

# Technical Indicator for a Better Intraday Understanding of Uptrends or Downtrends in the Financial Markets using Volume Transactions as a Trigger

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## Abstract

This article presents the usefulness of a proposal for a technical indicator based on the On-Balance-Volume (OBV) and Simple Moving Average (SMA) indicators. The indicator proposal called Cumulative-Trend-Volume-Trigger (CTVT) identifies the volume of transactions in a bullish or bearish trend represented in a way that is easy to observe and interpret on the chart. This graphical information can be considered for analysts and intraday buying and selling decision-makers in the financial markets. The proposal indicator was coded and created through the MetaEditor of the MetaTrader 4 trading platform. The indicator represents the momentum of the price moved by a greater volume than that of the last ten periods. The signal is visible until the volume of the current price is lower than the volume of two previous periods, indicating a loss of momentum or the start of a retracement. The price represented graphically by candlesticks must be in an uptrend or downtrend, closing above or below the simple moving average indicator of 20, 50, and 100 periods. The indicator's behavior is illustrated in intraday time frames of five and 15 minutes, using the SP500 market scenery. The results show an indicator that is easy to interpret on the graph and guides decision-making supported by market behavior. The recommendation for traders when analyzing the Cumulative-Trend-Volume-Trigger (CTVT) indicator is to use other technical elements that complement their study to make a buying or selling action. Future research could improve this indicator based on the proposal code and conditions presented.

## Keywords

Financial Market, Trading Indicator, Chart Analysis, Scenario Building

## 1. Introduction


Financial markets have been considered complex systems and have grown rapidly and impressively [1]. As a result, scientific research has become critical, relevant, and growing, and its progress seeks to explain its behavior and direction to make better investment decisions [2]. In the field of technical analysis, there are two types of professionals, the traditional chartist, and the statistical technician. The traditional chartist, whether or not he uses quantitative data to support the analysis, graphs are his primary tool, the rest being secondary. The traditional chartist performs a subjective analysis based on the ability of the individual to complete the task,


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also called "artistic graphism," since the interpretation of the graph is an art [3]. The investor's graphical interpretation is a qualitative approach to various crucial economic research questions [4]. Its practices are typical for individual investors. It does not replace quantitative studies but complements them since attempts continue to explain and predict institutional behaviors in modern capital markets [4, 5, 6].

The trading decisions to get profits and losses will not be correct when the trader has identical scenarios and alternatives [7]. Many traders in the financial markets have shown an excess of confidence in their financial education [8] and a high tolerance for risk. As a result, they search for repairing imminent losses in their decisions, taking complicated positions [9, 10, 11]. If those positions are favorable in a risk scenario, their future decisions will be of equal or greater danger [12, 13, 14, 15]. This situation leads to individual retail investors not behaving reasonably in the financial markets [16], showing addiction to trading, and a compulsive gambling problem, where trading style is more active and speculative, with a daily frequency of investment in derivatives and leveraged products [17].

94% of traders use some technical analysis [18], and their operations have short-term performance predictability, seeking intraday returns or profits in the shortest time possible [19, 20, 21, 22]. Most trading systems and analyses in the financial market using technical indicators created based on patterns that produce buy and sell signals to operate in the market [23, 24]. The compositions of some indicators come from financial statements, qualitative descriptive financial indicators, and fundamental variables to capture the influence of the sectoral or institutional economic environment for investment predictions [2, 25]. Although technical indicators do not help much in market timing, and no strategy can predict future price actions and movements [24], year by year, the research in creating new techniques has increased to understand and try to predict its direction [26].

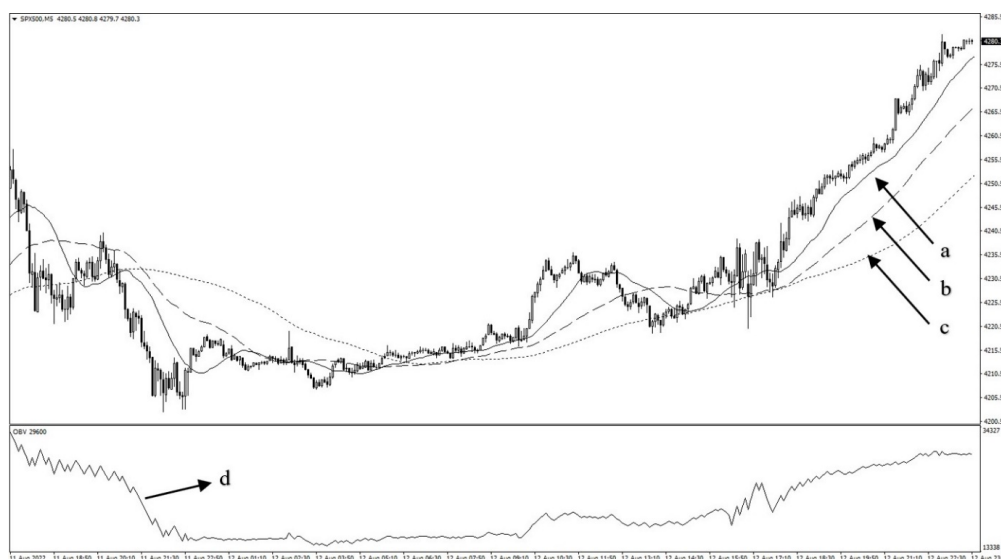
Academics, stock issuers, media representatives, and the Exchange Commission have been interested in learning more about long or short sales of financial products. For example, the way sellers can help correct short-term deviations of stock prices driven higher by its financial results [27]. Professionals have widely used technical signals, patterns, and indicators based on chart analysis. However, the scientific community's interest in conducting more academic studies addressing this topic is rising [2, 18, 28, 29]. For the individual investor and traditional chartist, charts are his primary tool, including those generated by technical indicators produced as a statistical result [3]. The primary purpose of financial traders is to choose the right time to place their investment positions [30], where the indicators are part of their analysis system in making their decisions. Research has proposed constant improvements to the existing indicators in search of a more valuable forecast [31].

Given the presented arguments, it is necessary to make an academic study of the existing literature and contribute to the technical analysis of individual traders seeking alternative market behavior interpretations. Therefore, this article proposes a technical indicator useful for price direction analysis and future decision-making that considers volume transaction that promotes price momentum in a bullish or bearish direction within a trend. For this purpose, within the technical indicators most used by professional operators, we find the simple moving averages (SMA) of 20, 50, and 100 periods [3, 32] and the On-Balance-Volume (OBV) calculated with the trading volume of a financial product at the closing price [33]. Therefore, both indicators are part of the proposal. As a scenario and for explanatory purposes, the SP500 index has been

chosen based on the underlying Standard & Poor's 500 stock market index, made up of 500 individual stocks that represent the market capitalizations of the largest US companies<sup>1</sup>.

## 2. Indicator description and rules composition

Technical indicators evaluate financial markets' depth [34] by applying mathematical formulas to the time series data of a financial product's opening, maximum, minimum, or closing prices to produce other valuable time data. This data helps forecast future trends or behavior of the financial market since they provide information that allows us to understand what has happened in the past and, from there, make decisions for the future [35]. For the present proposal, it is necessary to understand the composition of the following indicators: a) Simple Moving Average (SMA) of 20, 50, and 100 periods; and b) On-Balance-Volume (OBV), as can be seen in Figure 1. The function of each indicator is detailed below. The methodology for the algorithm construction used: first-step analysis of the problem, second-step design of variables, third-step design of the algorithm, fourth-step graphical design of the algorithm, and finally, implementation of the algorithm in a programming language [36].



**Figure 1:** 5-minute chart of the SP500 Stock Market Index. Statistical indicators on the graph: (a), (b), and (c) Simple Moving Averages (SMA) indicator of 20, 50, and 100 periods respectively; (d) On-Balance-Volume (OBV) indicator.

### 2.1. Simple moving average (SMA) indicator

Professional traders commonly use the Simple Moving Average (SMA) indicator [3, 32] as part of trading systems for decision-making [37, 38]. This indicator shows the value of the average

<sup>1</sup>Chicago Mercantile Exchange <https://www.cmegroup.com/markets/equities/sp/e-mini-sandp500.html>

price for a certain number of periods<sup>2</sup> [3]. Its calculation is as follows:

$$SMA = \frac{SUM(Close; N)}{N} \quad (1)$$

Simple Moving Average

- SMA = Simple Moving Average
- Close = Closing price
- N = Number of periods
- SUM(Close; N) = It is the sum of N periods

## 2.2. On-Balance-Volume (OBV) indicator

Volume indicators and their applicability for technical analysis give valuable information. Moreover, their relationship with price direction is positive, and traders who use this information obtain better results than those who do not [3, 39]. Joe Granville created the On-Balance-Volume (OBV) indicator in 1963 and measures buying and selling pressure as a cumulative indicator, adding volume on upside price closes or taking away volume on downside price closes. This indicator is helpful for chartists as they can find divergences and confirm trends<sup>3</sup> [40].

$$\begin{aligned} OBV &= OBV(prev) + Volume; Close - Close(prev) > 0 \\ OBV &= OBV(prev) - Volume; Close - Close(prev) < 0 \\ OBV &= OBV(prev); otherwise \end{aligned} \quad (2)$$

On-Balance-Volume (OBV)

- If the closing price is above the previous closing price, then:  
Current OBV = Previous OBV + Current Volume
- If the closing price is below the previous closing price, then:  
Current OBV = Previous OBV - Current Volume
- If the closing prices are equal to the previous closing price, then:  
Current OBV = Previous OBV (no change)

## 2.3. Proposal Cumulative-Trend-Volume-Trigger (CTVT) Indicator

The proposed indicator seeks to contribute to the analysis of financial markets with the following drawbacks:

- Using multiple indicators makes it difficult for traders to focus on decision-making, as they are overwhelmed by so much information to analyze on the chart.
- The simple moving average indicator (SMA) is a trend indicator that does not provide immediate action situations where the volume of transactions moves the price significantly.
- The On-Balance-Volume (OBV) indicator identifies the accumulated volume in one direction. However, it can provide erroneous signals as it does not have a price trend filter.



**Figure 2:** SP500 Stock Market Index 5-minute chart. Statistical indicators on the graph: (a), (b), and (c) Simple Moving Average (SMA) indicator of 20, 50, and 100 periods respectively; (d) On-Balance-Volume (OBV) indicator, (e) and (f) Cumulative-Trend-Volume-Trigger (CTVT) indicator.

The name of the proposed indicator is Cumulative-Trend-Volume-Trigger (CTVT). The indicator seeks graphically to show the upward and downward volume accumulation, evaluating the last ten periods and in a trend in favor. Based on the information provided by the On-Balance-Volume (OBV) indicator, prices close higher or lower than the previous price, driven by trading volume. The signal appears with a clear trend through the Simple Moving Average indicator (SMA) of 20, 50, and 100 periods, simultaneously, one on top of the other, indicating the harmony of the market direction. The price should close above or below the 20-period trendline. This combination avoids the non-directional biases of the price that, being in a trend, focuses the trader towards its impulse movement, confirmed by the volume of transactions that would be the trigger. As seen in Figure 2, the signal occurs on the chart, making it easier for the trader to recognize the moment it originates. The green color shows a bullish or buying opportunity, as seen in literal (e), while the red color is a bearish or sell signal, as can be seen in literal (f). The signal remains in effect until the current candle's closing price volume is lower than the last two periods, indicating that the volume strength is receding.

## 2.4. Cumulative-Trend-Volume-Trigger (CTVT) indicator coding

For the creation of the code, the application MetaEditor specializes in developing custom algorithms and indicators, whose programming language is MetaQuotes Language 4 (MQL4) and C++, oriented to high-level objects. Once coded and validated, the indicator is ready for application and execution on the MetaTrader 4 (MT4) platform<sup>4</sup>. The Simple Moving Average

<sup>2</sup>StockChart [https://school.stockcharts.com/doku.php?id=technical\\_indicators:on\\_balance\\_volume\\_obv](https://school.stockcharts.com/doku.php?id=technical_indicators:on_balance_volume_obv)

<sup>3</sup>StockChart [https://school.stockcharts.com/doku.php?id=technical\\_indicators:on\\_balance\\_volume\\_obv](https://school.stockcharts.com/doku.php?id=technical_indicators:on_balance_volume_obv)

<sup>4</sup>MetaQuotes <https://www.metatrader4.com/es/automated-trading/metaeditor>

(SMA) and On-Balance-Volume (OBV) indicators source codes are viable in the MT4 platform. The proposed code Cumulative-Trend-Volume-Trigger (CTVT) indicator has a sequence of 120 lines from the codes of the indicators already detailed in the same software, as it is presented in Listing 1.

Listing 1: Code Cumulative-Trend-Volume-Trigger (CTVT)

```

1 #include <stdlib.mqh>
2 #include <stderror.mqh>
3 ///-- indicator settings
4 #property indicator_chart_window
5 #property indicator_buffers 2
6 #property indicator_type1 DRAW_LINE
7 #property indicator_style1 STYLE_SOLID
8 #property indicator_width1 5
9 #property indicator_color1 0x00FF1A
10 #property indicator_label1 "Buy"
11 #property indicator_type2 DRAW_LINE
12 #property indicator_style2 STYLE_SOLID
13 #property indicator_width2 5
14 #property indicator_color2 0x0505F5
15 #property indicator_label2 "Sell"
16 ///-- indicator buffers
17 double Buffer1[];
18 double Buffer2[];
19 double myPoint; //initialized in OnInit
20 void myAlert(string type, string message)
21 {
22     if(type == "print")
23         Print(message);
24     else if(type == "error")
25     {
26         Print(type+" | Cumulative-Trend-Volume @ " + Symbol() + "," + ↵
                ↳ IntegerToString(Period()) + " | " + message);
27     }
28     else if(type == "order")
29     {
30     }
31     else if(type == "modify")
32     {
33     }
34 }
35 //+-----+
36 //| Custom indicator initialization function |
37 //+-----+
38 int OnInit()
39 {
40     IndicatorBuffers(2);
41     SetIndexBuffer(0, Buffer1);
42     SetIndexEmptyValue(0, EMPTY_VALUE);

```

```

43     SetIndexBuffer(1, Buffer2);
44     SetIndexEmptyValue(1, EMPTY_VALUE);
45     //initialize myPoint
46     myPoint = Point();
47     if(Digits() == 5 || Digits() == 3)
48     {
49         myPoint *= 10;
50     }
51     return(INIT_SUCCEEDED);
52 }
53 //+-----+
54 //| Custom indicator iteration function |
55 //+-----+
56 int OnCalculate(const int rates_total,
57                 const int prev_calculated,
58                 const datetime& time[],
59                 const double& open[],
60                 const double& high[],
61                 const double& low[],
62                 const double& close[],
63                 const long& tick_volume[],
64                 const long& volume[],
65                 const int& spread[])
66 {
67     int limit = rates_total - prev_calculated;
68     ///--- counting from 0 to rates_total
69     ArraySetAsSeries(Buffer1, true);
70     ArraySetAsSeries(Buffer2, true);
71     ///--- initial zero
72     if(prev_calculated < 1)
73     {
74         ArrayInitialize(Buffer1, EMPTY_VALUE);
75         ArrayInitialize(Buffer2, EMPTY_VALUE);
76     }
77     else
78         limit++;
79
80     ///--- main loop
81     for(int i = limit-1; i >= 0; i--)
82     {
83         if (i >= MathMin(5000-1, rates_total-1-50)) continue; //omit some ↯
84         ↵ old rates to prevent "Array out of range" or slow calculation
85
86         //Indicator Buffer 1
87         if(iOBV(NULL, PERIOD_CURRENT, PRICE_CLOSE, i) > iOBV(NULL, ↯
88             ↵ PERIOD_CURRENT, PRICE_CLOSE, 10+i) //On Balance Volume > On ↯
89             ↵ Balance Volume
90             && Close[1+i] > iMA(NULL, PERIOD_CURRENT, 20, 0, MODE_SMA, ↯
91             ↵ PRICE_CLOSE, i) //Candlestick Close > Moving Average

```



```

88      && Open[1+i] > iMA(NULL, PERIOD_CURRENT, 50, 0, MODE_SMA, ↵
      ↵ PRICE_CLOSE, i) //Candlestick Open > Moving Average
89      && Open[1+i] > iMA(NULL, PERIOD_CURRENT, 100, 0, MODE_SMA, ↵
      ↵ PRICE_CLOSE, i) //Candlestick Open > Moving Average
90      && iOBV(NULL, PERIOD_CURRENT, PRICE_CLOSE, i) > iOBV(NULL, ↵
      ↵ PERIOD_CURRENT, PRICE_CLOSE, 2+i) //On Balance Volume ↵
      ↵ > On Balance Volume
91      && iMA(NULL, PERIOD_CURRENT, 20, 0, MODE_SMA, PRICE_CLOSE, ↵
      ↵ i) > iMA(NULL, PERIOD_CURRENT, 50, 0, MODE_SMA, ↵
      ↵ PRICE_CLOSE, i) //Moving Average > Moving Average
92      && iMA(NULL, PERIOD_CURRENT, 50, 0, MODE_SMA, PRICE_CLOSE, ↵
      ↵ i) > iMA(NULL, PERIOD_CURRENT, 100, 0, MODE_SMA, ↵
      ↵ PRICE_CLOSE, i) //Moving Average > Moving Average
93  )
94  {
95      Buffer1[i] = Close[1+i] - 5 * myPoint; //Set indicator value at ↵
      ↵ Candlestick Close - fixed value
96  }
97  else
98  {
99      Buffer1[i] = EMPTY_VALUE;
100 }
101 //Indicator Buffer 2
102 if(iOBV(NULL, PERIOD_CURRENT, PRICE_CLOSE, i) < iOBV(NULL, ↵
    ↵ PERIOD_CURRENT, PRICE_CLOSE, 10+i) //On Balance Volume < On ↵
    ↵ Balance Volume
103     && Close[1+i] < iMA(NULL, PERIOD_CURRENT, 20, 0, MODE_SMA, ↵
    ↵ PRICE_CLOSE, i) //Candlestick Close < Moving Average
104     && Open[1+i] < iMA(NULL, PERIOD_CURRENT, 50, 0, MODE_SMA, ↵
    ↵ PRICE_CLOSE, i) //Candlestick Open < Moving Average
105     && Open[1+i] < iMA(NULL, PERIOD_CURRENT, 100, 0, MODE_SMA, ↵
    ↵ PRICE_CLOSE, i) //Candlestick Open < Moving Average
106     && iOBV(NULL, PERIOD_CURRENT, PRICE_CLOSE, i) < iOBV(NULL, ↵
    ↵ PERIOD_CURRENT, PRICE_CLOSE, 2+i) //On Balance Volume ↵
    ↵ < On Balance Volume
107     && iMA(NULL, PERIOD_CURRENT, 20, 0, MODE_SMA, PRICE_CLOSE, ↵
    ↵ i) < iMA(NULL, PERIOD_CURRENT, 50, 0, MODE_SMA, ↵
    ↵ PRICE_CLOSE, i) //Moving Average < Moving Average
108     && iMA(NULL, PERIOD_CURRENT, 50, 0, MODE_SMA, PRICE_CLOSE, ↵
    ↵ i) < iMA(NULL, PERIOD_CURRENT, 100, 0, MODE_SMA, ↵
    ↵ PRICE_CLOSE, i) //Moving Average < Moving Average
109 )
110 {
111     Buffer2[i] = Close[1+i] + 5 * myPoint; //Set indicator value at ↵
    ↵ Candlestick Close + fixed value
112 }
113 else
114 {
115     Buffer2[i] = EMPTY_VALUE;

```



```

116 |         }
117 |     }
118 |     return(rates_total);
119 | }
120 | //+-----+

```

### 3. Graphic result of the Cumulative-Trend-Volume-Trigger (CTVT) indicator, how it works, and its usefulness for intraday chart analysis

The utility of the Cumulative-Trend-Volume-Trigger (CTVT) indicator is at the moment of the decisive move by the market towards an upward or downward direction, following a trend and confirmed by the volume of transactions reason; it is named a trigger. In Figure 3, the origin points that are the most relevant signals are in literals (b) and (e), where the market harmonically seeks to initiate an upward trend, confirmed by the fact that the price closes on the simple moving average of 20, 50 and 100 periods. Its accumulated volume is greater than the last ten periods which is a movement that implies a decision. On the other hand, literals (c) and (f) certainly are indicator signals, not origin points. So, it is up to the operator to take them or not.

One of the advantages of the Cumulative-Trend-Volume-Trigger (CTVT) indicator is preventing the opening of wrong positions since you can have a growth in the accumulation of volume; however, they lack direction and harmony of movement in the market. We observe this in literals



**Figure 3:** The 15-minute chart of the SP500 stock market index shows the signals detected by the indicator (CTVT). Literal (a) false accumulation of bullish volume, (b) correct accumulation of bullish volume accompanied by a trend, (c) correct accumulation of bullish volume accompanied by a trend, (d) false accumulation of bullish volume, and (e) correct accumulation of bullish volume accompanied by a trend.

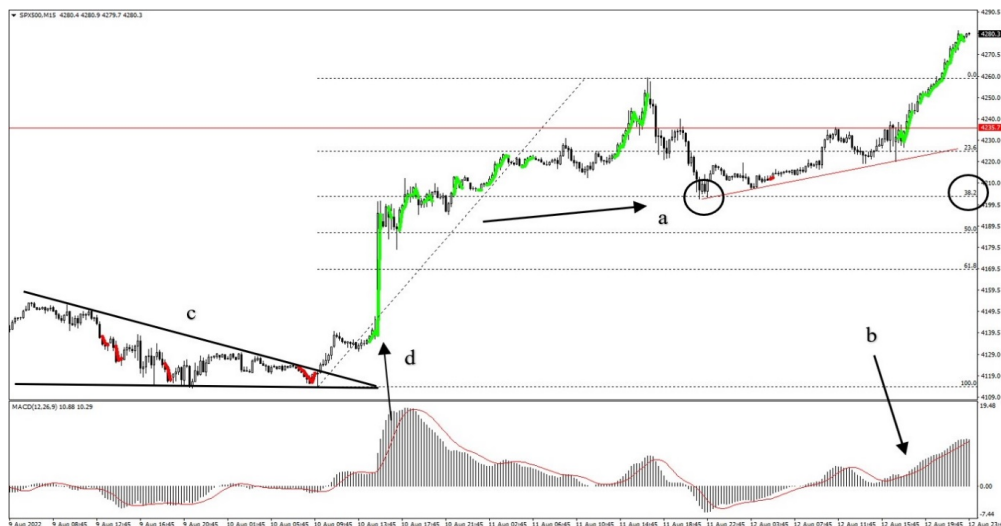


**Figure 4:** SP500 Stock Market Index 15-minute chart. The Cumulative-Trend-Volume-Trigger (CTVT) indicator is displayed over the price, showing buying (green) and selling (red) opportunities at times when the price is trending and has volume pushing in its favor.

(a) and (d) of Figure 3, where there is an upward direction of volume accumulation according to the On-Balance-Volume indicator. However, the price direction does not accompany it because they are below the 20-period Simple Moving Average (SMA) indicator. Therefore, since there is no harmony, there is no signal. Another advantage is the simplicity of the indicator and its easy observation. Figure 3 shows the indicator with its components on the chart. In Figure 4, we can see it without them, resulting in a cleaner graph with an indicator that evaluates the price trend and its accumulated volume of transactions, indicating trigger opportunities to buy or sell. In addition, the chartist technical analyst can combine his market study with other indicators, identifying movement patterns, price action, or swing trading, as seen in Figure 5.

#### 4. Limitations and future research

The Cumulative-Trend-Volume-Trigger (CTVT) indicator has the following limitations for its application, giving opportunities for future studies: (a) it provides valuable information on one-, five- and fifteen-minute intraday charts for technical analysts regarding volume and price direction; however, its buy and sell trigger signals must be accompanied by a complementary study of the chart for correct decision making; (b) it does not evaluate the broader context, such as the 30, 60 and 240-minute timeframes, nor daily or weekly charts; (c) to be used, its composition must be understood; otherwise ignorance can lead to ineffective decision making, (d) it was explicitly coded for the MT4 trading platform, for its application on other platforms can change the proposed code, (e) for the present study it has been evaluated only in the SP500 stock market index, (f) this is a study with a graphical perspective.



**Figure 5:** SP500 Stock Market Index 15-minute chart. Cumulative-Trend-Volume-Trigger (CTVT) indicator is shown on price combined with technical analysis and other indicators: (a) price rebound on Fibonacci 38.2% retracement, (b) MACD histogram, (c) triangle breakout, and (d) indicator (CTVT) showing a buying opportunity and confirmed by MACD indicator.

## 5. Concluding remarks

In this article, the Cumulative-Trend-Volume-Trigger indicator is proposed, which evaluates the direction of the price, considering the accumulated volume that drives it, giving the trigger signal when the price is in a trend. The current transaction volume is more significant than the ten previous periods. The indicator is simple to interpret and easy to observe on the chart, providing valuable information for the chartist's technical analysis of investors in the financial markets, preventing them from false signals that the market may provide. Decision-making must be based on complementary arguments and analysis, considering the behavior of the market in higher time frames. The proposed code is specific to be applied in the MT4 trading platform, leaving the code as a proposal to be evaluated, tested, and reformulated for future research and improvements.

## References

- [1] M. Gallegati, M. G. Richiardi, Agent based models in economics and complexity., 2009.
- [2] E. Domoto, K. Okuhara, A. O. N. Rene, Market forecasting by variable selection of indicators and emotion scores from text data, *Journal of Advanced Computational Intelligence and Intelligent Informatics* 26 (2022) 382–392.
- [3] J. J. Murphy, *Análisis técnico de los mercados financieros*, 332.632/M97tE, 2000.
- [4] B. Burton, *Qualitative research in finance—pedigree and renaissance*, *Studies in economics and finance* (2007).

- [5] J. Lintner, Distribution of incomes of corporations among dividends, retained earnings, and taxes, *The American economic review* 46 (1956) 97–113.
- [6] D. Kaczynski, M. Salmona, T. Smith, Qualitative research in finance, *Australian Journal of Management* 39 (2014) 127–135.
- [7] A. Tversky, D. Kahneman, The framing of decisions and the psychology of choice, in: *Behavioral decision making*, Springer, 1985, pp. 25–41.
- [8] T. Xia, Z. Wang, K. Li, Financial literacy overconfidence and stock market participation, *Social indicators research* 119 (2014) 1233–1245.
- [9] S. Diacon, J. Hasseldine, Framing effects and risk perception: The effect of prior performance presentation format on investment fund choice, *Journal of Economic Psychology* 28 (2007) 31–52.
- [10] P. J. Schoemaker, Are risk-attitudes related across domains and response modes?, *Management science* 36 (1990) 1451–1463.
- [11] I. Wahl, E. Kirchler, Risk screening on the financial market (risc-fm): A tool to assess investors' financial risk tolerance, *Cogent Psychology* 7 (2020) 1714108.
- [12] K. Bachmann, T. Hens, R. Stössel, Which measures predict risk taking in a multi-stage controlled decision process?, Bachmann, K., Hens, T., and Stössel (2016) 339–365.
- [13] G. Barron, I. Erev, Small feedback-based decisions and their limited correspondence to description-based decisions, *Journal of behavioral decision making* 16 (2003) 215–233.
- [14] R. Hertwig, G. Barron, E. U. Weber, I. Erev, Decisions from experience and the effect of rare events in risky choice, *Psychological science* 15 (2004) 534–539.
- [15] C. Kaufmann, M. Weber, E. Haisley, The role of experience sampling and graphical displays on one's investment risk appetite, *Management science* 59 (2013) 323–340.
- [16] P. Wilaiporn, C. Nongnit, C. Surachai, Factors influencing retail investors' trading behaviour in the thai stock market, 2021.
- [17] R. Cox, A. Kamolsareeratana, R. Kouwenberg, Compulsive gambling in the financial markets: Evidence from two investor surveys, *Journal of Banking & Finance* 111 (2020) 105709.
- [18] M. P. Taylor, H. Allen, The use of technical analysis in the foreign exchange market, *Journal of international Money and Finance* 11 (1992) 304–314.
- [19] H.-J. Lee, H. Choe, Individuals' return predictability in market and limit trades, *Asia-Pacific Journal of Financial Studies* 43 (2014) 59–88.
- [20] R. Kaniel, G. Saar, S. Titman, Individual investor trading and stock returns, *The Journal of finance* 63 (2008) 273–310.
- [21] L. Menkhoff, M. P. Taylor, The obstinate passion of foreign exchange professionals: technical analysis, *Journal of Economic Literature* 45 (2007) 936–972.
- [22] R. D. W. G., Half-day trading and spillovers, *Journal of Behavioral and Experimental Finance* 22 (2019) 105–115.
- [23] M. Ozturk, I. H. Toroslu, G. Fidan, Heuristic based trading system on forex data using technical indicator rules, *Applied Soft Computing* 43 (2016) 170–186.
- [24] P. Tharavanij, V. Siraprapasiri, K. Rajchamaha, Performance of technical trading rules: evidence from southeast asian stock markets, *SpringerPlus* 4 (2015) 1–40.
- [25] R. T. Takamatsu, L. P. Lopes-Fávero, Financial indicators, informational environment of emerging markets and stock returns, *RAUSP Management Journal* 54 (2019) 253–268.

- [26] H. A. do Prado, E. Ferneda, L. C. Morais, A. J. Luiz, E. Matsura, On the effectiveness of candlestick chart analysis for the brazilian stock market, *Procedia Computer Science* 22 (2013) 1136–1145.
- [27] K. B. Diether, K.-H. Lee, I. M. Werner, Short-sale strategies and return predictability, *The Review of Financial Studies* 22 (2009) 575–607.
- [28] Y.-H. Lui, D. Mole, The use of fundamental and technical analyses by foreign exchange dealers: Hong kong evidence, *Journal of International money and Finance* 17 (1998) 535–545.
- [29] Y.-W. Cheung, M. D. Chinn, Currency traders and exchange rate dynamics: a survey of the us market, *Journal of international Money and Finance* 20 (2001) 439–471.
- [30] H. Markowitz, Portfolio selection, *the journal of finance*. 7 (1), 1952.
- [31] D. Wen, L. Liu, Y. Wang, Y. Zhang, Forecasting crude oil market returns: Enhanced moving average technical indicators, *Resources Policy* 76 (2022) 102570.
- [32] J. Chan Phooi M'ng, R. Zainudin, Assessing the efficacy of adjustable moving averages using asean-5 currencies, *Plos one* 11 (2016) e0160931.
- [33] W. W. H. Tsang, T. T. L. Chong, et al., Profitability of the on-balance volume indicator, *Economics Bulletin* 29 (2009) 2424–2431.
- [34] M. Mursalov, Banking regulations and country's innovative development: the mediating role of financial development, 2020.
- [35] R. W. Colby, *The encyclopedia of technical market indicators*, McGraw-Hill, 2003.
- [36] E. F. M. Peñafiel, R. R. Miranda, W. Encalada, E. V. Villa, Methodology of construction of an algorithm for the systemic learning of first semester students of the tics subject, *KnE Engineering* (2018) 221–234.
- [37] L. I. Nickolaevich, G. I. Igorevna, R. D. Grigorievich, Generating a multi-timeframe trading strategy based on three exponential moving averages and a stochastic oscillator, *International Journal of Technology* 11 (2020) 1233–1243.
- [38] F. Gallegos-Erazo, Chat analysis of e-mini nasdaq-100 futures during the 2020 stock market crash, *Revista Universidad y Sociedad* 14 (2022) 452–461.
- [39] L. Blume, D. Easley, M. O'hara, Market statistics and technical analysis: The role of volume, *The journal of finance* 49 (1994) 153–181.
- [40] J. E. Granville, *Granville's New Key to Stock Market Profits*, Pickle Partners Publishing, 2018.