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Methodology for Building Trader's Investment Strategy Based on Assessment of the Market Value of the Company

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Abstract:

Purpose: *The purpose of this research is the formation of a methodology for investment decision making by a trader in the stock market, based on the enterprise value indicators.*
Design/Methodology/Approach: *The methodology for making investment decisions of a stock trader is based on a method of descriptive statistics used to describe the findings of the analysis of the dynamics of selected indicators characterizing the level of the company's shares market value, a method of grouping statistical data used in the process of forming groups of selected indicators characterizing the level of shares market value, a combinating method used for building a trader's investment strategy and choosing the optimal combination of financial indicators (as well as ranking the formed combinations by profitability) that characterize the level of the market value of the company's shares in the process of investment decision making.*
Findings: *The findings of the study revealed that to eliminate financial risks and increase the efficiency of trading operations in the stock market, the trader's investment strategy can be based on an economic and mathematical analysis of a set of indicators that evaluate the company's market value. The combinatorics method and regression analysis method can be efficiently used as methods of building a trader's investment strategy.*
Practical Implications: *The proposed methodology allows to comprehensively assess the level of the enterprise value and on the basis of which is possible to develop an effective trader's investment strategy, which can become a practical tool in conducting investment operations.*
Originality/Value: *The use of the combinatorics method allows us to adjust the trading (investment) strategy of the trader to the specifics of the external and internal factors of functioning of each individual company and also provide a comprehensive tool for investment decisions making.*

Keywords: *Stock market, trader strategy, investment decisions, company value, combinatorics method.*

JEL codes: *C02, C58, E22, G32*
Paper type: *Research article.*

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1. Introduction

Investment operations in stock markets have always been associated with a high level of capital risk. Whether a trader will be successful or not on trading floors is largely determined by the chosen investment strategy, which, in its turn, depends on the trader's behaviour, their degree and experience (Primbs and Rathinam, 2009; Garvey and Wu, 2010; Frydman *et al*., 2014; Tauni *et al*., 2019; Thalassinos *et al.,* 2015). The psychological aspects of trading often cause a conflict between the trader's theoretical and empirical knowledge (Andrikogiannopoulou and Papakonstantinou, 2019; Frydman and Wang, 2019; Mourali and Lakhal, 2020; Ferrouhi, 2020). A good background can be helpful in day-to-day operations on the one hand, yet harmful on the other.

A theoretically savvy trader is trying to identify all possible patterns in the market, take into account the basic fundamental indicators, or at least wait for the new market trend to be confirmed on the chart by using several technical indicators.

An experienced trader, even the one who lacks good theoretical background, bases their strategy on the simple algorithms, indicators, facts and patterns obtained empirically (Imas, 2014; Nachum *et al.,* 2016; Cueva *et al.,* 2019; He *et al.,* 2020; Ryu and Yang, 2020). On the one hand, such a strategy is less scientifically sound, on the other hand, it allows a trader to quickly navigate in the current market situation and make adequate investment decisions.

The information flow is also considered an important factor in effective exchange activities (Fortunato *et al.,* 2020; Anyikwa and Roux, 2020; Zhang *et al.,* 2020; Li *et al.,* 2020; Thalassinos and Stamatopoulos, 2015). Obtaining timely and reliable information, which could be used for making the right investment decision, used to be a fairly challenging task for a trader. Nowadays, although the information is abundant, it is becoming increasingly difficult. to make the right investment decisions.

Indeed, neither news or international rating agencies reports nor articles from specialized magazines, neither opinions of blogging traders or well-known analysts nor company's financial reports as well as plethora of analytical information support a trader in the process of decision making (Corgnet *et al*., 2015; Asparouhova and Bossaerts, 2017; Ugurlu *et al.,* 2014). This is evident from the official data of brokerage companies regarding the percentage of registered loss-making accounts. The following companies can serve as examples of this trend (the country where the company's head office is registered, and the percentage of loss-making accounts are indicated in brackets): Plus500CY (Cyprus, 80.6%) (Internetowy handel, 2020); FxPro UK Limited (United Kingdom, 79.0%) (FxPro, 2019); XTB Online Trading (Poland, 79.0%) (Forex, Surowce, 2019); Dukascopy Bank SA (Switzerland, 77.73%) (ECN Broker, 2019); Dom Maklerski TMS Brokers S.A. (Poland, 76.0%) (Forex, CFD, 2019); mBank SA, Dom Maklerski Mforex (Poland, 76.0%) (Forex ECN, 2019.); GAIN Capital UK Limited (Great Britain, 70%) (Forex trading, 2019).

The data show that less than 30% of successful traders are currently operating in the market in spite of the fact that each of the listed brokerage companies has at its disposal such tools as news channels and blogs, paid training programs and free knowledge bases, including video tutorials as well as ongoing situation forecasts made by the best company analysts, fundamental and technical data on almost every trading instrument as well as information on what positions according to particular trading instruments the company's clients are currently occupying on their trading accounts in percentage terms (Corgnet *et al.,* 2018).

Thus, the subject of the research is relevant and timely as the development of a scientifically sound, long-term trader's investment strategy is an indispensable condition for their effective activity in the financial markets. The purpose of the research is formation of methodology for investment decision making by a trader trading in the enterprise shares in the stock market, based on the analysis of the enterprise value indicators. The international CIECH group and its shares market value quarterly indicators for the period 2006-2018 were used as the subject of the research. The data for the research were taken from the Biznes Radar (Wskaźniki wartości rynkowej CIECH SA, 2019).

Studies devoted to the enterprise value assessment (Kossovsky *et al.,* 2004; Bird and Casavecchia, 2007; Gębka, 2014; Müller, 2014; Gómez-Navarro *et al.,* 2018; Sturm, 2020) as well as scientific rationale for trader's investment decision making served as theoretical framework of this scientific research. Among other scientific articles, it is possible to distinguish works on the study of the stock market uncertainty factor based on the measurement of its entropy. Such a measurement of entropy allowed the scientists to establish the interdependencies between the level of uncertainty in the functioning of the stock market and the stability of the functioning of individual entrepreneurial structures and the national economy as a whole and scientifically justified long-term investment in the stock market (Ahn *et al.,* 2019; Oriol and Veryzhenko, 2019; Abreu and Mendes, 2020; Cordi *et al.*, 2020; Kim and Ryu, 2020; Li *et al.,* 2020; Gao *et al.*, 2020).

Scientists also widely utilize various methods of mathematical modelling for building the trader's investment strategy such as modelling based on the α-stable distribution; diffusion models of affine jumps; hyperbolic models; stochastic volatility models based on Lévy processes (Xu *et al.,* 2011; Boubaker and Makram, 2012; Zhao *et al.*, 2020; Dong *et al.*, 2020; Özer *et al.*, 2020; Li *et al.,* 2020). Also, the interdependencies between stock returns in the stock market as well as stability and real growth of the national economy are being actively studied by the scientists in order to provide scientific justification of an effective trader's investment strategy. These studies are carried out using the method of uneven weighted cross-correlation (Guo, 2015; Bunting and Kevin, 2015; Bao *et al.,* 2016; Forner and Vázquez Veira, 2019). Based on the use of the simple and multiple regression method, scientists study the effect of operating results and company financial stability on the level of stock prices in the stock market (Dehuan and Jin, 2008; Atkeson *et al.*, 2017; Su and Wang, 2020; Takács

et al., 2020). In the formation of the trader's investment strategy the fundamental analysis and multi-criteria of decision-making methods are widely used (MCDM) (Duong *et al.*, 2010; Pätäri *et al.*, 2018; Kirat and Rezaee, 2019; Spyrou, 2019; Pham *et al.*, 2020; Aladesanmi, 2020; Khan, 2020; Schmitt *et al.*, 2020).

In the mentioned scientific papers, researchers investigate the mechanisms of the functioning of corporate structures and the stock market under various aspects, proposing the indicators of the market situation development. Based on this research, scientists provide the model of the trader's investment decision making.

2. Research Methodology

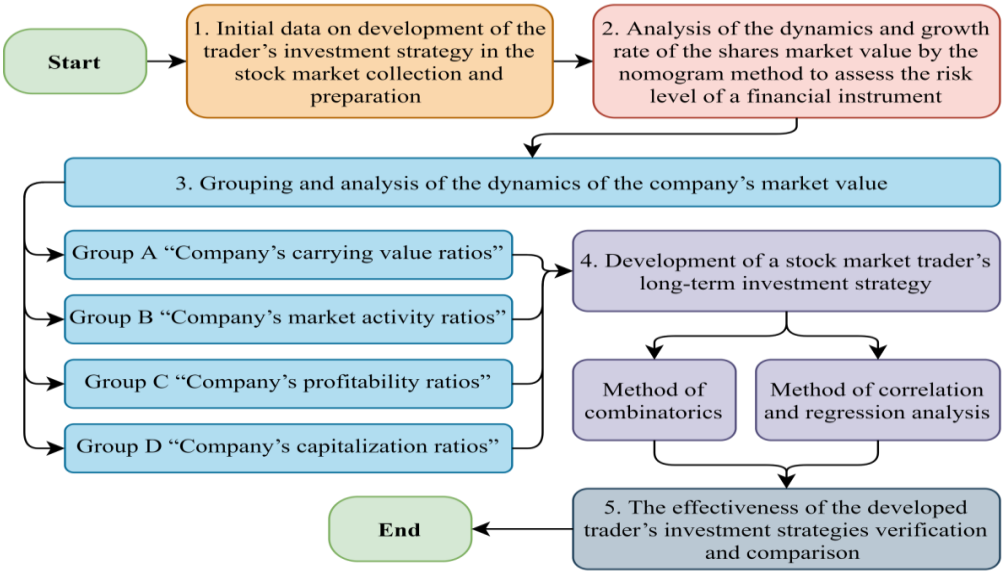
The methodology for making investment decisions of a stock trader is based on the following methods and techniques:

- a method of descriptive statistics is used to describe the findings of the analysis of the dynamics of selected indicators characterizing the level of the company's shares market value. According to the hypothesis, these indicators can change the market conditions (affect the formation of consumer demand or supply for company's shares);
- a method of grouping statistical data is used in the process of forming groups of selected indicators characterizing the level of shares market value;
- combinatorics method is used for building a trader's investment strategy and choosing the optimal combination of financial indicators (as well as ranking the formed combinations by profitability) that characterize the level of the market value of the company's shares in the process of investment decision making;
- the method of correlation analysis is used to reach the following goals: firstly, to identify the correlations between the change in the shares market value during the period t and changes in the selected ratios during the period t-1; secondly, to reduce the selected ratios when forming the economic and mathematical model that allows forecasting the company's shares market value depending on the values of the selected indicators; thirdly, to determine the optimal combination of the selected indicators by calculating their individual and integral information capacity;
- the Hellwig method is used for including optimal variables in the economic-mathematical model, which is the basis for building a trader's investment strategy using the method of correlation and regression analysis;
- the method of regression analysis for building and evaluating the statistical significance of the developed economic-mathematical model.

During the research, four groups of indicators for measuring the company's market value were formed: Group A – company's carrying value ratios; Group B – company's market activity ratios; Group C – company's profitability ratios; Group D – company's capitalization ratios.

The general scheme of the research methodology is presented in Figure 1. The proposed methodology allows to comprehensively assess the level of the enterprise market value and on this basis to form an effective trader's investment strategy.

Figure 1. *General outline of the research methodology*



Source: *Developed by the authors.*

The proposed methodology allows to comprehensively assess the level of the enterprise market value and on this basis to form an effective trader's investment strategy.

3. Analysis of the Dynamics and Growth Rate of the Company's Shares Market Value

A trader's job in the stock market involves carrying out trading operations with securities, the purpose of which is to generate income. In the process of conducting trading operations, the trader needs to thoroughly analyze the information coming from the stock market and quickly respond to emerging changes, thereby making investment decisions. The trader's working day begins with the selection and analysis of financial investment instruments. Moreover, each trader has their own original vision of the market and forms their own market strategy.

In this research, it is proposed to develop a methodology for trader's investment decision making in the stock market by analyzing the company's market value ratios. The object of the research is the international corporation CIECH, operating in the chemical industry sector. The shares of this company have been quoted since 2005 on the Warsaw Stock Exchange (Główny Rynek GPW, 2019), and since 2016 - on Börse Frankfurt (parallel quotation). The total number of shares as of May 25, 2019 amounted to 52.699.909 shares, and the total capitalization of the company amounted

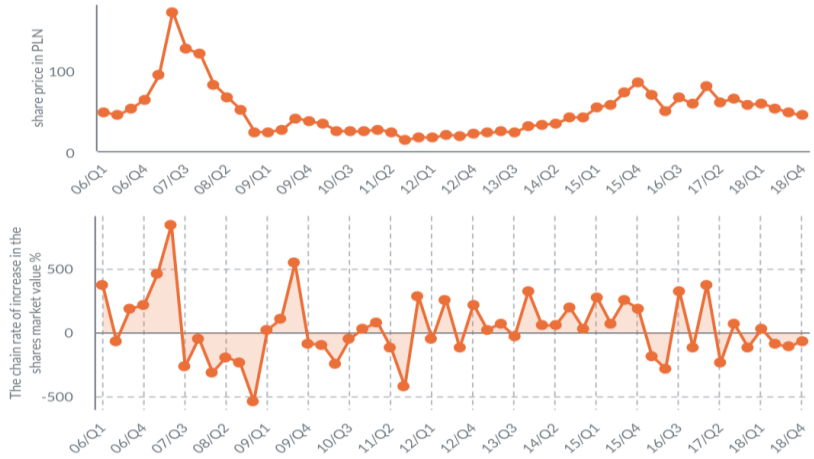
to more than 2.284 billion Polish zlotys, which characterizes this company as a fairly large player in the stock market. Quarterly dynamics and growth rate of the CIECH share price for 2006-2018 (total 52 quarters) is presented in Figure 2. The building of the trader's investment strategy in the stock market starts with analyzing the level of risk of the selected financial instrument. In order to do it, it is necessary to verify if the data shown in Figure 1 is normally distributed.

To build a normal distribution, the nomogram method is used. A scheme of the use of the method of constructing nomograms for analysis of the normality of the distribution of the sample of chain growth / reduction rate of the company's share price is presented in Figure 3.

The results of the analysis of the data on the CIECH share price by the method of building nomograms are presented in Figure 4. Analyzing of the data presented in Figure 4, it is possible to conclude that there is a normal distribution of the sample:

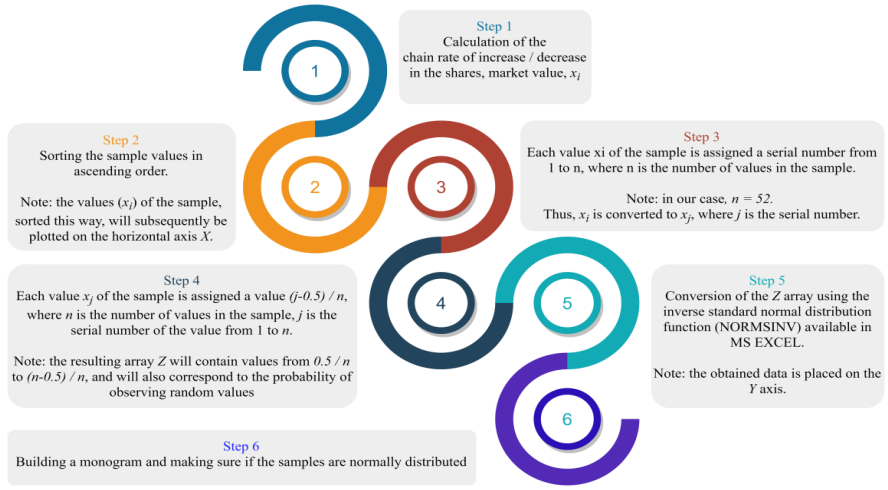
1) in the dynamics of the exchange value of CIECH shares in the analyzed period, fluctuations within ± 12.5% prevail (26 values out of 52), then there are fluctuations between 12.5% and 25.1% (10 values out of 52 or 19.23% of all analyzed indicators) (Figure 4a);
2) the points in Figure 4b are almost on a straight line (the determination coefficient is 0.972), and the slope of the regression line is close to 450. Therefore, the presented nomogram indicates high predictability of the risk level for the selected financial investment instrument, which is a factor that increases the trader's work efficiency.

Figure 2. *Dynamics and growth / decrease rate of the CIECH share price for 2006-2018 (quarterly data)*



Source: *Compiled by the authors based on data (www.biznesradar.pl. (n.d.).*

Figure 3. *The method of building nomograms used to analyze the normality of the distribution of a sample of increase / decrease chain rates in the company's share price*



Source: *Developed by the authors.*

Figure 4. *Nomogram of a sample of increase / decrease chain rates in the CIECH shares price for 2006-2018 (quarterly data)*

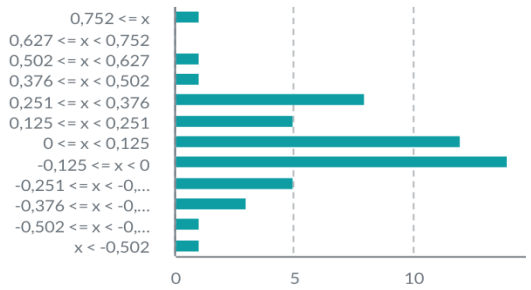


Fig 4a

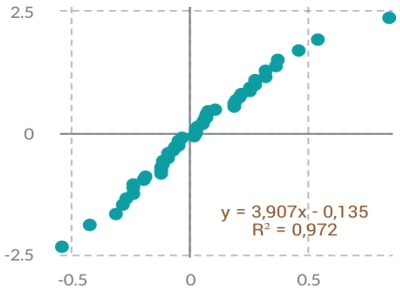


Fig 4b

Source: *Developed by the authors.*

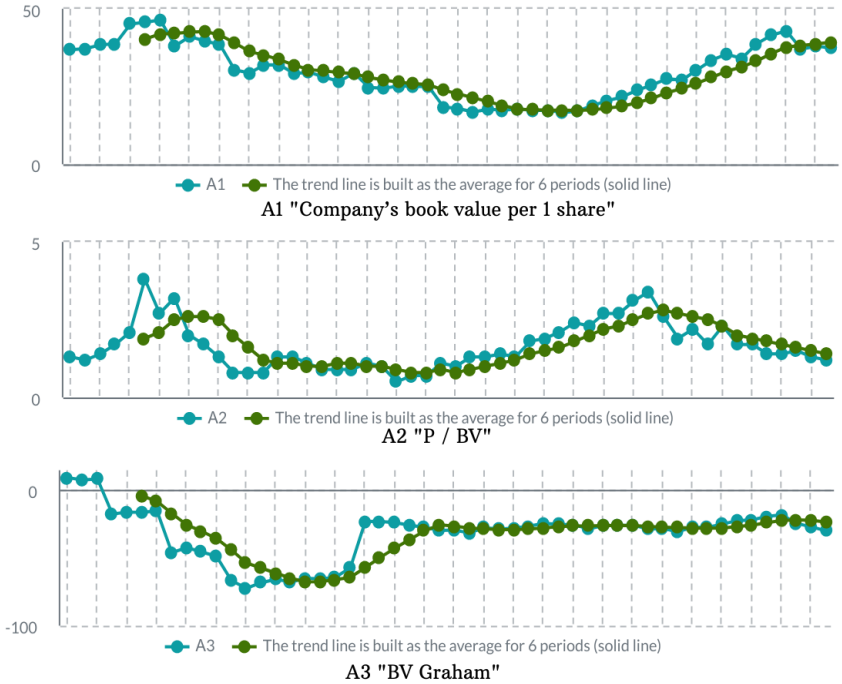
4. Grouping and Analysis of the Dynamics of the Company's Market Value

The next step towards the formation of a trader's investment strategy, according to the proposed author's methodology, is to group the company's shares market value ratios and the subsequent analysis of these indicators in dynamics. The selected CIECH shares market value ratios were divided into four groups (A, B, C, D) and are presented in the tables below. Group A is "Company's book value ratios", in other words, indicators representing basic information about the company's value:

- A1 - (Company's book value per 1 share (BV) = (assets - liabilities) / number of shares) - the indicator informs the investor about how much equity is per 1 company share;
- A2 - (P / BV = Share price / Company's book value per 1 share) - the indicator shows how much the investor should pay for one monetary unit (in this example, for one zloty) of the "net assets of the company" (equity of the company);
- A3 - (BV Graham = (Current assets - liabilities) / number of shares) - the indicator informs the investor how many current assets reduced by liabilities fall on 1 company share, in other words, how many most liquid assets are available to the company in terms of 1 share.

Dynamics of quarterly indicators of the CIECH book value for 2006-2018 presented in Figure 5.

Figure 5. *Group A. Dynamics of quarterly indicators of the CIECH book value for 2006-2018*



Source: *Compiled by the authors based on data (www.biznesradar.pl. (n.d.)*

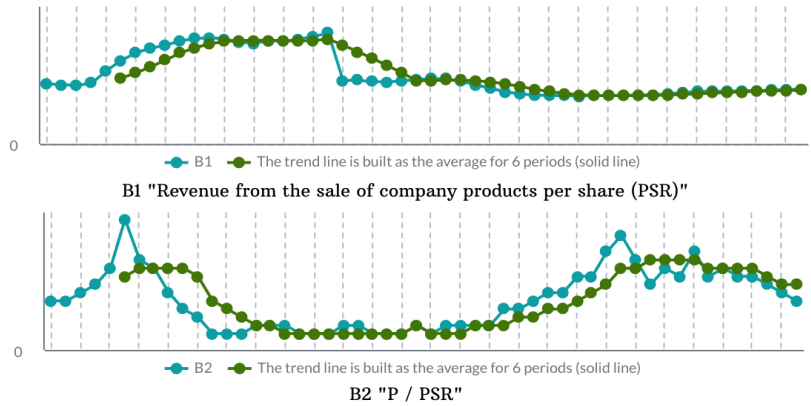
The data given in Figure 5, allow us to draw two main conclusions: in the researched period there is a cyclical change in the value of CIECH; at the end of the analyzed period, a downward trend has emerged, which indicates a decrease in the company's capitalization and the level of liquidity of its assets, as well as a deterioration in the general financial condition of the enterprise.

Group B includes “Company’s market activity ratios”, which characterize the company's market share and show the price that the investor must pay for this market share:

- B1 - (Revenue from the sale of company products per share (PSR) = Revenue from sales / Number of shares) - informs the investor about what the revenue from sales per 1 share is;
- B2 - (P / PSR = Stock price / Revenue from the sale of company products per share) - the indicator shows how much the investor must pay for one monetary unit (one PLN) of the value of the company's sold products.

Dynamics of CIECH quarterly indicators of the group B for 2006-2018 shows a decrease in revenue from sales of products per 1 company’s share and a decrease in the company's market share. However, at the end of the analyzed period there was a positive trend, which indicates an increase in the volume of products sold and a decrease in the price the investor must pay for 1 PLN of the income generated by the company (Figure 6).

Figure 6. *Group B. CIECH Quarterly Market Activity Dynamics for 2006-2018*



Source: *Compiled by the authors based on data (www.biznesradar.pl. (n.d.)*

The indicators of group C are “Company’s profitability ratios”, which characterize the feasibility of investment operations in the company's shares:

- C1 - (Earnings Per Share (EPS) = Net Profit / Weighted Average Outstanding Shares) - shows the profitability of the initial investment of shareholders;
- C2 - (P / EPS = stock price / earnings per share) - this indicator allows us to conclude the feasibility of investing in specific stocks based on an analysis of the shares market value ratio and the profitability of the corporation. The low level of this indicator may indicate the high efficiency of such an investment;

- C3 - (Operating profit per 1 share = operating profit / number of shares) is an indicator characterizing the effectiveness of the core business of the corporation;
- C4 - (Share price / Operating profit per 1 share) - this indicator allows us to conclude that it is advisable to invest in shares based on an analysis of the ratio of the market value of the share and the profitability of the core business of the corporation. A low level of this indicator is desirable from the point of view of the investor and may mean an increase in the stock value in the future, which will positively affect the income of the investor.

The data presented in Figure 7 indicate a decrease in CIECH's net and operating profit in the analyzed period, while the ratio of the shares market value to the net value and operating profit remains practically unchanged. This situation indicates a decreasing efficiency of investing in the shares of this corporation.

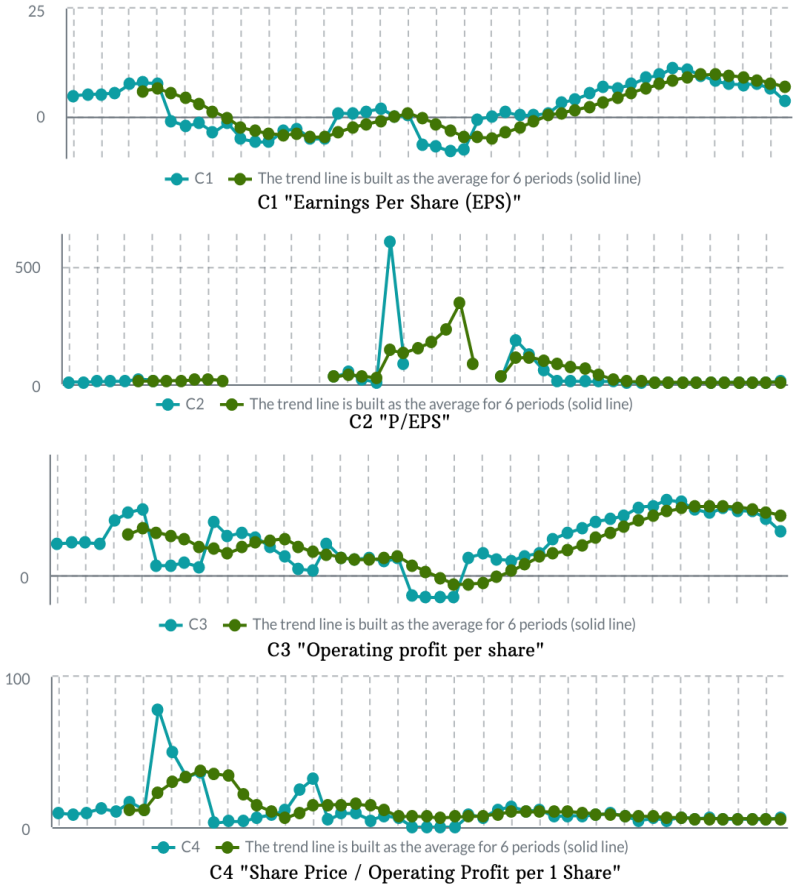
Group D is “Company’s capitalization ratios” (Figure 8):

- D1 - (EV = (Capitalization + Interest liabilities - Cash) / Number of shares) - this indicator allows to assess the real enterprise value per 1 share;
- D2 - (EV / P = Enterprise value / Revenue from sales of products / services) - this indicator informs about the degree of coverage of revenue from sales by the enterprise value;
- D3 - (EV / EBIT = Enterprise value / Operating profit) - the indicator informs about the degree of coverage of operating profit with the enterprise value (the lower the value of the indicator, the more attractive the investment may be);
- D4 - (EV / EBITDA = Enterprise value / (Operating profit + Depreciation)) - the indicator characterizes the ratio of the enterprise value to operating profit increased by depreciation.

The dynamics of the indicators presented in table 4 indicates a trend towards a decrease in the real enterprise value (indicators D1 and D2 have a downtrend) amid a decrease in operating profit, (indicators D3 and D4 are in a sideways trend and oscillate slightly above zero), which allows us to conclude that there is a high probability of a decrease market value of shares.

Since the main purpose of the research is to develop a long-term trader’s investment strategy based on the use of the main financial indicators of the enterprise market value, it is necessary to search for correlations between the company shares market value (Y) in period t and the considered financial indicators of the company shares market value in the previous period (t-1).The task can be solved using two methods – combinatorics method and method of correlation and regression analysis.

Figure 7. *Group C. CIECH Quarterly Profitability Dynamics for 2006-2018*



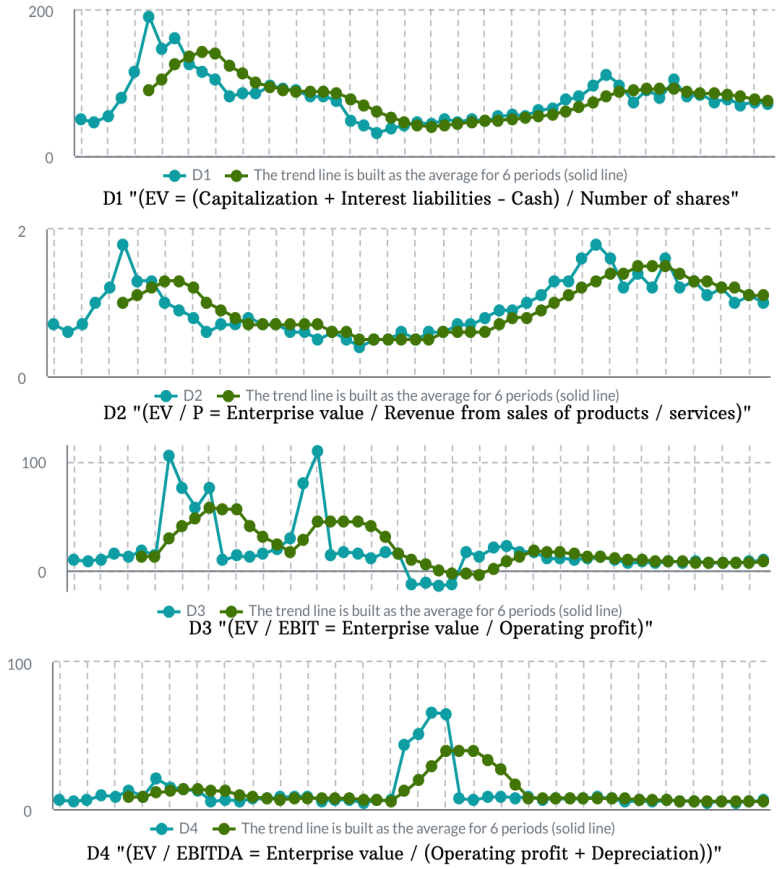
Source: *Compiled by the authors based on data (www.biznesradar.pl. (n.d.)*

5. Application of the combinatorics method in developing a trader's investment strategy

To build a trader's investment strategy using the combinatorics method, let us put forward the following hypothesis: what mostly affects the trader's investment decision making is the direction of the change in the values of these indicators, rather than their strength. In this case, it is possible to convert all the data into a binary matrix whose elements belong to the set {0, 1} ("0" corresponds to a decrease in the indicator values, and "1" corresponds to an increase in the values of the analyzed indicator).

The total number of possible combinations of 13 variables (selected analytical indicators A1, ..., D4) is 213-1 = 8191 (in this case, the priority is given to possible combinations of variables, rather than their sequence). In order to avoid overloading the investment decision-making model with an infinite m-set of variables, they can be limited to m_{max}= 4. Then, it is possible to use the following formula:

Figure 8. *Group D. Dynamics of capitalization level quarterly indicators of CIECH for 2006-2018*



Source: *compiled by the authors based on data (www.biznesradar.pl. (n.d.)*

$$C_n^m = \frac{n!}{(n-m)!\cdot m!}, \tag{1}$$

Where

C is the possible number of combinations;
n is the total number of variables;
m is the number of variables in combination.

Then,

$$C_{13}^1 = 13\,;\; C_{13}^2 = 78\,;\; C_{13}^3 = 286\,;\; C_{13}^4 = 715$$

Thus, the number of analyzed combinations is limited to 1092 combinations. In addition, the following condition is introduced: when buying shares, all variables included in a particular combination must be equal to “1”, when selling shares, all

variables must be equal to "0". If this condition is not met, the transaction in this period is not performed.

Comparative analysis of transactions using the generated 1092 combinations of financial indicators of the market value of CIECH shares for 2006-2018. (total 52 quarters) and its results are presented in the following tables: for the purchase of shares - in table. 1; for the sale of shares – in table. 2; the total result of transactions for sale and purchase is presented in the table 3. The indicated tables show the 5 most and 5 least effective combinations in terms of average return for the entire analyzed period. Transaction results are presented on condition of buying or selling of one share in each period.

So, the data presented in Table 1, allow us to single out a combination of financial indicators of the company's shares market value, which are the most effective indicators in the process of implementation of trading operations for the purchase of shares. Accordingly, Table 2 presents indicators that a trader can use when deciding to sell shares. Considering that when working on the stock market, buying and selling operations are an inseparable combination, to optimize the trading process, the authors proposed a combination of indicators that can be efficiently used to maximize the profitability of operations, both in the case of buying and selling company's shares (Table 3).

Thus, the use of the combinatorics method allows us to adjust the trading (investment) strategy of the trader to the specifics of the external and internal factors of functioning of each individual company and also provide a comprehensive tool for investment decisions making.

Table 1. *Comparative analysis of the results of purchase transactions of CIECH shares for 2006-2018 by formed combinations of variables*

Rank	Combination	Combination of variables	The number of periods without transactions	Transaction data								Summarizing [a]		
				Profitable Transactions				Unprofitable transactions				Profit / loss	Average profit / loss	
				Amount	Maximum [a]	Average [a]	Total [a]	Amount	Maximum [a]	Average [a]	Total [a]		for trading periods	for all periods
5 groups of the most profitable combinations														
1	K697	A2 B2 C4 D1	33	13	79.00	15,79	205,25	4	-19,96	-11,31	-45,25	160	9,41	3,2
2	K703	A2 B2 D1 D4	32	14	79.00	14,51	203,15	4	-19,96	-11,31	-45,25	157,9	8,77	3,16
3	K312	B2 C4 D1	32	13	79.00	15,79	205,25	5	-19,96	-10,26	-51,3	153,95	8,55	3,08
	K1013	B2 C4 D1 D2	32	13	79.00	15,79	205,25	5	-19,96	-10,26	-51,3	153,95	8,55	3,08
4	K187	A2 C1 C4	40	8	79.00	21,78	174,21	2	-15,95	-10,88	-21,75	152,46	15,25	3,05
	K296	B2 C1 C4	40	8	79.00	21,78	174,21	2	-15,95	-10,88	-21,75	152,46	15,25	3,05
	K333	C1 C4 D1	40	8	79.00	21,78	174,21	2	-15,95	-10,88	-21,75	152,46	15,25	3,05
	K334	C1 C4 D2	40	8	79.00	21,78	174,21	2	-15,95	-10,88	-21,75	152,46	15,25	3,05
	K681	A2 B2 C1 C4	40	8	79.00	21,78	174,21	2	-15,95	-10,88	-21,75	152,46	15,25	3,05
	K718	A2 C1 C4 D1	40	8	79.00	21,78	174,21	2	-15,95	-10,88	-21,75	152,46	15,25	3,05
	K719	A2 C1 C4 D2	40	8	79.00	21,78	174,21	2	-15,95	-10,88	-21,75	152,46	15,25	3,05
	K978	B2 C1 C4 D1	40	8	79.00	21,78	174,21	2	-15,95	-10,88	-21,75	152,46	15,25	3,05
	K979	B2 C1 C4 D2	40	8	79.00	21,78	174,21	2	-15,95	-10,88	-21,75	152,46	15,25	3,05
	K1048	C1 C4 D1 D2	40	8	79.00	21,78	174,21	2	-15,95	-10,88	-21,75	152,46	15,25	3,05

5	K318	B2 D1 D4	31	14	79.00	14,51	203,15	5	-19,96	-10,26	-51,3	151,85	7,99	3,04
	K1020	B2 D1 D2 D4	31	14	79.00	14,51	203,15	5	-19,96	-10,26	-51,3	151,85	7,99	3,04
5 groups of the most unprofitable combinations														
5	K216	A3 B1 C3	40	3	21,69	17,06	51,18	7	-46,2	-20,56	-143,94	-92,76	-9,28	-1,86
	K436	A1 A3 B1 C3	40	3	21,69	17,06	51,18	7	-46,2	-20,56	-143,94	-92,76	-9,28	-1,86
4	K37	A3 B1	36	6	21,69	9,63	57,77	8	-46,2	-18,95	-151,6	-93,83	-6,7	-1,88
3	K8	C3	23	12	21,69	9,48	113,79	15	-46,2	-14,19	-212,85	-99,06	-3,67	-1,98
2	K116	A1 B1 C3	37	3	21,69	17,06	51,18	10	-46,2	-17,22	-172,2	-121,02	-9,31	-2,42
1	K50	B1 C3	34	4	21,69	13,42	53,69	12	-46,2	-17,29	-207,53	-153,84	-9,62	-3,08

Note: *[a]PLN - Polish zloty*

Source: *Compiled by the authors.*

Table 2. *Comparative analysis of the results of sale transactions of CIECH shares for 2006-2018. by formed combinations of variables **

Rank	Combination	Combination of variables	The number of periods without transactions	Transaction data								Summarizing [a]		
				Profitable Transactions				Unprofitable transactions				Profit / loss	Average profit / loss	
				Amount	Maximum [a]	Average [a]	Total [a]	Amount	Maximum [a]	Amount	Maximum [a]		for trading periods	for all periods
5 groups of the most profitable combinations														
1	K91	D3 D4	29	13	46,20	13,94	181,18	8	-16,07	-6,72	-53,78	127,40	6,07	2,55
2	K85	C4 D4	29	13	46,20	13,71	178,20	8	-16,07	-6,72	-53,78	124,42	5,92	2,49
3	K373	C4 D3 D4	30	12	46,20	14,79	177,48	8	-16,07	-6,72	-53,78	123,70	6,19	2,47
4	K13	D4	26	14	46,20	12,99	181,90	10	-16,07	-6,18	-61,82	120,08	5,00	2,40
5	K5	B2	28	14	38,00	11,20	156,74	8	-16,07	-4,67	-37,32	119,42	5,43	2,39
5 groups of the most unprofitable combinations														
5	K3	A3	27	9	27,48	10,19	91,75	14	-79,00	-10,44	-146,14	-54,39	-2,36	-1,09
4	K49	B1 C2	37	5	3,70	2,03	10,16	8	-14,58	-8,28	-66,20	-56,04	-4,31	-1,12
3	K41	A3 C3	39	3	16,00	9,09	27,26	8	-79,00	-13,51	-108,06	-80,80	-7,35	-1,62
2	K4	B1	29	7	9,98	3,74	26,19	14	-29,60	-8,46	-118,43	-92,24	-4,39	-1,84
1	K8	C3	27	8	16,00	6,97	55,79	15	-79,00	-10,29	-154,35	-98,56	-4,29	-1,97

Note: *[a]PLN - Polish zloty*

Source: *Compiled by the authors.*

Table 3. *Comparative analysis of the results of purchase and sale transactions of CIECH shares for 2006-2018. by formed combinations of variables*

Rank	Combination	Combination of variables	The number of periods without transactions	Transaction data								Summarizing [a]		
				Profitable Transactions				Unprofitable transactions				Profit / loss	Average profit / loss	
				Amount	Maximum [a]	Average [a]	Total [a]	Amount	Maximum [a]	Amount	Maximum [a]		for trading periods	for all periods
5 groups of the most profitable combinations														
1	K697	A2 B2 C4 D1	19	22	79,00	15,04	330,93	9	-16,07	-8,83	-79,43	251,50	8,11	5,03
2	K703	A2 B2 D1 D4	18	23	79,00	14,30	328,83	9	-16,07	-8,82	-79,40	249,43	7,79	4,99
3	K312	B2 C4 D1	17	23	79,00	14,52	334,03	10	-16,07	-8,55	-85,48	248,55	7,53	4,97
	K1013	B2 C4 D1 D2	17	23	79,00	14,52	334,03	10	-16,07	-8,55	-85,48	248,55	7,53	4,97
4	K318	B2 D1 D4	16	24	79,00	13,83	331,93	10	-16,07	-8,55	-85,45	246,48	7,25	4,93
	K1020	B2 D1 D2 D4	16	24	79,00	13,83	331,93	10	-16,07	-8,55	-85,45	246,48	7,25	4,93
5	K184	A2 B2 D4	16	24	79,00	13,8	331,33	10	-16,07	-8,94	-89,38	241,95	7,12	4,84

						1								
5 groups of the most unprofitable combinations														
5	K37	A3 B1	28	7	21,69	8,38	58,67	15	-14,40	-13,72	-205,80	-147,13	-6,69	-2,94
4	K41	A3 C3	24	9	21,69	11,44	102,97	17	-46,20	-15,08	-256,42	-153,45	-5,90	-3,07
3	K4	B1	0	20	79,00	8,80	175,9	30	-29,60	-12,03	-360,88	-184,98	-3,70	-3,70
2	K50	B1 C3	24	8	21,69	9,32	74,56	18	-29,60	-14,77	-265,86	-191,30	-7,36	-3,83
1	K8	C3	0	20	21,69	8,48	169,58	30	-46,20	-12,24	-367,20	-197,62	-3,95	-3,95

Note: *[a]PLN - Polish zloty*
Source: *Compiled by the authors.*

6. Building of the Trader's Investment Strategy Using the Correlation and Regression Analysis Method

Based on the application of the correlation and regression analysis method, it is possible to build an economic and mathematical model of the relationship between the rate of increase / decrease in the company's share price (Y) in period t and the rate of change of the analyzed financial indicators in the period (t-1) (Table 4).

Table 4. *Correlation between the rate of increase / decrease in the CIECH (Y) share price in period t and the rate of change of the analyzed financial indicators in the period (t-1) for 2006-2018**

	Y	*A1*	*A2*	*A3*	*B1*	*B2*	*C1*	*C2*	*C3*	*C4*	*D1*	*D2*	*D3*	*D4*
Y	1,000													
A1	0,590	1,000												
A2	0,689	0,141	1,000											
A3	0,357	0,124	0,280	1,000										
B1	-0,120	0,310	-0,298	-0,752	1,000									
B2	0,791	0,444	0,869	0,477	-0,430	1,000								
C1	0,614	0,442	0,490	0,600	-0,574	0,800	1,000							
C2	-0,311	-0,276	-0,262	-0,105	0,030	-0,385	-0,462	1,000						
C3	0,561	0,524	0,395	0,193	-0,262	0,689	0,850	-0,438	1,000					
C4	0,114	0,239	0,252	-0,218	0,432	0,039	-0,349	0,128	-0,491	1,000				
D1	0,670	0,626	0,667	-0,228	0,436	0,621	0,236	-0,291	0,396	0,507	1,000			
D2	0,720	0,347	0,889	0,255	-0,354	0,960	0,713	-0,347	0,689	0,064	0,675	1,000		
D3	-0,004	0,233	0,065	-0,421	0,567	-0,090	-0,261	0,431	-0,229	0,892	0,425	-0,026	1,000	
D4	-0,191	-0,332	-0,073	-0,007	0,024	-0,232	-0,536	0,031	-0,654	0,925	-0,148	-0,232	-0,201	1,000

Note: ** The correlation dependence is significant for an indicator> 0.4433 (with a confidence level of 0.001 and 50 degrees of freedom)*
Source: *Compiled by the authors.*

The results of the correlation analysis given in Table 8 allow us to conclude that the following indicators can be included in the model describing the change in share price: A1, A2, B2, C1, C3, D1 and D2. To select the final indicators that will be included in the economic-mathematical model, the Hellwig method is used, which is based on the assessment of the so-called "information capacity" of combinations of variables. The total number of possible combinations (combinations) of 7 variables accounts 27-1=127. Thus,

$$C_7^1 = 7\,;\; C_7^2 = 21\,; C_7^3 = 35\,; C_7^4 = 35\,; C_7^5 = 21; C_7^6 = 7\,; C_7^7 = 1$$

The Hellwig method can be divided into two parts. In the first part, the individual information capacity of the variables in each particular combination is calculated using the following formula:

$$h_{kj} = \frac{r_{0j}^2}{\sum_{i \in I_k} |r_{ij}|} \tag{2}$$

Where

h_{kj} is the individual information capacity of the variable j in the combination k;
r_{0j} is the correlation coefficient of the potential independent variable j with the dependent variable;
$I_k = \{i; X_i \text{ e } K_k\}$ is a set of indices (numbers) of variables included in the combination k, that is, the combination k_k;
$\Sigma|r_{ij}|$ - the sum of the correlation coefficients of the variable j modulo with the remaining potential variables that are in this combination with it.

In the second part of the Hellwig method, for each combination of variables, the integrated (total) information capacity H_k is calculated as the sum of the individual information capacities included in this combination:

$$H_k = \sum_j h_{kj} \tag{3}$$

As an ideal combination of independent variables describing the dependent one, the only combination is chosen for which the integral information capacity is maximum (in this case, H_k and h_{kj} take values in the interval {0: 1} (Dziechciarz, 2002). The results of calculations according to the Hellwig method are presented in Table 5.

The final economic and mathematical model describing the dynamics of the company's share price from the analyzed financial indicators of market value will include the following independent variables: A1, A2, B2, and the economic - mathematical model will look the following way:

$$Y = -0.113 + 1.086\ A1 + 0.380\ A2 + 0.171\ B2.$$

Table 5. *Combinations of independent variables (indicators of the of CIECH share price for 2006-2018) with the highest indicator of integrated information capacity*

Combination	Independent variables in combination	Individual information capacity of independent variables in combination						Integrated information capacity combination
		A1	A2	B2	C1	D1	D2	H
K29	A1 A2 B2	0,220	0,236	0,271	0,000	0,000	0,000	0,727
K8	A1 A2	0,305	0,416	0,000	0,000	0,000	0,000	0,721
K100	A1 A2 B2 C1 D1	0,132	0,149	0,167	0,127	0,144	0,000	0,720

K69	A1 A2 C1 D1	0,158	0,206	0,000	0,174	0,180	0,000	0,718
K30	A1 A2 C1	0,220	0,291	0,000	0,195	0,000	0,000	0,706
K66	A1 A2 B2 D1	0,158	0,177	0,213	0,000	0,156	0,000	0,703
K64	A1 A2 B2 C1	0,172	0,190	0,201	0,138	0,000	0,000	0,701
K107	A1 A2 C1 D1 D2	0,137	0,148	0,000	0,131	0,142	0,143	0,701
K122	A1 A2 B2 C1 D1 D2	0,117	0,117	0,133	0,103	0,118	0,113	0,700
K33	A1 A2 D2	0,234	0,234	0,000	0,000	0,000	0,232	0,700

Source: *Compiled by the authors.*

This model is reliable. The reliability criteria of the proposed model are as follows: the multiple coefficient is R = 0.854, R^2 = 0.730, the normalized coefficient is R^2 = 0.712, the standard error is 0.3481, the calculated value of the Fisher F-criterion is 42.285 with its tabular value ≈2.800. Thus, the constructed equation can be considered statistically reliable and used in trading when making investment decisions. Simulation of the application of the proposed model on retrospective quarterly data from CIECH for 2006-2018 are presented in Table 6.

Table 6. *Analysis of the results of purchase and sale transactions of CIECH shares for 2006-2018 based on the developed economic-mathematical model*

The equation	Transaction type	Transaction data								Summarizing*		
		Profitable Transactions				Unprofitable transactions					Average profit / loss	
		Amount	Maximum*	Average*	Total *	Amount	Maximum*	Average*	Total *	Profit / loss	for trading periods	for all periods
Y = -0,113 + 1,086 A1 + + 0,380 A2 + 0,171 B2	Purchase	15	79,00	12,88	193,23	10	-46,20	-11,08	-110,77	82,46	5,50	1,59
	Sale	13	38,00	12,14	157,87	12	-21,69	-6,24	-74,91	82,96	6,38	1,60
	Purchase and Sale	28	79,00	12,54	351,10	22	-46,20	-8,44	-185,68	165,42	5,91	3,18

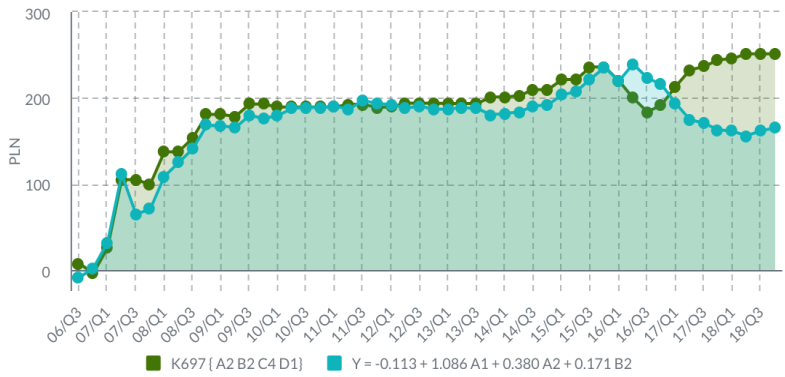
Note: **PLN – Polish zloty*
Source: *Compiled by the authors.*

If in the analyzed periods a trader was trading according to the proposed economic - mathematical model, the result would be the following: the total profit from the purchase of one share for all trading periods would be PLN 82.46, the average profit for 15 trading periods would be PLN 5.50, and for all 52 periods - PLN 1.59; in the same numerical range are profits from operations for the sale of shares - PLN 82.96, 6.38 and 1.60, PLN per share; the total profit from the purchase / sale amounted to PLN 165.42, respectively, on average for trading periods - PLN 5.91, and for all 52 periods, PLN 3.18.

7. Comparison of the Effectiveness of the Application of the Developed Trader's Investment Strategies

Let us compare the effectiveness of the proposed investment strategies (Figure 9).

Figure 9. *Profitability graph of the developed investment strategies, PLN*



Source: *Compiled by the authors.*

Analyzing the profitability of trading operations in dynamics according to the proposed strategies (Figure 9), the following patterns can be noted: until the 1st quarter of 2016, the results of using the first and second trading strategies are approximately the same; from the 1st quarter of 2016 until the middle of the 4th quarter of 2016, a large profitability of trading operations is observed according to a strategy based on correlation and regression analysis, and trading profitability is higher is a strategy based on the combinatorics method is used. In general, trading operations conducted on the basis of an investment strategy built using the combinatorics method are more effective (total income per share when implementing the combinatorics strategy is PLN 251.50, and when implementing a strategy based on the method of correlation and regression analysis - 165, 42 PLN). Therefore, it is possible to come to the conclusion that the strategy of combinatorics is more effective.

8. Conclusion

The findings of the research let us draw the following conclusions:

1. In order to eliminate financial risks and increase the efficiency of trading operations in the stock market, the trader's investment strategy should be based on an economic and mathematical analysis of a set of indicators that measure the enterprise value.
2. The combinatorics method and the method of correlation and regression analysis proved to be effective and successfully applied when building a trader's investment strategy.
3. Among the two proposed methods, the most effective in building a trader's investment strategy is the combinatorics method. Among the entire set of considered indicators of the enterprise value, the most informative are the following: the ratio of the share price to the

company book value per 1 share (A2); the ratio of the share price to the revenue from the sale of the company's products per 1 share (B2); the ratio of the share price to operating profit per 1 share (C4); the real enterprise value in terms of 1 share (D1).

Thus, the proposed original author's solution can become a practical tool for investment decision making in the stock market.

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