

Predicting Price Trends in the Wheat Market Using Technical Analysis Indicators

Paweł Oktaba

Narodowy Bank Polski, Oddział Okręgowy w Olsztynie, Poland

e-mail: pawel.oktaba@nbp.pl

ORCID: [0009-0003-8110-0184](https://orcid.org/0009-0003-8110-0184)

Małgorzata Grzywińska-Rapca

University of Warmia and Mazury in Olsztyn, Poland

e-mail: malgo@uwm.edu.pl

ORCID: [0000-0003-2088-2795](https://orcid.org/0000-0003-2088-2795)

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Abstract

Aim: The aim of the study was to determine the trend of wheat prices using technical analysis indicators.

Methodology: Selected technical analysis indicators were used to determine price trends. The parameters of two technical analysis indicators, modified from their default settings, were used to forecast price trends. The Parabolic Stop and Reversal (SAR) indicator, which is a valued trend indicator, was chosen. The second indicator used was the Relative Strength Index (RSI) oscillator, which is also popular with proponents of technical analysis. The data source used to forecast wheat price trends was information from the MetaTrader5 trading platform.

Results: The research analysis of the applied strategies shows that it is possible to realistically predict price trends on the wheat quotation market. There were two forecasts of the future price movement of wheat based on the indications of the indicators: (1) an indication to go long (in which case the investor should not expect a change in the trend) and (2) an indication to go short (both the SAR indicator and the RSI indicated a possible change in the trend to the downside).

Implications and recommendations: Based on the analysis conducted in the article, it was concluded that technical analysis tools are useful in predicting prices in the wheat futures market. The conducted analysis indicated that the application of technical analysis in predicting wheat futures prices is effective. Therefore, technical analysis indicators can be considered by investors as a tool to assist in making investment decisions in various markets, including the agricultural products market, and the use of technical analysis in price forecasting seems to be justified in the context of economic and geopolitical changes.

Originality/value: Due to the development of research methods and tools, it can be assumed that today's investors are looking for alternatives that allow them to reduce the time needed to gather and analyse market data. The presented approach to forecasting market prices based on technical analysis indicators showed that it can be used by a wider range of market participants than fundamental analysis, which requires more extensive econometric knowledge.

Keywords: technical analysis, Parabolic Stop and Reversal (SAR), Relative Strength Index (RSI), wheat prices

1. Introduction

Forecasting, in the sense of predicting future events on the basis of rational and scientific premise, enables new sources of information about the likely directions of change of a given economic phenomenon or process (Hamulczuk, 2011; Janecki, 2021; Skarżyńska, 2011; Sroka, 2022). Price forecasting can be an important source of information for many economic actors operating in different markets (Ayankoya et al., 2016; Oktaba and Grzywińska-Rapca, 2023; Świetlik, 2019; Zhang et al., 2020).

Investors use a variety of tools when trying to predict future price movements, but technical analysis tools such as candlestick patterns, moving averages, trend and resistance lines, as well as indicators are relatively popular. Technical analysis tools commonly used in behavioral finance include Bollinger Bands, Moving Average Convergence Divergence (MACD), Relative Strength Index (RSI), and Moving Averages. These tools aid in backtesting investment strategies, evaluating stock price movements, and forecasting future prices (Dicle and Levendis, 2017; Dongrey, 2022). Technical analysis tools therefore provide reliable signals for making investment decisions. The integration of Technical Analysis methodology into Behavioral Theory for large capitalization firms has shown a combination of fundamental rational and psychological-emotional irrational factors, enhancing trading rules performance over time (Olfer, 2022). Additionally, the application of technical analysis tools like Simple Moving Average, Bollinger Bands, and RSI has been extended to fields beyond finance, such as predicting magnetic storms based on Earth's magnetosphere data, showcasing the versatility and adaptability of these tools. The aim of the study is to determine the trend of wheat prices using technical analysis indicators (Vasiliou et al., 2008). In behavioural finance, pattern analysis is one of the methods used to understand market behaviour and investor decision-making. Pattern analysis in behavioural finance involves various techniques such as Hidden Markov Models (HMM) for detecting temporal patterns in financial data (Vijaya, 2016), Social Network Analysis combined with Multi-way Factor Analysis (MFA) to identify groups of similar behaviors and trajectories of actors in a network (Drusinsky, 2012), and Shannon entropy as a measure of behavioral trading patterns in financial markets, distinguishing between algorithmic and non-algorithmic traders (Liberati and Zappa, 2013). Additionally, cognitive limitations and selective attention play a significant role in investor behavior, as seen in the attention hypothesis developed around pricing patterns in the pharmaceutical sector (Rothman, 2017). These diverse approaches help in understanding the impact of behavioural factors on investment decisions and performance, providing insights for investors, financial planners, and investment advisors. Moving averages play an important role in behavioural finance, particularly in the context of technical analysis and trading strategies. Research shows that moving average (MA) principles are popular among financial market practitioners, and research examines the dynamics of

MA-based trading systems. These principles are used by both fundamentalist and chartist traders, with demand for the latter influenced by the difference between current and long-term MA prices (Chiarella, 2005; Gurrib, 2014). However, empirical evidence suggests that common moving average techniques may not be able to reliably predict stock market behaviour, with limited predictive power observed for various combinations of moving averages compared to market returns (Chiarella et al., 2005). Nevertheless, optimised moving average crossover strategies have shown the potential to outperform buy-and-hold strategies, particularly under certain market conditions, highlighting the importance of moving averages in shaping investment decisions (Chiarella et al., 2004).

Selected technical analysis indicators were used to determine price trends. The rationale for making forecasts using technical analysis was that, unlike econometric modelling or fundamental analysis, technical analysis can be a tool that is more frequently used in the economic environment. It can also be assumed that forecasts made using technical analysis are as accurate as those made using other tools. The empirical material for the forecasting exercise consisted of futures quotes from the Chicago Board of Trade¹ futures exchange.

In market terms, the analysed forecasts focused on one of the most important agricultural product markets – wheat. The object of the analysis was to forecast price trends in the wheat market.

2. Literature Review

Forecasting price movements under any economic conditions allows one to achieve the expected goals or predict the consequences of decisions (Banasiak, 2010, Gorton et al., 2013), and thus can be considered to some extent as a way of reducing investment risk (Gayed, 1990; Jajuga, 2009). Investors seeking to diversify their investment portfolios place their assets in different sectors, making the agricultural commodity market an attractive place to invest capital (Banasiak, 2010; Stevens, 2002). Forecasting prices using econometric methods is based on the assumption that the phenomenon being predicted is reflected in the number of determinants that influence it. As a tool that does not require the consideration of many factors, which can undoubtedly broaden the circle of users (not only analysts, but also individual investors), wheat price forecasting was carried out using technical analysis, employed to predict prices in stock, currency, commodity and futures markets (Hanczyk, 2021, Murphy, 2017, Picasso et al., 2019). Technical analysis, along with fundamental analysis and others, is a popular method to help investors make investment decisions (Borowski, 2017, 2020; Kaleta et al., 2020). While fundamental analysis focuses on examining the economic, financial and operational fundamentals of an asset or company in order to assess its intrinsic value and determine whether the current valuation is too low or overvalued, the aforementioned technical analysis is mainly used to forecast the price movements of selected financial assets by investors who invest their money in various instruments, most often in the stock market or foreign exchange market (Dolan, 2011; Nti et al., 2020; Rockefeller, 2019; Syamala Rao et al., 2023). Based on three basic premise (Murphy, 2017):

- The market discounts everything – i.e. it studies price formation over time and ignores factor analysis.
- Prices are trending – i.e. they move in the same direction over a period of time. These are the basic principles of technical analysis. The task of the technical analyst is to identify a trend and follow it until the first signs of a change in direction appear.
- History repeats itself – this principle is largely related to the study of the human psyche. The assumption is that just as the human psyche does not change, the shapes that appear on charts repeat themselves over a period of time. The idea, therefore, is that the key to understanding the future lies in analysing the past.

¹ MetaTrader5 investment platform from Oanda TMS.

Technical analysis does not guarantee that predictions made on its basis will always be correct, but no perfect forecasting method has yet been discovered that can accurately predict the future. There are many opinions that deny the possibility of using technical analysis to predict future price levels. Opponents of technical analysis believe that there is no evidence of its effectiveness and that if the predictions it makes are correct, it is only because market participants believe in its effectiveness (Hańczyk, 2021; Stevens, 2002;). According to Fama's (1970) Effective Markets Hypothesis (EMH), the weak form of the EMH assumes that the prices of securities reflect all available public market information but may not reflect new information that is not yet publicly available. It additionally assumes that past information regarding price, volume, and returns is independent of future prices. According to the theory of weak efficiency, it is not possible to obtain above-average profits using historical analysis of time series presenting the quotations of a given stock or other commodities. This concept calls into question the importance of technical analysis, which in the case of a market with poor performance cannot provide information allowing to "win against the market". Technical analysis, like other methods of predicting future market movements, is not a perfect method and does not take into account risk or fundamental factors. However, its skillful use, combined with the right trading system and risk management, increases the accuracy of investment decisions. Technical analysis is carried out on the basis of historical data of price movements and, and at the same time, using a selected indicator or group of indicators (ratios), forecasts are made of the potential future price movement of the asset in question. Technical analysis is based on the assumption that prices follow trends. The key question is whether the market trend will continue or whether there will be a change and, if so, in which direction (will the price rise or fall). The following technical analysis indicators are used to determine the moment of a trend reversal (Choudhry and Garg, 2008; Huang, et al., 2008; Murphy, 2017). The most popular oscillators² are the Relative Strength Index (RSI) and the Stochastic Oscillator (STS). When analysing certain time intervals³, it can be very helpful to use trend indicators, which represent the strength of the prevailing trend, giving more weight to the amplitude of price changes and the periods of analysis closest to the current one. Popular indicators in this category are the Momentum Index (CCI) and Momentum. There is also a category of indicators that are designed to help predict the price trend that a particular market is in. Among the most popular in this group of indicators are Bollinger Bands and, for example, the Parabolic Stop and Reversal (SAR) (Hassen, 2017). In addition to indicators, technical analysis also distinguishes price formations, creates trend lines and determines support and resistance levels, among other things (Grimes, 2012). A fundamental aspect of technical analysis is the concept of price trend, which refers to the likely direction of movement (up or down) of the price of an asset. The trend is of fundamental importance when deciding whether to buy or sell, because according to the principles of technical analysis, investments should always be made in line with the direction of price movements (Kahn, 2011). The literature distinguishes trends according to their duration (long-term trend lasting several months to several years, medium-term trend lasting several months, and short-term trend – several weeks).

The length of a trend can vary depending on the time interval observed (Shannon, 2008). For small time intervals it is possible to observe a trend change even several times in one trading session – *intraday trading*⁴ (Nison, 1995; Sincere, 2011). The most popular form of price representation among stock traders is the Japanese candlestick, conveying information about market sentiment and activity,

² Oscillators, i.e. indicators that oscillate between certain values and are used to read divergences, neutral market conditions or to assess the state of a market (overbought or oversold).

³ Time intervals are a fundamental concept in technical analysis. Charts of financial instruments are created from transmitted continuous quotes, which are graphically displayed on the trading platform in the form of price charts. The way in which price changes are displayed is determined, among other things, by the choice of time frame. For investments made within one day, shorter time intervals such as M1 or M5 can be chosen, while for observing long-term trends, investors use longer time intervals such as H4 or D1 (Kalista, 2021).

⁴ Intraday trading – an investment strategy that involves repeatedly opening and closing positions within a single day or trading session.

as well as potential future movements of the asset in question. Figure 1 shows examples of two candlesticks: (1) white (up) and (2) black (down).

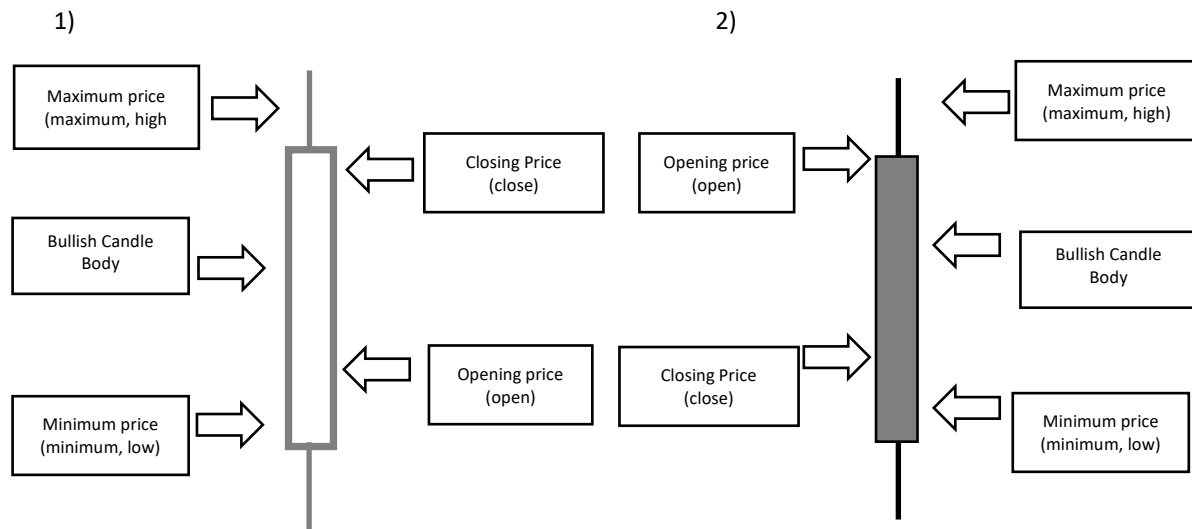


Fig. 1. Construction of a rising candlestick (a) and a falling candlestick (b)

Source: own work.

It should be noted that candlesticks can occur at different durations (time intervals) (Lejman-Gąska, 2018; Surdel, 2006;). The smallest (shortest) candlestick duration used in popular applications such as Metatrader is 1 minute (M1) and the longest is 1 month (MN). In summary, candlestick charts are formed from the opening, closing, maximum and minimum values recorded in a given time interval (range).

In summary, technical analysis and neoclassical theories of capital markets offer different perspectives and methodologies for understanding and predicting market behaviour. Advantages of technical analysis over neoclassical theories include:

- Focus on price action – technical analysis mainly focuses on the study of price movements and patterns in the market, rather than addressing the fundamental factors driving these movements. This can provide traders with insights into market sentiment and potential future price movements that may not be addressed by fundamental analysis alone.
- Quantitative approach – technical analysis often uses quantitative techniques, such as chart analysis and statistical analysis, to identify trends, support/resistance levels and other patterns in market data. These methods can offer traders systematic and objective decision-making tools, which can be particularly useful in fast-paced trading environments.
- Short-term trading opportunities – technical analysis is well suited to identifying short-term trading opportunities, focusing on identifying patterns and trends that can be exploited to profit in relatively short time frames. For this reason, it is popular with day traders and swing traders who seek to capitalise on short-term price movements.
- Adapting to market conditions – technical analysis techniques can be applied to a variety of asset classes and market conditions, including stocks, currencies, commodities and cryptocurrencies. Traders can adjust their technical strategies based on prevailing market conditions, allowing for greater flexibility and adaptability.
- Behavioural Finance – technical analysis incorporates elements of behavioural finance, which recognises that market participants do not always behave rationally and that market prices can be influenced by psychological factors such as fear, greed and herd behaviour. By studying price

patterns and investor sentiment, technical analysts seek to understand these behavioural trends and exploit them for profit.

- Risk management – technical analysis can also be used to manage risk, such as placing stop-loss orders and determining optimal entry and exit points for trades. By identifying key support and resistance levels, technical analysts can determine the risk/reward ratio and manage their positions accordingly.

In conclusion, technical analysis has its advantages, but it should be noted that it has its limitations and is not without its critics. Neoclassical theories, on the other hand, provide a broader framework for understanding the fundamental factors that drive market behaviour, such as economic growth, interest rates and corporate earnings. Ultimately, successful traders often combine elements of both technical and fundamental analysis in their decision-making processes to gain a more complete picture of the market.

3. Methodology

Information from the Metatrader5⁵ investment platform was used as the data source for forecasting wheat price trends.

The indicator – Relative Strength Index RSI (Relative Strength Index) – was presented by J. Welles Wilder Jr. in 1978, becoming one of the most popular and widespread technical analysis tools. It is designed to measure the magnitude of price movements, as well as the speed of price change in a given market. By default, the indicator focuses on the closing prices of the time series data, while this can be modified according to the analyst's preference. The RSI, according to its formula, measures the average rise and fall of prices in order to determine the zone in which the market is. This indicator takes values from 0 to 100 points, with the default range from 0 to 30 points being identified as the oversold state of the market, and the range from 70 to 100 points as the overbought state. The range from 30 to 70 points is called neutral. It is allowed to modify the ranges at any time, depending on the market on which the indicator is used (Wilder, 1978). The formula for calculating RSI indicator is as follows:

$$RSI_i = 100 - \left(\frac{100}{1 + \frac{U_{i,N}}{D_{i,N}}} \right), \quad (1)$$

where: $U_{i,N}$ – the average value of the positive price movement N of the session in the moment i ,
 $D_{i,N}$ – the average value of the negative price movement N of the session in the moment i
 (Juszczak and Balina, 2011b; Nowakowski and Borowski, 2003).

Parabolic SAR was also presented by Welles Wilder in 1978. The precise calculation of the Parabolic SAR depends on several key factors. The SAR starting point is set to the highest price reached at the start of a downtrend or the lowest price reached at the start of an uptrend. The SAR increment is the amount the SAR moves each period – it can start very small but increases exponentially as the trend extends. Each time the price reaches a new low (downtrend) or high (uptrend), that point becomes the new extreme point. The acceleration factor governs how fast the SAR increment increases – a higher value means the SAR dots will move faster, with the default being 0.02. Finally, the maximum increment puts a cap on how large the SAR increment gets, preventing the dots from moving unreasonably fast. The default maximum increment is 0.2. Based on these factors, the Parabolic SAR calculation steps through each period to identify the SAR value starting with the initial SAR point set at the trend's beginning. The increment is added to get the new potential SAR value for that period. It sets the SAR to the extreme point after assessing if the new SAR value has flipped to the other side,

⁵ <https://www.tms.pl/rynek/wykresy/WHEAT>.

starting a “Stop and Reverse”. This function gives the indicator its name and allows it to dynamically respond to shifts in trend momentum. The plotting of that dot on the chart indicates that the new SAR value has not switched. In the event that a new extreme point is achieved, that value serves as the starting point for the computation. The increment value is then increased (accelerated) based on the acceleration factor. This sequence repeats for the next period using the updated SAR and increment values. This allows the SAR indicator to accurately reflect trend momentum – the dots accelerate rapidly as the trend extends but slow down and eventually reverse when the trend shows weakness, signalling a trend change (Wilder, 1978). The Parabolic SAR indicator is calculated according to an algorithm using two formulas. The first one is used for long positions (uptrend):

$$PSAR(i) = (HIGH(i-1) - PSAR(i-1)) * AF + PSAR(i-1). \quad (2)$$

The second one – for short (downtrend):

$$PSAR(i) = (LOW(i-1) - PSAR(i-1)) * AF + PSAR(i-1), \quad (3)$$

where: PSAR – parabolic value – with index (i) – current, a z ($i-1$) preceding the calculated.

- HIGH – maximum price.
- LOW – minimum price.
- AF (Acceleration Factor). Its value increases with the step set for each period when new price extremes are reached. Wilder recommends using an initial coefficient of 0.02, which increases by 0.02 with each new bar until it reaches a maximum of 0.2.

AF Formula:

$$AF = 0,02 + ix * K, \quad (4)$$

where:

- ix – the number of periods accumulated since the beginning of the calculation;
- K – price change step, which defaults to 0.02 (Wilder, 1978).

In the investment strategy presented in this article, the parameters of two technical analysis indicators were modified from their default settings. It was decided to use the Parabolic Stop and Reversal (SAR) indicator, which is a valued trend indicator. The second indicator chosen was the Relative Strength Index (RSI) oscillator, which is very popular among technical analysis followers, and is designed to measure the strength of a trend (Wilder, 1978). Most technical analysis indicators have the ability to be customised, i.e. to change their settings to better suit a particular market. In the research conducted for this article, modifications were made to both the Parabolic Stop and Reversal (SAR) and Relative Strength Index (RSI) indicators. In the case of the former, the 'step' parameter was set to 0.01 and the 'max' parameter to 0.015 (the default values were 0.02 for the step and 0.2 for the max). This modification reduced the number of potential trading signals, but had a positive effect on the quality (accuracy) of the generated indications. The parameters of the RSI indicator were also modified. While the number of periods taken into account in the calculation remained unchanged (14), the levels of the indicator related to indications of a change in trend were changed to 40 and 60 (the default was 30 and 70).

4. Results

The analysis of the research carried out on the examined strategy showed that it is realistically possible to predict price trends in the wheat quotation market. The changes made in the default indicator parameters allowed for the identification of undisturbed trends. From Q1 2013 to Q3 2023, 34 price trends determined on the basis of the above strategy were observed, covering daily time intervals (D1).

The average duration of a price trend during this period was 111 days. The average price movement (increase or decrease in prices) in the direction indicated by the strategy discussed in the article was 14% of the indication price, whilst 26 out of a total of 34 trend change indications had a price movement in the direction indicated by the strategy of at least +5%. In 19 cases there was a movement of at least +10%, in 13 cases there was a movement of more than 15% and in 7 cases there was a movement of more than 20%. It should be stressed that there were no situations where the price did not 'move' in the expected direction after the strategy indication, but there were still two indications at the level of price movements of only 0.94% and 0.95%. Moreover, due to the relatively long average duration of the trend in the strategy in question and the specific nature of the wheat asset (as opposed to the 'shares' of a listed company, which are supposed to grow as much as possible), the quotations of this commodity move in a horizontal trend⁶ fluctuates according to the season and other events. Within the strategy indications, there were also unfavourable price movements after the moment of the trend reversal indication. The average price movement in the direction opposite to the indicators was 7%, compared to an average movement in line with the indicators of 14%. In only two cases was the move against the indicator more than 14% i.e. the average for the correct indicators (Table 1).

Table 1. Performance of the strategy based on parabolic SAR and RSI indicators for the period from Dec 2012 to Sept 2023

Specification	Date of occurrence of the signal	Duration (days)	Signal Type	Opening Price \$/Bushel	Extreme price movement after a signal occurs (%)	
					as indicated in	against the indication
1	11.12.2012	290	Downward	\$8.20	25	1
2	30.09.2013	43	Growth	\$6.80	4	5
3	13.11.2013	110	Downward	\$6.45	15	5
4	04.03.2014	86	Growth	\$6.42	16	2
5	30.05.2014	180	Downward	\$6.30	26	0
6	28.11.2014	56	Growth	\$5.77	17	9
7	26.01.2015	150	Downward	\$5.22	12	4
8	26.06.2015	35	Growth	\$5.66	8	13
9	03.08.2015	259	Downward	\$5.00	12	6
10	19.04.2016	62	Growth	\$4.84	8	6
11	21.06.2016	197	Downward	\$4.57	15	3
12	05.01.2017	78	Growth	\$4.25	12	3
13	27.03.2017	72	Downward	\$4.19	1	10
14	08.06.2017	55	Growth	\$4.50	27	1
15	03.08.2017	187	Downward	\$4.55	10	7
16	07.02.2018	131	Growth	\$4.60	20	4
17	25.07.2018	48	Growth	\$5.43	10	7
18	12.09.2018	142	Downward	\$5.05	4	7
19	20.02.2019	89	Downward	\$4.87	14	2
20	21.05.2019	80	Growth	\$4.78	17	3
21	12.08.2019	65	Downward	\$4.73	5	10
22	17.10.2019	133	Growth	\$5.25	13	5
23	28.02.2020	25	Downward	\$5.20	5	11
24	25.03.2020	34	Growth	\$5.78	1	11
25	29.04.2020	76	Downward	\$5.15	8	6

⁶ A horizontal trend, also known as a sideways trend, can be defined as the absence of an uptrend or downtrend. In such a case, the price moves along a horizontal axis on the chart with relatively small deviations (Murphy, 2017).

Specification	Date of occurrence of the signal	Duration (days)	Signal Type	Opening Price \$/Bushel	Extreme price movement after a signal occurs (%)	
					as indicated in	against the indication
26	15.07.2020	252	Growth	\$5.48	26	11
27	25.03.2021	25	Downward	\$6.15	4	10
28	20.04.2021	57	Growth	\$6.60	17	3
29	17.06.2021	43	Downward	\$6.38	4	14
30	02.08.2021	156	Growth	\$7.28	20	7
31	06.01.2022	43	Downward	\$7.43	1	12
32	22.02.2022	111	Growth	\$8.48	59	15
33	17.06.2022	368	Downward	\$10.32	45	1
34	21.06.2023	50	Growth	\$7.35	6	16
Average		111		\$5.85	14	7

Source: own elaboration based on MetaTrader5.

Figure 2 shows wheat prices in weekly candlesticks (W1) from April 2019 to September 2023.



(X-axis – time, Y-axis – price in US dollar cents per 1 bushel of wheat⁷)

Fig. 2. Wheat prices in the period April 2019 – September 2023, Chart W1 – weekly candles.

Source: in-house analysis based on MetaTrader5.

The start of the uptrend was set at a price of around \$4.2 per bushel, a relatively low price level compared with the whole of the previous decade. The second point reference level, the price level at the turn of June and July 2020, was set for the entire uptrend – the local price minimum at that time. Point 2 in the figure marks the area on the chart where the upper channel of the trend first acted as

⁷ On the largest commodity exchange in Chicago, wheat is quoted in US dollar cents per 1 bushel – the equivalent of 27.2 kg (Juszczak and Balina, 2011).

resistance (the price only briefly rose above the indicated level and then fell below it) and then as support before further growth. Point 3 marks the beginning of the war in Ukraine and the massive price spike that followed. From the point of view of a technical analyst, it is clear that this rally was in line with the trend that had been in place for many weeks – while the magnitude of the rally was a surprise. Points 4 and 5 are the levels on the trend line that acted as support during the price correction that occurred as time went on and investor attitudes changed. In both cases (numbers 4 and 5), one can see how the price 'bounced' off the level set, first by the upper and then by the lower channel of the trend line. It can be predicted that in future the price of wheat will try to 'meet' the lower channel of the trend determined in the drawing, while according to the art of technical analysis it is also necessary to determine the channel of the downward trend, starting from the price highs of spring 2022.



Fig. 3. Chart D1 of wheat price quotations with indicators indicated

Source: in-house analysis based on MetaTrader5.

Figure 3 presents three different situations due to the indications of the indicators that make up the investment strategy discussed in the article. One can distinguish two states (predictions about the future price movement) due to the indications of indicators.

An indication to take a long position (uptrend): the position of the SAR indicator below the price chart, while the RSI indicator reaches a value greater than or equal to 60 points during the close of a given candlestick – the implementation of the above conditions is to give a signal for a potential change of the trend to the upward trend (price increase). Indications for taking a long position are marked in the figure as situation no. 1 and situation no. 3. In the case of situation no. 1, the Parabolic SAR indicator changed its position to a place below the price chart – an indication to take a long position, while the RSI indicator did not reach the level of 60 points – there was no indication to take a long position. In this case, the investor (observer) should not expect a change in the trend because the indicated signal is potentially false, which was confirmed in the situation at that time – the price of the asset (wheat) did not change the trend to an upward trend. A different course of events took place in situation no. 3, where both the SAR indicator and the RSI indicated a change in trend.

An indication to take a short position: placing the SAR indicator above the price chart, while the RSI indicator reaches a value less than or equal to 40 points during the close of a given candlestick – the implementation of the above conditions is to give a signal for a potential change of the trend to the downside (price drop). The implementation of the above-mentioned conditions was met in situation no. 2, presented in Figure 3. In this case, both the SAR and RSI indicators indicated a potential downward trend change, and the price fell as indicated.

5. Discussion and Conclusions

On the basis of the analysis carried out in this article, it can be concluded that technical analysis tools are useful in predicting prices on the wheat futures market. On the one hand, this may indicate that the use of technical analysis in forecasting the prices of wheat contracts is effective. On the other hand, opponents of technical analysis believe that there is no evidence of its effectiveness, and if the use of its tools works, it is only because investors believe in its effectiveness. If traders believe that the downtrend will stop at a given level of the Fibonacci retracement grouping, then when prices reach a certain support area, they start buying the financial asset. An increase in demand therefore leads to an increase in prices and a real reversal of the downward trend. On the basis of the analysis carried by the authors, it was shown that a number of popular Fibonacci ratios can be found on the wheat futures market (0.382, 0.618, 1.618, 2.382 etc.). It follows that either technical analysis is an effective tool for forecasting the price of wheat futures, or there is a sufficiently large group of short-term investors (speculators) in the wheat futures market who use technical analysis to forecast prices and the support/resistance levels they set are visible in the analysed market. This is because these investors use similar programs and tools of technical analysis. With the help of Fibonacci ratios, they determine future areas of support/resistance and when prices reach these levels, they enter into buy/sell trades. However, there must be a sufficiently large and, above all, having large capital, group of investors whose investment decisions have a key impact on the upward price movement (or downtrend). Therefore, this may indicate that the wheat futures market has become an attractive place for financial market participants to invest their funds, wanting to diversify their investment risk in this way. Yet, it should be emphasised that a large number of speculations on the futures market for wheat (as well as other agricultural commodities) can lead to excessively high (or low) price levels, the source of which cannot be explained on the basis of the values of fundamental indicators, such as the level of consumption or the level of production of a given agricultural commodity.

Investment methods based on technical analysis have shown varying degrees of effectiveness. Studies have highlighted that technical analysis can still be favored by investors, leading to positive returns and portfolio protection during market turmoil (Arshanapalli et al., 2020; Trembiński and Stawska, 2020; Zhilei, 2022). Research has evaluated the performance of different technical analysis indicators, showing significant differences in returns compared to a buy-and-hold strategy across various market indices (Abbasi et al., 2020). Additionally, the combination of technical analysis with real-time identification of financial bubbles has been found to outperform a buy-and-hold strategy, particularly during market instability (Wang et al., 2019). Furthermore, incorporating deep neural networks with technical indicators has demonstrated significant effects in stock price prediction and return on investment, showcasing the potential of advanced technologies in enhancing technical analysis methods.

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Prognozowanie trendów cenowych na rynku pszenicy za pomocą indyktorów analizy technicznej

Streszczenie

Cel: Celem badania jest wyznaczenie za pomocą indyktorów analizy technicznej trendów cenowych pszenicy.

Metodyka: Do wyznaczenia trendów cenowych zastosowano wybrane indykatory analizy technicznej. Do prognozowania trendów cenowych zastosowano zaś zmodyfikowane względem domyślnych ustawień parametry dwóch wskaźników analizy technicznej. Zdecydowano się na wybór indykatora *Parabolic Stop and Reversal* (SAR), będącego cenionym wskaźnikiem trendu. Jako drugi indyktor wybrano popularny wśród zwolenników AT oscylator *Relative Strength Index* (RSI). Źródłem danych wykorzystanych do prognozowania trendów cenowych pszenicy są informacje pochodzące z platformy inwestycyjnej MetaTrader5.

Wyniki: Przeprowadzone analizy badań dotyczących zastosowanych strategii wskazują na realną możliwość przewidzenia trendów cenowych na rynku notowań pszenicy. Wyróżniono dwie prognozy odnośnie do przyszłego ruchu cenowego pszenicy ze względu na wskazania indyktorów: (1) wskazanie do zajęcia pozycji długiej (w tym przypadku inwestor nie powinien oczekiwać zmiany trendu) i (2) wskazanie do zajęcia pozycji krótkiej (indykatory zarówno SAR, jak i RSI wskazały na potencjalną zmianę trendu na spadkowy).

Implikacje i rekomendacje: Na podstawie analizy przeprowadzonej w artykule można stwierdzić, iż narzędzia analizy technicznej są przydatne w przewidywaniu cen na terminowym rynku pszenicy. Wskazuje ona, że zastosowanie analizy technicznej w prognozowaniu cen kontraktów na pszenicę jest efektywne. W związku z powyższym indykatory analizy technicznej mogą być traktowane przez inwestorów jako narzędzie wspomagające w podejmowaniu decyzji inwestycyjnych na różnych rynkach, w tym na rynku produktów rolnych, a wykorzystanie analizy technicznej w prognozowaniu cen wydaje się uzasadnione w kontekście zmian ekonomicznych i geopolitycznych.

Oryginalność/wartość: W związku z rozwojem metod i narzędzi badawczych można przypuszczać, że dzisiejsi inwestorzy poszukują alternatyw pozwalających im skrócić czas gromadzenia i analiz danych rynkowych. Zaprezentowane podejście prognozowania cen rynkowych bazujące na indykatorach analizy technicznej wskazuje, że może być ona stosowana przez szersze grono uczestników rynku aniżeli analiza fundamentalna wymagająca szerszej wiedzy ekonometrycznej.

Słowa kluczowe: analiza techniczna, *Parabolic Stop and Reversal* (SAR), *Relative Strength Index* (RSI), ceny pszenicy
