty of this problem, we try to discuss a special case of optimization here that it is related to hyperbolic shapes.

The main idea of this issue comes from that most movements in financial markets have exponential growth or decline. Exponential functions are the main functions involved in constructing hyperbolic functions. Of course, it must be admitted that this topic has many details. In fact, it can be said that our goal is to approximate functions using exponential functions or hyperbolic functions.

In [15], by using hyperbolic functions, the author tries to find a solution for the generalized Blasius problem. Suppose there are two fixed points in the movement of the financial market and the path length between these two points is also a fixed number, using numerical approximation methods, we try to calculate the maximum and minimum amount of financial market movement. Without loss of generality, we limit the discussion to finding the minimum value.

## 2. Main Result.

**Mathematical modeling:** Forex indicators are one way of examining market data. One of the best methods is using approximations of quadratic curves. For example, the Parabolic SAR indicator is an indicator that approximates the trend by a parabola. Of course, not all indicators necessarily map the direction of the trading trend with a curve. But discovering a clear curved path for the trading trend is definitely the dream of many great analysts. The problem that we are dealing with here is actually trying to generalize the idea of approximating the direction of the trading process by using hyperbolic functions. Exponential functions are the main functions involved in constructing hyperbolic functions. Of course, it must be admitted that this topic has many details. In fact, it can be said that our goal is to approximate functions using exponential functions or hyperbolic functions.

Suppose there are two fixed points in the movement of the financial market and the path length between these two points is also a fixed number, using numerical approximation methods, we try to calculate the maximum and minimum amount of financial market movement. The main idea that is in our minds is the approximation of financial market trends by using hyperbolic functions. We approximate the path between these two points with a hyperbolic sine function. Finally, we try to find the maximum or minimum points of this hyperbolic sine function. As mentioned in the previous section, we are actually going to discuss is the finding the maximum or minimum in a marketing process. In other word, we have two fixed points; also we know the length of the curve between these two points. Finally, we must find the optimum point on the path between these two points, using numerical approximations. Because the hyperbolic curve is an excellent approximation to examine the trend of a financial market, our main focus is on examining the behavior of this indicator.

**Main Problem:** We have two fixed points  $A = (a, b), B = (c, d)$ . Also; we have a cable with length  $s$  that connects these two points. Assume that  $m$  is the height of minimum point of this cable. Our goal is to approximate the value of this number by numerical methods.

### Solution:

It is known that the equation of a catenary in Cartesian coordinates has the form:

$$y = m \cosh\left(\frac{x}{m}\right).$$

Set

$$d - b = v, c - a = h.$$

Therefore,

$$v = m \cosh\left(\frac{c}{m}\right) - m \cosh\left(\frac{a}{m}\right),$$

$$s = m \sinh\left(\frac{c}{m}\right) - m \sinh\left(\frac{a}{m}\right).$$

We arrive at

$$s^2 - v^2 = 4m^2 \sinh^2\left(\frac{c-a}{2m}\right). \quad (1)$$

Finally,

$$s^2 - v^2 = 4m^2 \sinh^2\left(\frac{h}{2m}\right). \quad (2)$$

Now, set  $x = \frac{h}{2m}$ . We obtain

$$s^2 - v^2 = \frac{h^2}{x^2} \sinh^2 x.$$

Hence,

$$\frac{s^2 - v^2}{h^2} = \frac{\sinh^2 x}{x^2}.$$

Thus,

$$\frac{\sinh x}{x} = \sqrt{\frac{s^2 - v^2}{h^2}} = L.$$

Solving this equation is not easy. So we have to use numerical methods. In this regard, we set

$$f(x) = \frac{\sinh x}{x} - L.$$

Notice that since  $\frac{\sinh x}{x}$  varies very quickly, we can also set

$$g(x) = \log\left(\frac{\sinh x}{x}\right) - \log(L).$$

Now, using numerical methods, we look for the zeros of this function. Notice that the values of the variable L are known.

Since

$$\frac{\sinh x}{x} \approx \frac{e^x}{2x}$$

Thus, by using Padé approximant in this manner, we have

$$\frac{\sinh x}{x} \approx \frac{e^x}{2x} \approx \frac{1 + \left(\frac{1}{2}\right)x + \left(\frac{1}{9}\right)x^2 + \left(\frac{1}{72}\right)x^3 + \left(\frac{1}{1008}\right)x^4 + \left(\frac{1}{30240}\right)x^5}{x - \left(\frac{1}{2}\right)x^2 + \left(\frac{1}{9}\right)x^3 - \left(\frac{1}{72}\right)x^4 + \left(\frac{1}{1008}\right)x^5 - \left(\frac{1}{30240}\right)x^6} \tag{3}$$

Also, by using Padé approximant, we have

$$\frac{\sinh x}{x} = \frac{7x^2 + 60}{60 - 3x^2}. \tag{4}$$

For large values of L we use the first relation and for small values of L we use the second relation.

By using Newton's method, set  $x_0 = 0$ , we have Table 1 for the roots of the above equations.

**Table 1. Numerical solutions.**

| L    | x      |
|------|--------|
| 1.25 | 1.8273 |
| 1.75 | 1.9330 |
| 2.25 | 2.3796 |
| 2.75 | 2.7039 |
| 3    | 2.8384 |
| 3.25 | 2.9595 |
| 3.5  | 3.0696 |
| 4    | 3.2638 |
| 4.25 | 3.3503 |
| 4.5  | 3.4311 |

We can also use the approximations of differential equations to quantify this differential equation. Of course, this requires the use of other properties, of the catenary equation. These properties are based on the differential properties of a catenary.

### 3. Conclusion

The trend of financial market charts is often locally approximate to the exponential function chart. One of the best indicators that use the exponential function to approximate financial market charts is the Macd indicator. Figure 4 shows an example of this indicator in the financial market trend.



Figure 4: Macd Indicator

It is clear from the trend of the financial market chart that we are constantly dealing with uptrends and downtrends in the trend. The best combination of ascending and descending exponential functions is the hyperbolic function. So the idea of using hyperbolic functions to approximate the trend of a financial market is a logical idea. In this article, in addition to dealing with this idea, we try to examine specific cases of optimization on hyperbolic functions. Finding the maximum or minimum points in the process of a financial market is definitely one of the most important issues for financial market analysts. These points are actually entering or leaving of a financial market. In fact, in this article we have approximated the trend of a financial chart to a hyperbolic function. Then, by finding the numerical approximation of the minimum point of the financial market trend, we in fact found the entry point or the buying point approximately.

**Conflict of interest:** The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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