

ASSESSMENT OF EFFICIENCY OF PIOTROSKI F-SCORE STRATEGY IN THE WARSAW STOCK EXCHANGE

Magdalena Kusowska

Abstract

Piotroski F-score is a strategy applied to the stock exchange that integrates the analysis of financial signals into the so-called investing in value. The aim of the article is to evaluate the efficiency of Piotroski F-score on the example of the Warsaw Stock Exchange in period 2014–2020. The legitimacy of addressing this subject results from the insufficient amount of research conducted so far. There are very few analyzes of the F-score strategy both in Poland and in foreign markets. The article presents the results of applying Piotroski F-score to the WIG30 index in order to verify whether the strategy leads to an increase in the rate of return on investment in value companies. The study confirmed that analysis of financial statements as an additional stage of value investing can provide the investor with higher returns. It has been also proved that the F-score strategy is more efficient than simple investing in the WIG30 index. Portfolios with high F-score companies appeared to be more efficient than portfolios including only low Fscore firms.

Keywords: Piotroski F-score, value investing, fundamental analysis, Warsaw Stock Exchange, WIG30.

JEL Classification: G17, G18

1. Introduction

The stock market offers countless opportunities for investors to multiply their capital. As nowadays widely known investment strategies may appear to be insufficient to gain an advantage over other market participants, more and more new investment solutions and methods are being proposed. Investors are looking for rare, unconventional strategies to select companies with good prospects worth including in their portfolios. One of the investment methods in the stock market that deserves special attention is the Piotroski F-score strategy, which combines the elements of investing in value with fundamental analysis.

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The article aims at assessing the effectiveness of F-score strategy on the example of WIG30 index in 2014–2020. It has been verified whether Piotroski F-score applied to value companies leads to the increase in the rate of return on investment in shares. Moreover, the results of high F-score portfolios were compared with the low F-score, as well as with the portfolio of all WIG30 companies. For this purpose, the companies' financial data was analyzed and different variants of investment portfolios were created. The legitimacy of addressing this subject results from the insufficient amount of already conducted research, both in Poland and abroad. Piotroski F-score strategy appears to be neglected by analysts, despite its potential to increase the return on the investment portfolio. The article was divided into several sections. First, Joseph Piotroski's justification for combining value investing with the analysis of financial signals was introduced. A brief review of the literature was presented, consisting of research conducted by Piotroski himself, and later also by other authors. The further sections present the methodology and results of the research conducted by the author of this article. The last section presents the conclusions formulated on the basis of the obtained results.

The article was based on the author's master thesis entitled "Assessment of efficiency of Piotroski F-score strategy in the Warsaw Stock Exchange". The thesis was written under the supervision of professor Błażej Prusak at the Faculty of Management and Economics of Gdańsk University of Technology.

2. Literature Review

Piotroski F-score is a strategy proposed and developed by American accounting professor Joseph Piotroski. In 2000 he published an article "Value Investing: The Use of Historical Financial Statement Information to Separate Winners from Losers", in which he introduced an equity investment strategy and proved its effectiveness through the results of his research. The F-score strategy is based on applying the elements of fundamental analysis to make a profit in the stock exchange. Using the data from the financial statements, an investor is able to identify which companies are "winners" and which are "losers". Piotroski pointed out the elements of financial analysis that prove the attractiveness of company's shares and should serve as an additional stage of the already known and used value investing. Although, much research has confirmed the efficiency of investing in value, its success was largely based on the profit generated by the stocks of a handful of exceptionally well-performing firms, simultaneously taking into account many weak-performing firms with unsatisfactory prospects. Piotroski drew attention to the neglect of value stocks by analysts and the lack of recommendations and forecasts for value companies.

Strategy proposed by Piotroski (2000) consists of two levels. The first step is to determine the B/M ratio for all analyzed companies. 20% of firms with the highest B/M ratio are selected for the second stage, which involves the analysis of the nine

financial signals grouped into three categories: profitability, leverage/liquidity and operating efficiency. Companies are assigned a binary rating for each signal. If the signal realization is assessed as “good”, it receives a score of 1, and if it perceived as “bad”, the score is 0. Next, the F-score indicator is determined, and that is the sum of individual binary signals and it is a direct criterion of attractiveness of investment in shares of a given company. The value of this indicator ranges from 0 to 9, where a low value means that the company has few good signals, therefore higher value of the indicator means greater attractiveness of company’s shares for the investor.

Piotroski (2000) calculated the F-score indicator for a sample of 14 043 companies with a high B/M ratio over a 21-year period between 1976 and 1996. In the conducted study, he proved that his two-stage approach can change the distribution of profits and allow investors to select companies that are actually worth including in the investment portfolio from among all value firms. According to Piotroski’s results, selecting companies with high B/M and, at the same time, high F-score indicator, can increase the average return by at least 7.5 percentage points per year. The entire distribution of returns is shifted to the right. As proved in Piotroski’s research, F-score strategy generates a 23% annual return from 1976 to 1996 and appears as robust over time.

The proven profitability of Piotroski F-score strategy gained the interest of other researchers. Analysts testing Piotroski’s method introduced some modifications, especially when it comes to the research sample. Walkshäusl (2020) confirmed the effectiveness of the F-score strategy in developed non US countries and emerging markets in the period 2000–2018. Tripathy and Pani (2017) proved the validity of Piotroski’s approach in the case of investing in equities in the Indian market between 2009 and 2015. Krauss, Krüger and Beerstecher (2015) verified Fscore strategy from the investor’s point of view and they intended to determine whether the high rates of return previously announced by researchers testing Piotroski’s approach could be realistically obtained by individual or professional investors. According to their results for period 2005–2015, F-score strategy could potentially be implemented by individual investors whose capital is very limited, for example equals several thousand USD per position. However, such investors should be careful with publicly announced returns as usually majority is absorbed by market frictions. By contrast, benefits of the strategy appears to be completely inaccessible for institutional investors.

Another research based on Piotroski’s investment approach was conducted by Nast (2017). This study, however, was to some extent a polemic with Piotroski’s guidelines. Nast examined the significance of the nine F-score signals and assessed the ranked scale calculation methodology, as a replacement for the binary methodology. Moreover, he undertook to evaluate the importance of accounting-based fundamental analysis in the context of the current challenges of behavioral finance and technological advance. Analysis concerned stocks listed on Johannesburg Stock Exchange and considered period was 2004–2017. Nast confirmed the effectiveness

of his ranked scale calculation methodology applied to relevant financial signals. He proved that the strategy remains effective over time.

An interesting approach to Piotroski's strategy was proposed by Mohr (2012). He intended to provide empirical evidence regarding the debate whether conclusions from fundamental analysis depend on the context of the valuation of stocks in the sample. Mohr's methodology was very similar to that of Piotroski, however, Mohr studied growth shares, therefore he calculated P/B ratio for all companies belonging to the research sample. The analyzed data concerned the eurozone stock market in the period from 1999 to 2010. According to Mohr's results, market-neutral asset strategy which involves buying high F-score growth stocks and shorting low F-score growth stocks appears to be effective and provide investors with significant returns. Mohr proved the effectiveness of applying the F-score to growth investing.

Another research was conducted by Tikkanen and Äijö (2018). They applied F-score to various value investing strategies. The data concerned European companies and the considered period was 1992–2014. The authors of the study analyzed the following ratios: B/M (book to market), EBIT/EV (earnings before interest and taxes divided by enterprise value), EBITDA/EV (earnings before interest, taxes, depreciation and amortization divided by enterprise value), E/M (earnings divided by market capitalisation), D/M (dividends to market capitalization) and Novy Marx profitability ratio (total revenue decreased by cost of goods sold, divided by total assets). Applying F-score strategy improved profits for all investigated value strategies, with the best results obtained for EBIT/EV ratio.

When it comes to Polish market, there is a significant shortage of research on the F-score strategy. The most recent study concerning Polish stock exchange was conducted by Pilch (2021). The overall period covered by the study was 2017–2020 and sample included 54 companies from the IT and video games industries. Pilch confirmed the usefulness of Piotroski's method in the selection of companies characterized by a good financial condition, and thus generating higher rates of return in the Warsaw Stock Exchange. The results obtained by Pilch show that the F-score strategy has not been deprived of its effectiveness, despite the fact that many years have passed since Piotroski's publication.

Overall, the studies presented in this part largely confirm the effectiveness of F-score strategy. Some of the studies significantly extended Piotroski's initial guidelines. This strategy is attractive to researchers due to high rates of return and various possibilities and variants of its implementation.

3. Methodology

In order to assess the efficiency of Piotroski Fscore in the Warsaw Stock Exchange in period 2014–2020, the following research hypotheses were formulated:

- H1: An investment undertaken in accordance with the Piotroski F-score strategy generates a higher rate of return than an investment in the WIG30 index.
- H2: An investment in value companies with a high F-score generates a higher rate of return than an investment in value companies with a low F-score.
- H3: Investing in companies with a high book to market ratio and, at the same time, a high F-score indicator generates higher rate of return than investing in companies with a high book to market ratio.

The research period lasted from 31.03.2014 to 31.03.2020. Starting from 2014, an investment portfolio was created annually on the last trading day of March, therefore the investment period was six years. The analysis implemented the methodology of Piotroski (2000), however it is important to note that some modifications were introduced.

The process of selecting companies for the portfolio consisted of two stages, as proposed by Piotroski (2000). Initially, the analysis covered 30 companies each year, depending on the composition of the WIG30 index at the time of creating the portfolio. In the first stage, the ratio B/M was calculated for all companies included in the WIG30 index in each year of the analyzed period. The B/M ratio was calculated based on the market price and book value at the end of December preceding the year of portfolio creation. The companies were sorted in descending order of B/M value and the top 15 companies moved to stage two, excluding companies from the financial sector and provided that the selected companies are in the top 20 companies with the highest B/M. Otherwise, fewer companies were allowed to enter stage two.

The second stage of portfolio creation involved calculating the F-score for each company. Therefore, the following nine signals, in accordance with the guidelines of Piotroski's (2000), were analyzed and assigned binary values:

- return on assets (ROA) – the ratio of net income before extraordinary items to beginning-of-the-year total assets; positive ROA means a score of 1, otherwise score of 0,
- cash flow from operations (CFO) – the ratio of cash flow from operations to beginning-of-the-year total assets; positive CFO means a score of 1, otherwise score of 0,
- change in return on assets (Δ ROA) – the difference between ROA of the current year and ROA of the previous year; Δ ROA greater than 0 means a score of 1; otherwise score of 0,
- accruals (ACCR) – net income for the current year before extraordinary items less cash flow from operations, divided by beginning-of-the-year total assets; ACCR receives a score of 1 if CFO is greater than ROA; otherwise score of 0,
- change in leverage (Δ LEV) – the difference between current ratio of total long-term debt to average total assets and ratio of the previous year; negative Δ LEV means a score of 1; otherwise score of 0,

- change in liquidity (ΔLIQ) – difference between ratio of current assets to current liabilities at fiscal year-end and the ratio of the previous year; positive ΔLIQ means a score of 1; otherwise score of 0,
- external financing (EQOFF) – issue of common equity in the preceding year; EQOFF receives a score of 1 if no common equity was issued in the preceding year; otherwise score of 0,
- change in gross margin ($\Delta MARG$) – difference between the current ratio of gross profit to total sales and the ratio of previous year; positive $\Delta MARG$ means a score of 1; otherwise score of 0;
- asset turnover ($\Delta TURN$) – the difference between the ratio of total sales to total assets at the beginning of the year and the ratio of previous year; positive $\Delta TURN$ means a score of 1; otherwise score of 0.

Every year, the above signals were analyzed for each company with a high B/M value. The values assigned to the individual signals were summed to obtain aggregate F-score. In the period 2014–2019, a portfolio was created each year, containing companies with high B/M and simultaneously high F-score. Firms with F-score of 8 or 9 were recognized as high F-score firms. It was assumed that funds were evenly distributed among individual companies included in the portfolio. Each time, one year after portfolio creation, logarithmic rates of return were calculated to assess the profitability of the investment.

In addition to portfolio of value companies with high F-score, portfolio of value companies with low F-score, as well as portfolio containing all high B/M companies, were created. Firms with F-score of 4 or less were recognized as low F-score firms. An investment in a benchmark was also simulated, i.e. all companies belonging to the WIG30 index.

The main source of data was the portal BiznesRadar.pl. It provided data used to calculate financial signals and B/M ratios as well as share prices for all companies, except for Play Communications SA, Synthos SA and TVN SA, whose share prices come from the WSE website and the book value from the portal Bankier.pl.

4. Results

This section compares the rates of return on four investment options. The first investment included value companies with high F-score, i.e. 8 or 9. At the same time, the simulation of investing in value companies with low F-score, i.e. 4 or less, was carried out. Another option included all value companies, i.e. firms with high B/M. In order to establish a benchmark when assessing the effectiveness of the F-score strategy, a simulation of the rate of return on the portfolio containing all WIG30 stocks in the analyzed period was also carried out.

Table 1 presents the annual rates of return on the four analyzed investments: high Fscore, low F-score, high B/M and WIG30. The rates of return for all variants showed high volatility in the period 2015–2020. The greatest volatility was observed for the low F-score portfolio, as these were the companies that generated both maximum and minimum rates of return compared to other investment options. The highest rate of return in the analyzed period was 35.96% in March 2017 for the low F-score portfolio, and the lowest rate was –68.83% in 2020 also for companies with low values of F-score indicator, however it is important to mention that loss of 68.55% generated by high F-score companies was at very similar level. The smallest volatility was observed for the WIG30 index with the maximum rate of 12.60% and the minimum rate of –42.43%. For the high F-score, the maximum annual profit amounted to 23.37% in March 2017. The annual rates of return for high B/M companies ranged from –57.45% to 22.99% during the period under review. The third year of the analyzed period appeared to be the most profitable as each of the four portfolios generated a relatively high positive rate of return. On the other hand, each of the variants generated the largest loss in the last year of the analysis.

Table 1. Annual rates of return on the four investment options over the analyzed period

Date \ Portfolio	High FSCORE	Low FSCORE	High B/M	WIG30
31.03.2015	16.31%	–29.29%	–3.78%	–0.27%
31.03.2016	–0.38%	–4.12%	–16.99%	–16.07%
31.03.2017	23.37%	35.96%	22.99%	12.60%
31.03.2018	–16.90%	–15.48%	–14.53%	1.59%
31.03.2019	8.84%	–1.61%	2.98%	3.77%
31.03.2020	–68.55%	–68.83%	–57.45%	–42.43%

Source: author's own elaboration.

Figure 1 compares the rates of return on investments in portfolios of high Fscore companies, low F-score companies, high B/M companies and all companies belonging to WIG30. At the end of the period under review, i.e. 31st March 2020, all portfolios generated a loss. The lowest return rate of –83.37%, representing an extremely significant loss, was incurred due to investment in companies with a low F-score indicator. A relatively large loss of 66.77% was observed also in the case of investments in value companies. The portfolios of high F-score and WG30 were at similar level, with returns of –37.32% and –40.82%, respectively. High F-score

firms generated over two times smaller loss than low Fscore companies. Of the four investment options, the stocks of high F-score companies proved to be the most efficient, but nevertheless generated a loss of 37.32%.

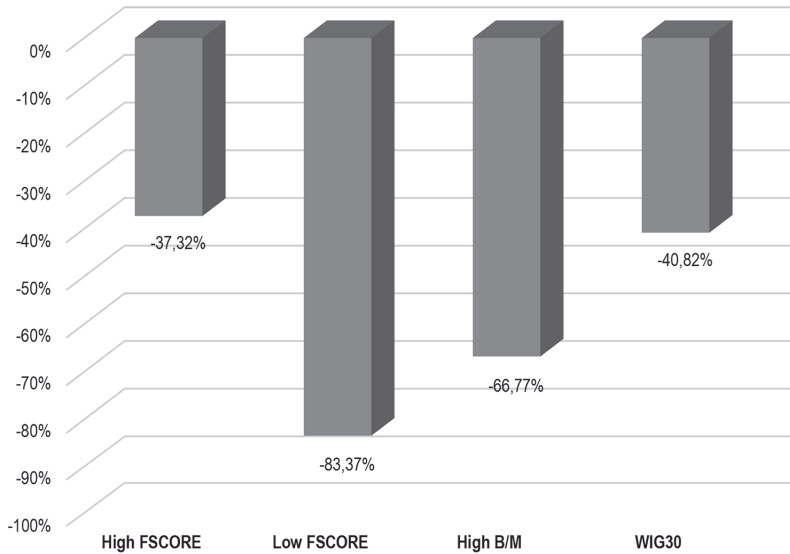


Figure 1. Comparison of returns on the four investment options at the end of the analyzed period

Source: author's own elaboration.

Figure 2 presents the cumulative returns on investments in high F-score, low F-score, value companies and WIG30 portfolios. In the analyzed period, common trend patterns can be observed for all four investments. The cumulative rates of return on the low F-score, high B/M and WIG30 portfolios were at a similar level, while the high F-score rates were significantly higher. During the first five years in the case of investment in high F-score companies, steadily positive return rates were obtained, peaking at 39.29% in 2017, however the sharp decline was observed in the last year, resulting in a loss of 37.32% at the end of analyzed period. This sudden drop at the end of the period was due to the inclusion of PKP Cargo SA in the portfolio, as its shares turned out to be highly unprofitable. The decline in rates of return in the last year of the analysis concerned all four portfolios, and the largest loss of 83.37% was incurred on investment in the low F-score portfolio.

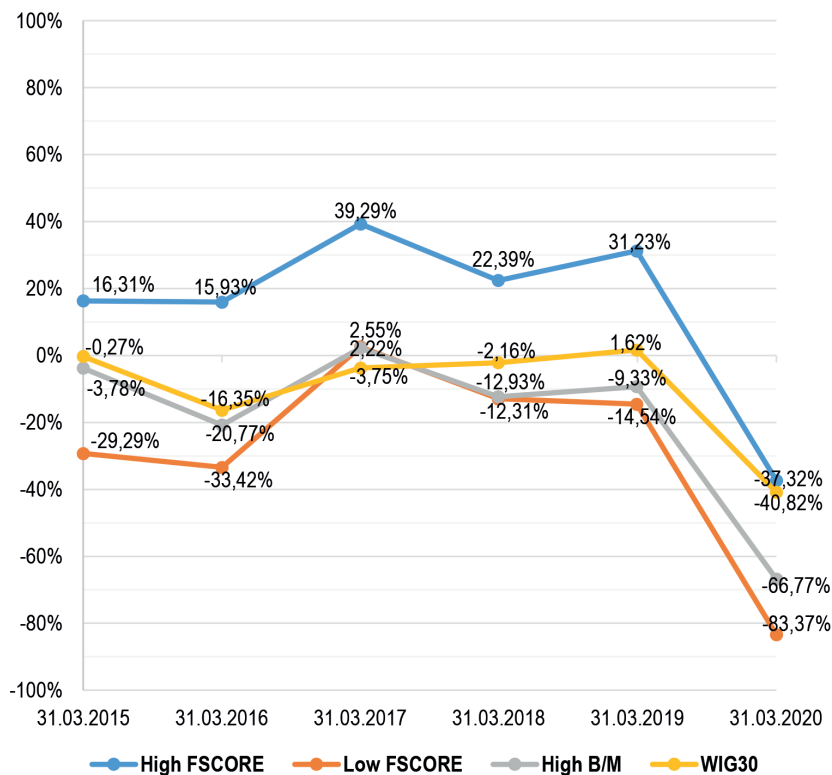


Figure 2. Comparison of cumulative returns on the four investment options over the analyzed period

Source: author’s own elaboration.

Table 2 compares the rates of return generated by companies with Fscore in the range from 3 to 9 (as F-score of 0, 1 and 2 were not attributed to any of the companies over the entire period under review). Surprisingly, over the entire period, the highest overall rate of return of 52.88% was achieved by companies with F-score equal to 3. However, it is worth mentioning that the result of 3 was assigned only 5 times, including Jastrzębska Spółka Węglowa SA in the third year of the analysis, which generated a high return rate of 151.60%. The F-score of 9 was obtained by companies only in the third and fifth year, however, these companies achieved a significant positive return of 50.07%. Every time one of the companies reached a score of 9, it generated profit. Thus, the overall loss of the high F-score portfolio was due to the inclusion in the portfolio of companies with a score of 8, which generated a total loss of 72.98%. In the analyzed period, the biggest loss was generated by companies with the F-score of 7 and 4, amounting to 168.12% and 119.74%, respectively.

Table 2. Comparison of the rates of return for each aggregate F-score

Period F-score	2014– 2015	2015– 2016	2016– 2017	2017– 2018	2018– 2019	2019– 2020	2014– 2020
3	–	–9.90%	62.78%	–	–	–	52.88%
4	–29.29%	–0.27%	–4.26%	–15.48%	–1.61%	–68.83%	–119.74%
5	–15.36%	–33.02%	29.09%	–9.88%	–	–37.58%	–66.74%
6	11.29%	–18.63%	5.20%	–16.38%	0.00%	–88.24%	–106.77%
7	–12.85%	–48.39%	–37.55%	–12.55%	–18.48%	–38.30%	–168.12%
8	16.31%	–0.38%	17.38%	–16.90%	–20.83%	–68.55%	–72.98%
9	–	–	29.36%	–	20.71%	–	50.07%
3–9	–3.78%	–16.99%	22.99%	–14.53%	2.98%	–57.45%	–66.77%

Source: author's own elaboration.

5. Conclusions

The conducted research shows that all investment variants, i.e. companies with a high F score, low F-score, high B/M and WIG30 index, generated a loss at the end of the six-year investment period between 2014 and 2020.

According to the research carried out for companies of WIG30 index, applying Piotroski F-score strategy generated a higher rate of return than investing in WIG30, therefore the first hypothesis was confirmed. Furthermore, an investment in value companies with a high F-score generated a higher rate of return than the investment in value companies with a low F-score, which is consistent with the second hypothesis. The third hypothesis was also confirmed, as the rate of return on investment in value companies with a high F-score was higher than that of all value companies belonging to the WIG30.

Although all investment options generated a loss, the portfolio of high Fscore companies with a loss of 37.32% at the end of the analyzed period turned out to be the most efficient. On the other hand, low F-score portfolio generated the biggest loss of 83.37%. Portfolios of companies with high B/M and all WIG30 firms generated loss of 66.77% and 40.82%, respectively.

The implementation of the F-score strategy did not guarantee the elimination of high B/M companies generating negative rates of return. During the analyzed period, each of the companies with a maximum F-score value of 9 generated a positive rate of return, however, in line with the strategy, the portfolio also included companies with F-score equal to 8 and not all of these firms appeared to be a prof-

itable investment. The biggest loss in the case of the portfolio of companies with high F-score was generated by the shares of PKP Cargo SA with the score of 8 in the last year of the investment. During the first five years of the period under review, in the case of investment in the portfolio of high F-score companies, steadily positive cumulative return rates were observed, with the minimum rate of 15.93% after the second year, and maximum rate of 39.29% after the third year of analysis. Due to investment in PKP Cargo SA, the rate of return was negative at the end of the sixth year. Had this company not qualified for the portfolio, high F-score investment variant would have generated a profit at the end of the period under review. The share price of the company PKP Cargo SA had experienced a gradual but significant and sustained decline since the third quarter of 2019, causing the price in March 2020 to be much lower than the year before. However, the company met 8 financial requirements of the F-score strategy and the share price decline was not predicted. Due to the relatively small number of companies included in the WIG30, the significantly outlier rate of return of one company had a large impact on the result of the entire portfolio.

An important issue is the structure of the WIG30 index in relation to the analyzed strategy. Many of the WIG30 companies are controlled by the state. The management of such companies is not necessarily driven by purely economic interests and management boards may not have sufficient qualifications or complete decision-making autonomy. In the case of the analyzed investment strategy, state-owned companies may not show such dependencies as would occur in the case of private companies.

It can be concluded from the study that the financial condition of WIG30 companies is at a good level, as relatively high F-score of 6 was assigned most frequently, that is 20 times, and none of the companies received the lowest scores 0, 1 and 2. However, despite the relatively high F-score, the WIG30 did not prove to be a profitable portfolio in the analyzed period.

Although the six-year investment in high F-score companies generated a loss, it turned out to be more efficient than the other three investment options, i.e. low F-score, high B/M and WIG30 portfolios. This proves the legitimacy of considering the financial signals proposed by Piotroski as an additional stage of investing in value.

For the future research, it is recommended to include more companies to limit the impact of outliers on results. Moreover, it is worth considering applying a longer research period and eliminating state-owned companies from the sample.

Summary

The study presented in the article proved that the F-score strategy proposed by Joseph Piotroski is efficient while investing in the Warsaw Stock Exchange. Despite the fact that the portfolio of high F-scores companies generated a loss at the end of

the analyzed period 2014-2020, it appeared to be the most efficient out of all four presented investment options, obtaining a final rate of return equal to -37.32% . Low F-score companies turned out to be the least efficient and generated a return rate of -83.37% at the end of the period under review. Portfolios of companies with high B/M and all WIG30 firms generated return rates -66.77% and -40.82% , respectively.

Investing in value companies with a high F-score proved to be more efficient than the other three investment variants, therefore all hypotheses posed in the paper were confirmed.

High F-score firms generated over two times smaller loss than low F-score companies and outperformed high B/M companies and WIG30 index by about 30 percentage points and 3 percentage points, respectively. Although all return rates at the end of the investment period were negative, obtained results proved the legitimacy of analyzing the financial signals proposed by Piotroski as an additional stage of investing in value.

Piotroski F-score proved to be definitely more efficient than a standard investment in value. However, it is important to emphasize, that performed analysis covered a relatively short, six-year period and was limited only to entities belonging to the WIG30 index. In order to ensure a more accurate and broader analysis of Piotroski F-score strategy, it is recommended to extend both sample size and time period. A slightly more frequent change of portfolio could also be applied.

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OCENA SKUTECZNOŚCI STRATEGII PIOTROSKI F-SCORE NA GIEŁDZIE W WARSZAWIE

Streszczenie

Piotroski F-score to strategia stosowana na giełdzie, która integruje analizę sygnałów finansowych w tzw. inwestowanie w wartość. Celem artykułu jest ocena efektywności Piotroskiego F-score na przykładzie Giełdy Papierów Wartościowych w Warszawie w latach 2014–2020. Zasadność podjęcia tego tematu wynika z niewystarczającej ilości dotychczas przeprowadzonych badań. Niewiele jest analiz strategii F-score zarówno w Polsce, jak i na rynkach zagranicznych. W artykule przedstawiono wyniki zastosowania Piotroskiego F-score do indeksu WIG30 w celu weryfikacji, czy strategia prowadzi do wzrostu stopy zwrotu z inwestycji w wartościowe spółki. Badanie potwierdziło, że analiza sprawozdań finansowych jako dodatkowy etap inwestowania wartości może zapewnić inwestorowi wyższe zyski. Udowodniono również, że strategia F-score jest skuteczniejsza niż zwykle inwestowanie w indeks WIG30. Portfele z firmami o wysokim wskaźniku F okazały się bardziej efektywne niż portfele zawierające tylko firmy o niskim wskaźniku F.

Słowa kluczowe: Piotroski F-score, inwestowanie wartości, analiza fundamentalna, Giełda Papierów Wartościowych w Warszawie, WIG30.