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Potential Confusion Between Value Investing and Fundamental Analysis Explored Through Piotroski F-Score

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ABSTRACT
This article addresses the potential confusion between fundamental analysis (FA) and value investing (VI) in stock analysis, particularly highlighting the over-reliance on financial ratios that can obscure their distinctions. It examines the role of the f-score, developed by Piotroski as a VI indicator, which is frequently misinterpreted within the context of FA [1]. By analyzing its utilization in academic literature, the study examines to clarify how the f-score should be understood as a value investing tool and contribute to a clearer framework distinguishing the two approaches, thereby enhancing future research and educational efforts. This article employs bibliometric analysis. Our study finds that while the f-score is frequently associated with FA metrics, its intended purpose as a measure of VI more relevant. Additionally, we categorize value investing indicators into Single Value Investing Indicators (SVII) and Combined Value Investing Indicators (CVII), building upon the foundational works of Graham & Dodd and Lakonishok et al. [2],[3]. The findings suggest that Piotroski's f-score is more appropriately classified as a CVII and more effective in predicting abnormal returns when used within the value investing framework rather than fundamental analysis.

INTRODUCTION

There is potential confusion between fundamental analysis (FA) and value investing (VI) in stock analysis, although they are closely related. Generally, this potential confusion may stem from an over-reliance on specific ratios. For instance, while a stock with a low market to book value ratio (M/B) may appear undervalued within the framework of value investing, this low ratio might actually reflect deteriorating fundamentals (i.e., a value trap), an issue that comprehensive fundamental analysis would uncover. This confusion can occur in the reverse scenario. An investor may believe they are engaging in value investing, while in reality, they might be conducting FA without fully conducting to the core principles of VI. An investor performing fundamental analysis might be looking at all key metrics such as earnings, dividends, and cash flows, however if they are not explicitly focusing on undervaluation and the margin of safety then they are not truly engaging in value investing. Instead, they are simply performing a general analysis of the stock's fundamentals.

This article investigates whether there are signs of confusion in academic research regarding the distinction between the scope FA and VI. This objective is motivated by Walkshäusl who identified that the f-Score, originally developed as a VI indicator is frequently discussed within the framework of FA [4]. F-score was explicitly formulated and introduced by Piotroski [1] as a VI tool. Walkshäusl found that three out of eight articles addressed the f-score as a value investing indicator i.e., [5]–[7]. Meanwhile, five others examined it as an indicator of a firm's fundamental i.e., [8]–[12].

The potential confusion will be examined from the perspective of the utilization of f-score indicator which is developed by Piotroski [1]. This article presents two arguments to support that this indicator can represent the discussion on this potential confusion. First, Piotroski is the most cited research paper on VI [1]. Even though it is explicitly referred to as a value investing indicator, the role of f-score as a value investing indicator is potentially neglected [4]. Second, indicator of f-score consists of nine integrated evaluations representing three key financial ratios in assessing a company's fundamentals (i.e., profitability, liquidity, and operating efficiency). It is recommended for identifying portfolios of low M/B value stocks. This specific recommendation is also reinforced by the formulation of a similar indicator called the g-score, introduced by Mohanram to identify stock portfolios with higher returns on high M/B value stocks [13]. We expect that this study will contribute to develop a clear framework that outlines the distinctions and overlaps between fundamental analysis and value investing, serving as a reference for future research and assisting educators in effectively teaching these concepts.

LITERATURE REVIEW

Theoretical Frame Work of Value Investing

The potential overlap in defining and using indicators between value investing and fundamental analysis may also be driven by Chee et al who argue that the theoretical framework underpinning the value investing strategy has not yet been adequately formulated, despite value investing being the oldest and most popular style [14]. Recent systematic reviews of the value investing literature have attempted to address this issue. Roca identified four key research directions in value investing: (1) competing explanations of the value premium, (2) anomalies research, (3) momentum and fundamentals, and (4) misconceptions about investing [15]. Among these, the least explored topic is the 'wrong beliefs' category, which addresses how investment returns and firm performance may fail to represent current or future performance accurately. Additionally, Battisti et al conducted a systematic review that focuses on future research suggestions for value investing, particularly regarding the analysis of sustainable competitive advantage. The identifications by Roca and Battisti et al [16]1934; Fisher, 1958; Fama and French, 1992; Lakonishok, Shleifer and Vishny, 1994 are valuable in guiding future research on value investing [15], [16]1934; Fisher, 1958; Fama and French, 1992; Lakonishok, Shleifer and Vishny, 1994. However, this article contends that these reviews have not yet sufficiently addressed the criticism posed by Chee et al regarding the underdeveloped theoretical framework underlying the development of value investing indicators [14].

Battisti et al identified two primary references commonly cited in the value investing literature published between 2007 and 2017, namely Graham

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& Dodd [2] and Lakonishok et al. [3] [16]1934; Fisher, 1958; Fama and French, 1992; Lakonishok, Shleifer and Vishny, 1994. Their review of value investing research highlights the predominance of indicator development within the field. This focus on indicator development, as opposed to theoretical discussion, is further emphasized by Roca [15]. In this section, we aim to conduct a literature review using criteria distinct from those employed by Battisti et al [16]1934; Fisher, 1958; Fama and French, 1992; Lakonishok, Shleifer and Vishny, 1994 while maintaining a similar objective—namely, to identify the evolution of value investing indicators and the theoretical framework supporting their application. The article search criteria are presented in Table 1.

Table1. Article Searching Process and Limitations

Details of the Literature Review Stages	Criteria
Key word	*"Value stock"* OR "*growth stock"*[1]
Source	Scopus
Element	– *Title* – Published in peer-reviewed journals – Published between 2009 and 2023 – Subject areas: Economics, Econometrics, and Finance; Business; Management and Accounting – Written in English
Identify selected articles	– Research objectives – Value investing indicators – Research findings – Theoretical foundation presented explicitly or implicitly – Dependent variable – Categories of value investing indicators
Synthesis	Mapping of value investing strategy indicators and the underlying theories supporting in value investing

[1] These keywords also consider Piotroski [1] as a highly cited study on value investing indicators. Piotroski [1] found that the average return on a value stock portfolio was significantly higher than that of a growth stock portfolio. This finding prompted the present research to use the keywords 'growth stock' and 'value stock,' with the expectation of uncovering alternative articles that differ from Battisti et al [16] but remain relevant to value investing strategies. Battisti et al [16] examined value investing research using the search keyword 'value investing,' focusing on articles published between 2007 and 2017. Searching was conducted on August 30, 2021

This study examines articles published between 2009 and 2023. The decision to focus on this period is informed by the findings of Battisti et al [16]1934; Fisher, 1958; Fama and French, 1992; Lakonishok, Shleifer and Vishny, 1994, who were unable to identify any articles on value investing published in 2008. Battisti et al [16]1934; Fisher, 1958; Fama and French, 1992; Lakonishok, Shleifer and Vishny, 1994 posited that this absence may be linked to the global financial crisis of 2008. As a result, this study excludes the year 2008 and begins its review with articles published in 2009, reflecting the post-crisis period. The year 2023 marks the upper limit of the search, as it corresponds to the time at which this review was conducted.

This study identified 89 articles without restrictions on publication year, based on research subjects aligned with the criteria outlined in Table 1. The earliest and most recent articles on value investing, as determined by the search methodology employed in this research, were published in 1957 and 2022. After imposing a publication year restriction (i.e., from 2009 to 2023), a total of 30 articles were located. Ultimately, this study refined the selection to 26 articles from the initial 30, based on their relevance to the research objectives, as assessed through their abstracts and conclusions.

We identified two theoretical groups that underlie the implementation and development of value investing indicators. This identification is presented in Table 2. The two theoretical groups were distinguished based on the assumptions regarding investor rationality. The first group assumes that investor behavior is consistently rational, encompassing theories such as the Efficient Market Hypothesis, Clean Surplus Theory, and Rational Expectations Theory. The second group comprises research that posits that investors exhibit irrational behavior in investment decisions that can be predicted, including studies in Behavioral Finance, Life Course Theory, and Business Cycle Theory. These theories also serve as the foundational framework for the use of value investing indicators, as detailed in Table 2.

Table 2. Theoretical Framework for Developing Value Investing Indicators

Identification basis	Investors' assumptions are always rational	Investors' assumptions are not always rational
Theory	Efficient Market Hypothesis, Clean Surplus Theory and Rational Expectation Theory	behavioral finance, life course theory & business cycle theory
Indicator	Developed with primary reference to accounting information (i.e., financial statement analysis)	Developed with primary reference to non-accounting information (e.g., herding, risk preferences, stock valuation complexity, knowledge levels, information access, stock market liquidity, and thinly traded stocks)
References as primary sources according to Battisti et al., [16]1934; Fisher, 1958; Fama and French, 1992; Lakonishok, Shleifer and Vishny, 1994	Graham & Dodd [2], Fisher [17] and Lakonishok et al. [3]	Graham & Dodd [2] and Lakonishok et al. [3]
Empirical research	Khatwani & Mishrharda [18]; Fong [19]; Fong [20]; Jason [21]; Chiang [22]; Shen & Tzeng [23]; Singh & Kaur [24]; Yeh & Hsu [25]; Prombutr et al. [26]; Yu & Kim [27]; Athanassakos [28]	Ahmad & Oriani [29]; Ahmad & Oriani [29]; Bevanda et al. [30]; Neves et al. [31]; Xiong et al. [32]; Figlioli et al. [33]; Vasconcelos & Martins [34]; Rana & Phillips [35]; Coakley et al. [36]; Gietzmann & Raonic [37]; Bergeron [38]; Chandra & Reinstein [39]; He et al. [40]; Kumar [41]; Hodge et al. [42]; Jong & Apilado [43];

The primary difference between the two groups of value investing research lies in the factors identified as drivers of prices for inefficiently valued investmentinstruments. The first group suggests that investors will quickly recognize these inefficiencies, leading to a swift adjustment toward efficient pricing based on rational evaluations. Conversely, the second group contends that instances of asset prices or investment instruments will persistently exhibit inefficiencies. The underlying drivers of these inefficient prices are attributed to decision-making processes influenced by behavioral biases (i.e., irrational considerations). Consequently, the shift toward what is perceived as an efficient price is similarly influenced by these biases.

Furthermore, this study identified two groups of value investing indicators. This categorization considers the findings of Battisti et al [16]1934; Fisher, 1958; Fama and French, 1992; Lakonishok, Shleifer and Vishny, 1994, who identified the two most frequently cited references in value investing literature: Graham & Dodd [2] and Lakonishok et al. [3]. Graham & Dodd introduced a value investing strategy based on the comparison of accounting components in financial statements with market perceptions. The indicators include market-to-book value (MB), price-to-earnings ratio (P/E), price-to-cash flow ratio (P/C), and dividend yield [2].

This study classifies these indicators into two categories: Single Value Investing Indicators (SVII) and Combined Value Investing Indicators (CVII). The SVII primarily identifies potential undervalued stocks based on Graham & Dodd [2] indicators, either individually or in conjunction (i.e., MB, P/E, P/C, and dividend yield). In contrast, the CVII refers to the work of Lakonishok et al. [3], which posits that a value investing strategy should not solely rely on the comparison of financial statement components with market prices.

Piotroski f-score as comprehensive measurement of value investing

Piotroski [1] formulated f-score as a comprehensive measurement VI which is inspired by Lakonishok et al. [3]. Piotroski f-score consists of nine measurements based on fundamental value based on the company's financial statements [1]. This measure, as demonstrated by Piotroski, is more effective when the portfolio is restructured to focus on stocks with a low market-to-book value [1]. Fundamental value component of the f-Score is calculated as follows: (1) A return on assets (ROA) with a positive value in the current year is assigned a score of one, while a negative value is assigned a score of zero. ROA is calculated using earnings before tax divided by total assets. (2) If the ROA for

the current year is higher than that of the previous year, a score of one is assigned; otherwise, the score is zero. (3) A positive operating cash flow in the current year is assigned a score of one; otherwise, it is assigned zero. (4) If operating cash flow exceeds net income, a score of one is assigned; otherwise, it is zero. Net income is measured using earnings before tax. (5) A reduction in the debt-to-asset ratio from the previous year is assigned a score of one; otherwise, it is zero. The debt-to-asset ratio is calculated by dividing long-term debt by the average total assets, where average total assets are derived from the total assets in the current and previous years. (6) An increase in the current ratio from the previous year (t-1) is assigned a score of one; otherwise, it is zero. The current ratio is calculated by dividing current assets by current liabilities. (7) If a company conducts a rights issue in the current year, a score of zero is assigned; otherwise, a score of one is given. (8) An increase in gross profit margin compared to the previous year (t-1) is assigned a score of one; otherwise, it is zero. (9) An increase in the asset turnover ratio compared to the previous year is assigned a score of one; otherwise, it is zero. The asset turnover ratio is calculated by dividing operating revenue by average total assets.

The maximum score of f-score fundamental value is nine, which represents the best FA. On the other hand, the minimum value is zero, which represents the worst FA. First, Piotroski found that the highest f-score has a higher average stock portfolio return than the lowest f-score [1]. His first finding represented the return predictive power of f-score as FA. Second, Piotroski found that the f-score VI indicator could detect a potential stock winner by the highest FA for some stocks that most investors were not giving attention to these [1]. Piotroski measured this low attention by the low MB value [1]. Piotroski proved that MB needed to be identified more deeply to uncover the potential value premium stock, considering that low MB indicates high financial distress by Altman's z-score [1].

RESEARCH METHODS

This article conducte bibliometric analysis to investigate potential confusion in academic research regarding the distinction between FA and VI. This mothode quantitatively analyze academic literature and publications. It can navigate researchers to evaluate the impact of articles, journals, authors, and institutions in a specific field by examining patterns in citation and publication data. Our bibliometric analysis followed the stages outline by Indarti et al as described in Figure 1 [44]. We limit the article mining only to Scopus-indexed articles, and only include journal articles, conference papers, book chapters, and books. All articles were analyzed using Vos-viewer software that can provide literature mapping based on a certain unit of analysis. We used keywords of both the author and index as a unit of analysis. The analysis of keyword is a type of co-occurrence analysis in Vos-viewer software. Co-occurrence analysis calculates the frequency of keywords used in articles. This calculation is the basis for estimating the relationship between keywords from all articles visuall

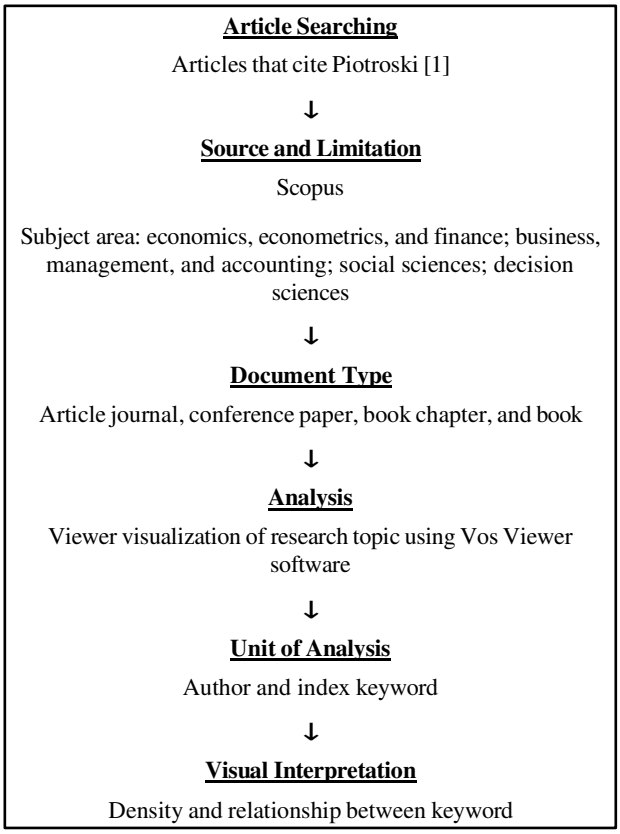

Figure 1. Bibliometric analysis protocol

RESULTS AND DISCUSSION

Table 1 presents the results of the article mining process based on the established protocol. In the initial phase, 374 Scopus-indexed articles citing Piotroski [1] were identified.[2] After excluding papers that fell outside the relevant subject areas, the dataset was reduced to 288 articles. These articles

[2] Searching was conducted on August 30, 2021

were then categorized by document type, year of publication, and Scopus rankings, with a focus on journal articles as depicted in Figure 2. The majority of the analyzed documents were journal articles (261 articles, or 90.63% as shown in Figure 2.1). Most of these journal articles are ranked in the first quartile according to Scopus rankings (146 or 55.94%) out of a total of 261 journal articles (Figure 2.2). Figure 2.3 illustrates a steady increase in the number of articles citing Piotroski [1] from 2001 to 2021.

Table 1. Summary of Article Mining Processes and Result

Search Material	Limitation and Result
Source	Scopus
Keyword	Articles that cite Piotroski's [1]
Year	No limitation
The number of articles	374 articles
The number of articles with limitations based on Figure 1	288 articles
The number of keywords	834 keywords
The minimum number of keywords that can be visualized	At least 2 times appear from 288 articles
The number of keywords visualized based on the minimum frequency limit for keywords	169 keywords

Source: processes and result analysis using Vos-Viewer

Figure 2.1 The number of articles by document types

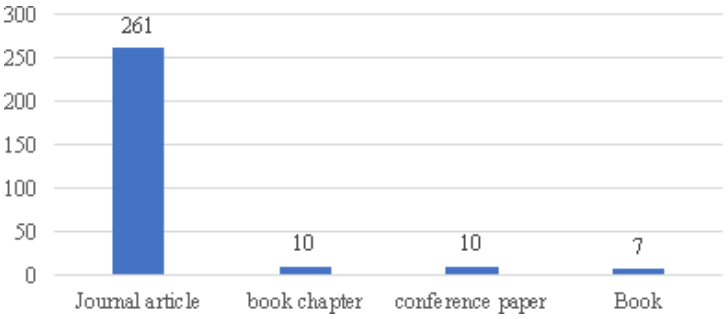

Figure 2.2 Scopus-indexed Journal articles

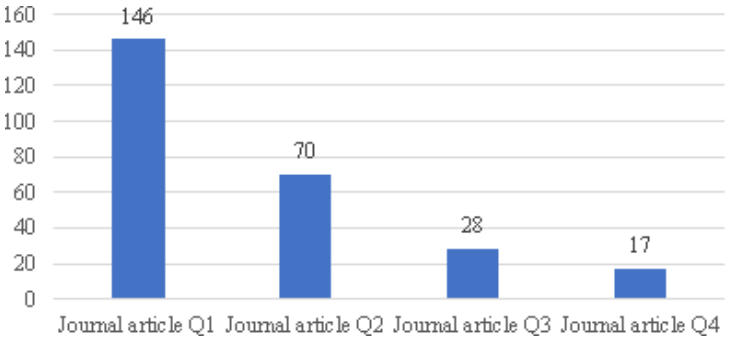

Figure 2.3 The number of articles by year

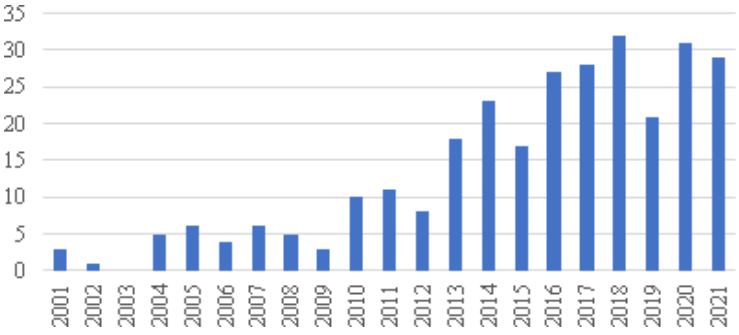

Figure 2. The number of Mined Articles

Figure 3.1 illustrates keyword frequency density, where higher frequency keywords are represented by red areas. Additionally, more frequently used keywords are displayed with larger font sizes. Figure 4 provides further details, revealing that FA is the most frequently used keyword, while VI ranks fourth. FA also has the strongest connections with other keywords, with a total link strength of 89. In comparison, VI ranks third in total link strength, with a value of 52.

Figures 3.1 and 4 suggest that most articles citing Piotroski [1] focus more on FA than VI. However, these findings do not provide a clear comparison of how the f-score keywords relate to FA and VI. To explore this, we analyzed the relationship between f-score keywords and both FA and VI. We identified four variations of the f-score keyword: (1) fscore, (2) f-score, (3) Piotroski's f-score, and (4) f_score, which we assumed to have equivalent meanings. The f_score variation was excluded from further interpretation due to its weak link strength and lack of observed connections to FA or VI. Figures 3.2 to 3.4 present the relationships between the remaining three f-score variations (i.e., f-score, fscore, and Piotroski's f-score) and the FA and VI keywords.

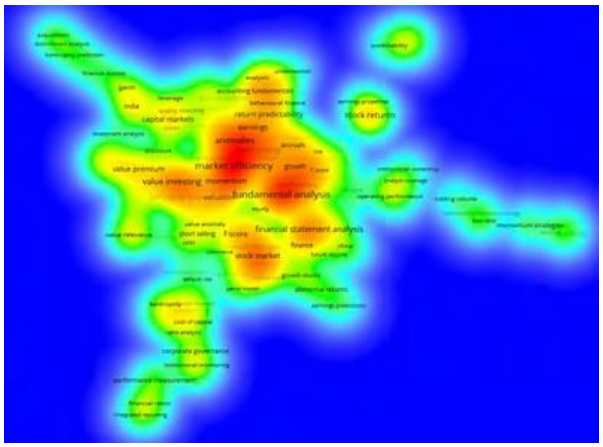

Figure 3.1. Density

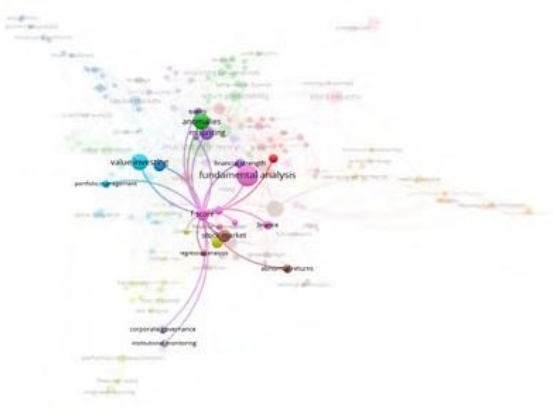

Figure 3.2. f-score keyword relationship

Figure 3. Visual mapping of literature which cites Piotroski's [1] based on keywords using Vos-viewer

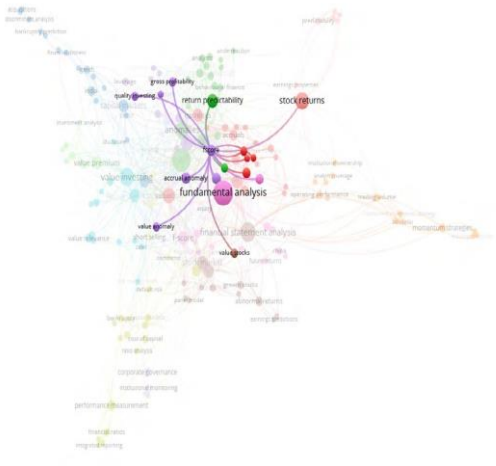

Figure 3.3. fscore keyword relationship

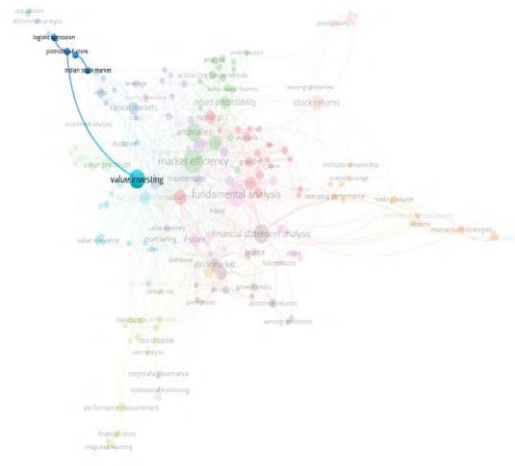

Figure 3.4. Piotroski's f-score keyword relationship

Figure 3. Visual mapping of literature which cites Piotroski [1] based on keywords using Vos-viewer

Figure 3.2 presents the direct relationships between the f-score keyword and both FA and VI. While f-score is directly linked to both keywords, FA and VI themselves do not share a direct relationship, indicating that they were not simultaneously used in the same article. This suggests that discussions of FA and VI in the context of the f-score indicator were addressed separately. Figure 3.3 illustrates the

connections between fscore, FA, and VI, revealing that fscore is directly associated with FA but not with VI. On the other hand, Figure 3.4 shows that Piotroski's f-score is connected to VI, but no direct relationship with FA is observed. The findings from Figures 3.3 and 3.4 are consistent with those of Figure 3.2, confirming that FA and VI are treated as distinct topics in the analysis of the f-score indicator.

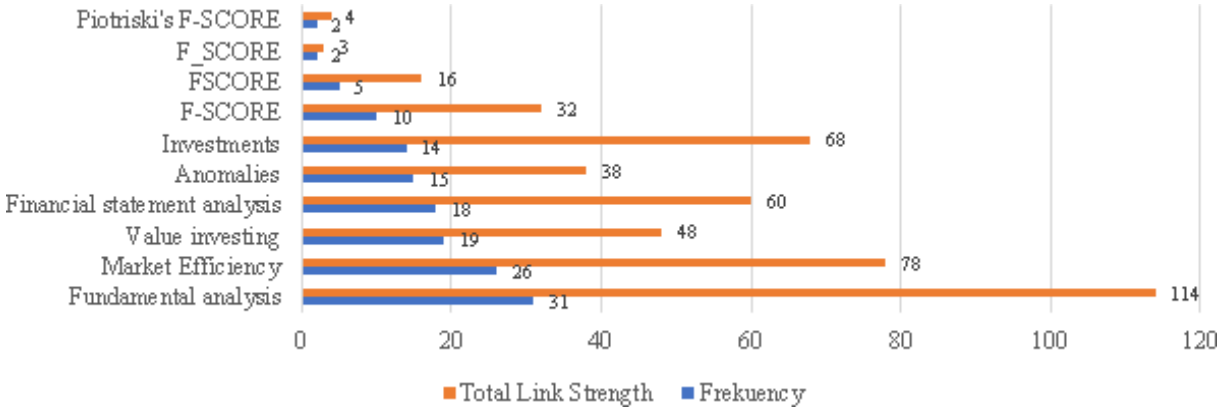

Figure 4. Article keywords based on the highest frequency and total link strength and alternative ways of writing f-score keywords

We performed additional searches of research papers and reviewed articles published after Walkshäusl [4] that cite Piotroski [1] and contain specific terms in their titles, keywords, or abstracts. Our article mining focused on Scopus-indexed papers that reference Piotroski [1] and include particular keywords (i.e., f-score; fscore; f_score and Piotroski f-score) to ensure that all identified articles concentrate on the f-score indicator. These four keywords were identified through our mapping of 372 articles citing Piotroski [1] using VOSviewer. We identified nine articles, detailed in Table 2, which include the authors, sample characteristics, and research objectives. The majority of these studies investigate the f-score indicator as a measure of financial performance [45]–[47], i.e., [48]–[51]. Furthermore, two articles analyze the f-score indicator within the framework of value investing i.e., [52], [53].

Table 2. Research on f-score Indicators after Walkshäusl [4]

Article	Sample	Research objective using f-score indicator
Festa et al. [45]highlighting the potential contribution of intellectual capital (IC	Top five pharmaceutical companies di India	Predicting bankruptcy risk
Jun et al. [52]	All listing companies in South Korea.	Identifying potential winners and losers based on f-score using accrual quality instead of market-to-book value
Kolte et al. [46]	Top 6 retail listing companies in India	f-score as a part of companies' fundamental assessment
Pätäri *et al.* [53]particularly that of Piotroski's (J Account Res 38:1, 2000. https://doi.org/10.2307/2672906	All listing companies in the German stock market	Modified accrual quality and market-to-book value to identify winner's and loser's portfolio stock
Rossi et al. [47]	Airplane companies in India	Predicting bankruptcy risk and potential earnings manipulation
Gimeno *et al*, [51]	Listing companies in Euro first 300 and S&P 500 index.	Modifying f-score which was called *neutral* f-score as a fundamental firm value

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Article	Sample	Research objective using f-score indicator
Chaudhari and Ghorpade [48]	All listing companies of the United States	Forecasting a firm's position based on Pitroski's f-score using ARIMA (Auto-Regressive Integrated Moving Average) model.
Ng and Shen [49]"ISSN":"1467629X-","abstract":"We examine two quality investing strategies using gross prof-itability (GP	All listing companies in Hong Kong, Japan, South Korea, Singapura, and Taiwan	Comparing return predictive power between f-score and Gross profit-ability as fundamental companies' assessment
Kumsta and Vivian [50]	Non-finance listing companies in the United Kingdom	Examining whether f-score is more dominant as liquidity or uncertainty information

The utilization of f-score as a measure of FA does not significantly deviate from its original purpose as a tool for VI. However, the differing concepts of FA and VI present the potential for varying expectations regarding return estimations. VI is a strategy aimed at identifying undervalued stocks due to mispricing [2], meanwhile FA is generally understood as an investment approach that considers a company's prospects, primarily derived from financial statements, without regard to the fairness of stock prices [54]

In this context, we argue, drawing on utility theory, that stock returns derived from using f-score as a measure of VI should exceed those obtained from FA. Utility theory elucidates the level of human satisfaction in economic activities, guiding decisions regarding the consumption of goods or services among various alternatives. In investment terms, utility can be quantified by return on investment [55]. Therefore, the application of utility theory to the VI strategy compared to FA can be illustrated through higher expectations of investment returns.

The concept of utility maximization posits that investors tend to gravitate towards stocks with lower prices, even when FA metrics are identical. Evaluating undervalued stocks necessitates accurate price assessments, while FA does not take into account the fairness of stock prices. Therefore, investing in undervalued stocks is likely to yield greater expected utility than investments based on fair stock prices.

CONCLUSION

This study addresses the potential confusion between fundamental analysis (FA) and value investing (VI) by examining the application of Piotroski's (2000) f-score. Our bibliometric analysis reveals that although the f-score is often used within the context of FA, it is more accurately categorized as VI framework. VI focuses on identifying undervalued stocks, whereas FA tends to assess a company's financial performance without considering stock mispricing. In addition, we identified two theoretical groups underlying the development of value investing indicators. The first group assumes rational investor behavior, encompassing theories like the Efficient Market Hypothesis and Rational Expectations Theory. The second group, grounded in Behavioral Finance, suggests that investor behavior is influenced by irrational factors, leading to persistent market inefficiencies. These groups provide distinct frameworks for the use of value investing indicators. Our study further categorizes these indicators into Single Value Investing Indicators (SVII) and Combined Value Investing Indicators (CVII), building on the foundational works of Graham & Dodd (1934) and Lakonishok et al. (1994). We identify that while the f-score is frequently used in FA contexts, it is more accurately categorized as a Combined Value Investing Indicator (CVII). The distinction between these categories contributes to a clearer understanding of how the f-score should be applied within value investing. Overall, this study refines the differentiation between FA and VI, providing valuable insights for future research and educational efforts. This study has several limitations. First, it focuses solely on Scopus-indexed articles, which may result in the exclusion of relevant research from other databases. Second, the bibliometric analysis relies on specific keywords related to the f-score, potentially overlooking studies that use alternative terminology. Further research could broaden the dataset and test the empirical application of value investing indicators.

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