SILESIAN UNIVERSITY OF TECHNOLOGY PUBLISHING HOUSE

SCIENTIFIC PAPERS OF SILESIAN UNIVERSITY OF TECHNOLOGY 2026
ORGANIZATION AND MANAGEMENT SERIES NO. 245

THE EFFECTIVENESS OF THE PIOTROSKI F-SCORE STRATEGY ACROSS INTERNATIONAL MARKETS: A LITERATURE REVIEW

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Purpose: This article conducts a comprehensive and critical review of the empirical literature on the Piotroski F-score strategy, assessing its effectiveness, international robustness, theoretical underpinnings, practical limitations, and evolutionary adaptations in global equity markets.
Design/methodology/approach: The study employs a targeted literature review methodology. Peer-reviewed publications were systematically identified through searches in Scopus and Web of Science databases using keywords such as "Piotroski F-score", "F-score", "fundamental analysis", and "value investing". Rigorous inclusion criteria focused on empirical studies testing the strategy or its modifications across defined markets and periods, excluding purely theoretical or non-academic works. Findings were synthesized by geographic context, performance outcomes, sources of returns, and thematic clusters identified via bibliometric analysis.
Findings: The Piotroski F-score exhibits strong cross-market effectiveness, particularly in emerging economies with lower informational efficiency, where it generates significant risk-adjusted premiums (e.g., Walkshäusl, 2020). The return premium is predominantly attributed to behavioral mispricing from investor underreaction rather than risk compensation. The strategy performs best among small-cap, low-liquidity stocks and serves as a valuable complement to multifactor approaches. Notable exceptions (e.g., Poland) and practical frictions (transaction costs, capacity constraints) highlight contextual dependencies. Contemporary research extends the F-score through machine learning, ESG integration, distress prediction, and macroeconomic conditioning.
Research limitations/implications: The review is constrained to published empirical studies and lacks a formal meta-analysis. Future research should explore machine learning enhancements, macroeconomic sensitivities, transaction cost impacts on net returns, and behavioral mechanisms of information diffusion to further refine theoretical foundations.
Practical implications: The F-score remains a low-cost, accessible tool for fundamental investors, especially as an overlay in value or multifactor strategies. However, practitioners—particularly large institutions—must account for liquidity constraints and implementation costs, which can substantially erode gross returns in real-world applications.
Originality/value: This review offers the first structured international synthesis of Piotroski F-score literature, documenting its evolution to a versatile framework while evaluating universality, drivers, and viability across global markets.
Keywords: Piotroski F-Score, value investing, fundamental analysis, financial strength, stock returns.
Category of the paper: Literature review.

1. Introduction

A central debate in modern finance theory pits proponents of the Efficient Market Hypothesis (EMH; Fama, 1970), which posits that asset prices fully reflect all available information, against evidence of market anomalies documented in the literature. One prominent example is the post-earnings-announcement drift (Bernard, Thomas, 1989), where stock prices exhibit systematic continuation in the direction of earnings surprises, indicating that markets do not always incorporate new information instantaneously or rationally. Such inefficiencies provide the foundation for fundamental analysis-based investment strategies aimed at exploiting discrepancies between market prices and firms' intrinsic value (Abarbanell, Bushee, 1998).

These strategies are rooted in value investing, a approach pioneered by Graham and Dodd (1934). The core premise is that systematically selecting stocks with low valuation multiples—such as the book-to-market ratio (B/M) - generates superior long-term returns. A critical challenge, however, is the "value trap" phenomenon: many seemingly undervalued firms are inexpensive for fundamental reasons, as deteriorating financial health ultimately results in poor performance and investor losses.

To address this challenge, Piotroski (2000) introduced the F-score, a straightforward yet effective fundamental scoring system. The F-score aggregates nine binary accounting-based signals derived from publicly available financial statements to measure a firm's financial strength. By applying this high F-score filter to a portfolio of high book-to-market stocks, the strategy identifies likely "winners" with improving fundamentals while avoiding "losers" characterized by deteriorating financial condition, thereby significantly reducing exposure to value traps.

Empirical evidence on the Piotroski F-score strategy reveals considerable variation in performance across market contexts and firm characteristics (e.g., Bülow, 2017; Krauss et al., 2015; Singh, Kaur, 2015; Pilch, 2023; Walkshäusl, 2020; Ho et al., 2023; Lopes, Galdi, 2006). Studies on the U.S. market generally confirm that high book-to-market stocks with high F-scores outperform those with low scores, though reported returns differ substantially depending on sample periods, portfolio construction, and rebalancing frequency. For instance, certain implementations involving frequent rebalancing have documented elevated returns for long-only strategies. In markets such as India and Poland, high F-score value stocks have similarly generated superior performance, including statistically significant risk-adjusted returns or positive annual excess returns relative to low-score portfolios (Singh, Kaur, 2015; Pilch, 2023). The strategy's effectiveness appears particularly pronounced in emerging markets with lower informational efficiency (Ho et al., 2023; Lopes, Galdi, 2006). One notable example from Vietnam shows high F-score portfolios delivering substantial positive raw and risk-adjusted returns with strong statistical significance. Cross-country evidence further supports the robustness of the F-score strategy, with a comprehensive study documenting annual risk-adjusted premiums for high-minus-low F-score portfolios of approximately 9.9% in developed (non-U.S.) markets and 12.0% in emerging markets (Walkshäusl, 2020). In contrast, evidence from the U.S. indicates that the strategy's efficacy may vary over time, with some analyses suggesting diminished or conditional performance in more recent periods after controlling for additional risk factors (Turtle, Wang, 2017). Across the reviewed studies, the strongest returns are typically observed among small- and medium-sized firms or stocks with lower liquidity, where mispricing opportunities are greater. However, several studies emphasize significant practical implementation challenges, including liquidity constraints, elevated transaction costs, and limited strategy capacity, which can substantially erode net returns in real-world settings (e.g., Bülow, 2017; Krauss et al., 2015; Hyde, 2018; Pilch, 2023; Lopes, Galdi, 2006).

In the realm of academic research, previous studies have predominantly centered on individual markets. These markets range from highly developed stock exchanges in nations such as the United States or Germany to emerging markets in countries like Vietnam or India. The utilization of diverse methodologies and research periods across these studies leads to challenges in synthesizing the findings and drawing universal conclusions about the strategy's applicability. This article addresses a significant research deficiency by presenting the inaugural comprehensive, international synthesis of the extant literature concerning the efficacy of the Piotroski F-score strategy. The study's originality is manifested in three pivotal aspects.

- Firstly, the study aggregates quantitative rates of return from both developed and emerging markets in order to identify structural factors that determine the effectiveness of the strategy in question. Factors considered include information asymmetry and market efficiency.
- Secondly, in contrast to conventional reviews, the article undertakes a critical analysis of the issue of "institutional scalability." It does so by confronting theoretical backtest results with the realities of transaction costs and liquidity constraints, which frequently receive insufficient attention in academic literature.
- Thirdly, the paper charts the evolution of the F-Score methodology towards contemporary applications, encompassing integration with machine learning and ESG (Environmental, Social, Governance) criteria.

This article provides a comprehensive and critical review of the empirical literature on the Piotroski F-score strategy, evaluating its effectiveness, cross-market robustness, and practical limitations. By synthesizing evidence from a wide array of international settings—ranging from highly efficient U.S. and European markets to less efficient emerging markets—the review identifies the contextual factors that enhance the strategy's performance as well as those that constrain its applicability and profitability.

The article is structured as follows. Section 1 introduces the Piotroski F-score and its role in fundamental analysis. Section 2 details the construction and mechanics of the F-score investment strategy. Section 3 provides a comprehensive review of the empirical literature evaluating the strategy's effectiveness across diverse international markets. Section 4 outlines the methodology employed in conducting this literature review. Section 5 synthesizes the findings, offers a critical analysis, and discusses key implications. Finally, Section 6 presents the main conclusions and suggests avenues for future research.

2. The Piotroski F-Score Strategy

A thorough understanding of the Piotroski F-score construction is essential for accurately interpreting the empirical evidence on its performance. The enduring appeal of Piotroski's (2000) approach stems from its simplicity and exclusive reliance on publicly available financial statement data, requiring no proprietary information or sophisticated analytical tools. This accessibility renders the F-score a versatile and practical screening mechanism, readily applicable by a broad spectrum of investors across diverse international markets.

The Piotroski F-score is calculated as the aggregate of nine binary (0/1) signals, organized into three broad categories: profitability, financial leverage/liquidity (often referred to as financial stability), and operating efficiency. A firm receives one point for each signal it satisfies and zero otherwise, resulting in a composite score ranging from 0 to 9. The individual signals comprising the F-score are detailed in Table 1.

Table 1.
Piotroski F-Score Signals

Category	Signal	Description	Criterion for Scoring 1 Point
Profitability	ROA	Return on assets	ROA > 0 in the current fiscal year
	CFO	Operating cash flow	CFO > 0 in the current fiscal year
	ΔROA	Change in return on assets	ΔROA > 0 (improvement relative to prior year)
	ACCRUAL	Earnings quality	CFO > Net income
Leverage, Liquidity, and Funding	ΔLEVER	Change in financial leverage	Decrease in long-term debt-to-average total assets (or no increase)
	ΔLIQUID	Change in current ratio	Increase in current ratio relative to prior year
	EQ_OFFER	Equity issuance	No new equity issuance in the current fiscal year
Operating Efficiency	ΔMARGIN	Change in gross margin	Increase in gross margin relative to prior year
	ΔTURN	Change in asset turnover	Increase in asset turnover relative to prior year

Source: Author's elaboration based on Piotroski, 2000.

The resulting F-score ranges from 0 (indicating the weakest financial condition) to 9 (indicating the strongest). Following Piotroski (2000), firms with high F-scores—typically those scoring 8 or 9—are classified as financially strong and expected to exhibit improving fundamentals. In subsequent international studies, researchers have frequently adopted a more inclusive threshold of 7-9 to construct larger and better-diversified portfolios, particularly in markets with fewer listed firms (e.g., Pätäri et al., 2018, 2022). Conversely, low F-score firms—generally those scoring 0-2 (or sometimes 0-1)—are identified as financially weak and prone to further deterioration.

Piotroski's (2000) original investment strategy employs a zero-investment long-short portfolio constructed as follows. First, the universe of stocks is restricted to those in the highest book-to-market (B/M) quintile, identifying a sample of value firms. Within this subset, stocks are ranked by F-score: long positions are taken in high F-score firms (typically scoring 8-9), while short positions are established in low F-score firms (typically scoring 0-1). The portfolio is rebalanced annually at the end of each fiscal year. Although initially applied in this specific context, subsequent research has established that the F-score's predictive ability extends well beyond traditional value stocks. However, as the ensuing literature review will illustrate, its effectiveness is not unconditional and varies systematically with market conditions and implementation details.

3. Literature review

Since its introduction in Piotroski (2000), the F-score has spurred a substantial body of empirical research examining its effectiveness across diverse market environments. This literature review synthesizes key findings from these studies, evaluating the strategy's robustness and universality by analyzing performance evidence from markets differing in institutional development, informational efficiency, and liquidity.

The foundation for subsequent research is Piotroski's (2000) seminal study, which examines the U.S. market over the period 1976-1996. Focusing on the quintile of firms with the highest book-to-market (B/M) ratios—corresponding to the 20% of stocks with the lowest price-to-book values—Piotroski sorts these value stocks into portfolios based on their F-score. The zero-investment hedge strategy that buys high F-score firms (scores of 8-9) and shorts low F-score firms (scores of 0-1) generates an average annual market-adjusted return of 23 percentage points. In absolute terms, the high F-score portfolio earns 23.5% per year, substantially outperforming both the broad CRSP value-weighted market index (which returns 17.9%) and the average value stock. This evidence demonstrates that the F-score effectively discriminates between strong and weak value firms, delivering significant excess returns in the U.S. context (Piotroski, 2000).

Subsequent empirical research on the Piotroski F-score strategy in the U.S. market has primarily explored three interrelated themes: the economic sources of the observed return premium, practical implementation constraints, and the impact of macroeconomic conditions.

Regarding the sources of the F-score return premium in the U.S. market, Piotroski and So (2012) provide both conceptual and empirical evidence that it stems primarily from investor expectation errors regarding firms' fundamental trajectories, leading to systematic mispricing rather than compensation for systematic risk. The F-score effectively identifies financially robust value firms whose improving prospects are underappreciated by the market, thereby explaining portions of the value and momentum anomalies. From a practical perspective, Krauss et al. (2015) revisit the strategy over the 2005-2015 period using realistic implementation assumptions. Their analysis reveals that gross returns diminish substantially—and in many cases turn negative—after accounting for transaction costs, bid-ask spreads, and liquidity constraints, particularly in frequent rebalancing scenarios or among small-cap and low-liquidity stocks where the theoretical premium is most pronounced. Furthermore, Anderson et al. (2021) examine the sensitivity of the F-score to macroeconomic conditions using U.S. data from 1973-2016. They document that macroeconomic variables and monetary policy exert a significantly stronger influence on firms' financial signals (and thus F-scores) during recessions than expansions, implying that financial strength becomes more contingent on external economic factors in downturns.

Evidence from developed markets outside the United States generally supports the effectiveness of the Piotroski F-score strategy, albeit with notable cross-country and contextual variation. In Germany, Pätäri et al. (2018, 2022) document substantial value added when the F-score is used to complement traditional value strategies, emphasizing its downside protection during bear markets and persistent performance over multi-year holding periods. In the United Kingdom, Rathjens and Schellhove (2011) report the counterintuitive finding that the F-score generates stronger returns among growth stocks than value stocks, while more recent work by Kupiainen (2024)—covering 2000-2022—demonstrates that integrating the F-score with price momentum materially enhances risk-adjusted performance, as evidenced by higher Sharpe ratios. On the Australian market, Hyde (2018) confirms significant abnormal returns (0.85% monthly premium for large companies and 1.36% monthly premium for small companies, in the case of capitalization-weighted portfolios), though these are largely attributable to exposure to conventional risk factors (size, value, and momentum). In the eurozone, Gimeno et al. (2020) highlight limitations of the original binary F-score construction, showing that machine-learning extensions, such as neural network-based NF-scores, deliver superior predictive power and portfolio outcomes. Across the Nordic countries (Sweden, Denmark, Finland, and Norway), Brindelid and Nilsson (2021) find that high F-score portfolios consistently outperform broad market indices over the 2012-2020 period, with the strongest results observed in Norway.

Walkshäusl (2020) provides robust cross-country evidence supporting the international applicability of the Piotroski F-score strategy. In a comprehensive analysis spanning 35 markets—including 23 developed and 12 emerging economies—the study documents significant risk-adjusted premiums for high-minus-low F-score portfolios, with particularly strong performance in emerging markets, where informational inefficiencies are more pronounced. In established markets (excluding the US), the strategy yielded an average premium of 10 per cent, whereas in emerging markets, it resulted in a premium of approximately 12 per cent. These findings are corroborated by a growing body of country-specific research in emerging economies:

- Brazil (Lopes, Galdi, 2006): The strategy proves effective, though returns are maximized over a two-year holding period, consistent with slower information diffusion in less efficient markets.
- China (A-shares; Deng, 2016): A substantial monthly premium of approximately 1.3% for long-short portfolios (approximately 16.5% per annum.), driven primarily by stocks with low liquidity, limited analyst coverage, and—counterintuitively—lower book-to-market ratios.
- India (Tripathy, Pani, 2017): High F-scores are associated with statistically significant improvements in both contemporaneous and future market-to-book ratios (MTB) and return on equity (ROE).
- Indonesia (Sharia-compliant firms; Asmadi et al., 2021): The F-score successfully identifies companies exhibiting superior financial strength.
- Turkey (Gülcan, Sakinç, 2025): High F-scores exert a positive and statistically significant influence on price-to-book, price-to-earnings ratios, and subsequent stock returns.
- Vietnam (Ho et al., 2023): The strategy generates profitable outcomes not only among value stocks but also within the growth segment, the investment yielded a return of 30.8% (raw return) and 30.5% (market-adjusted return).
- South Africa (van der Merwe et al., 2016): Buy-and-hold portfolios of high F-score firms deliver higher annual returns over one-year horizons compared with longer periods, suggesting relatively rapid incorporation of fundamental information following financial statement releases.

A notable exception to this generally positive pattern is observed in the Polish market. Pilch (2022, 2023) documents that, over the 2012-2022 period, high F-score firms underperformed the average value stock portfolio, rendering the F-score a counterproductive selection tool in this context. A quantitative analysis of the extant literature reveals the results of studies by authors such as Piotroski (2000), Walkshäusl (2020), Ho et al. (2023), and Deng (2016). Hyde (2018) and Pilch (2022, 2023) posit a robust correlation between the magnitude of excess returns generated and the degree of market development as well as its informational efficiency. The available data appear to substantiate the hypothesis of a discernible efficiency gradient. In less efficient markets (for example, Vietnam and China), simple fundamental analysis based on historical data allows for high rates of return, thus contradicting the poor form of market efficiency. In developed markets (e.g., Australia and Western Europe), the F-score premium is subject to compression, functioning primarily as a compensation for exposure to known risk factors such as size, value, and momentum, rather than as a consequence of mispricing. The case of Poland (Pilch 2022, 2023) signifies the presence of distinct local conditions (e.g. ownership structure, liquidity) that have the potential to nullify the efficacy of the strategy. Table 2 provides a comprehensive summary of empirical findings on the Piotroski F-score strategy across international markets.

Table 2.
Summary of Key Empirical Studies on the Piotroski F-Score Strategy

Author(s) and Year	Market	Study Period	Key Findings
Piotroski (2000)	United States	1976-1996	The long-short strategy (high F-score long, low F-score short) among high book-to-market stocks generates substantial abnormal returns, with the hedge portfolio earning approximately 23 percentage points annually.
Piotroski, So (2012)	United States	Conceptual and empirical analysis	The F-score premium is attributable to behavioral mispricing stemming from investor underreaction to fundamental improvements rather than compensation for systematic risk.
Krauss et al. (2015)	United States	2005-2015	After incorporating realistic transaction costs, bid-ask spreads, and liquidity constraints, gross returns are significantly eroded, often rendering the strategy unprofitable in practice, particularly with frequent rebalancing.
Anderson, Chowdhury, Uddin (2021)	United States	1973-2016	Macroeconomic variables and monetary policy exert a stronger influence on F-scores and firm financial signals during recessions than expansions, highlighting the contingent nature of financial strength in adverse economic conditions.
Rathjens, Schellhove (2011)	United Kingdom	1991-2008	Counterintuitively, the F-score generates stronger returns among growth stocks (low B/M) than traditional value stocks.
Kupiainen (2024)	United Kingdom	2000-2022	Integrating the F-score with price momentum in a hybrid strategy significantly enhances risk-adjusted performance (higher Sharpe ratios) relative to standalone value or momentum approaches.
Hyde (2018)	Australia	1992-2013	The F-score strategy generates significant abnormal returns, but these are largely attributable to exposure to conventional risk factors (size, value, and momentum).
Pätäri et al. (2018, 2022)	Germany	2000-2015	The F-score adds substantial value as a complementary filter to traditional value strategies, offering particular downside protection during bear markets and remaining effective over three-year holding periods.
Brindelid, Nilsson (2021)	Nordic countries (Sweden, Denmark, Finland, Norway)	2012-2020	High F-score portfolios consistently outperform broad market indices across all four countries, with the strongest results observed in Norway.
Gimeno et al. (2020)	Eurozone	2006-2017	The original binary F-score has limited efficacy; a neural network-based extension (NF-score) significantly enhances predictive power and portfolio performance.
Walkshäusl (2020)	35 markets (23 developed ex-U.S., 12 emerging)	2000-2018	The F-score is a robust positive predictor of risk-adjusted returns internationally, with particularly strong premiums in emerging markets.
Deng (2016)	China (A-shares)	2006-2014	The strategy delivers substantial monthly premiums (approximately 1.3% for long-short portfolios), concentrated in low-liquidity stocks with limited analyst coverage and, counterintuitively, among lower book-to-market firms.
Tripathy, Pani (2017)	India	2010-2015	High F-scores are positively and statistically significantly associated with both current and future market-to-book ratios (MTB) and return on equity (ROE), confirming the indicator's predictive ability for future performance.
Lopes, Galdi (2006)	Brazil	1994-2004	The F-score strategy is effective, but returns are maximized over a two-year holding period, consistent with slower information diffusion in emerging markets.

Cont. table 2.

Ho et al. (2023)	Vietnam	2009-2019	The strategy generates positive returns for both value and growth stocks, demonstrating broader applicability beyond traditional high book-to-market firms.
Gülcan, Sakinç (2025)	Turkey (industrial firms on Borsa Istanbul)	2010-2022	The F-score exerts a positive and statistically significant influence on price-to-book ratios, price-to-earnings ratios, and stock returns, confirming its analytical value in this market.
Asmadi, Izzaty, Erwan (2021)	Indonesia (Sharia-compliant firms on Jakarta Islamic Index)	2017-2018	The F-score effectively discriminates financial quality among Sharia stocks, identifying 4 firms with excellent condition (F-score 8-9), 25 with moderate, and 1 with poor condition out of 30 analyzed.
Pilch (2022, 2023)	Poland	2012-2022	High F-score firms underperform the average value portfolio, representing a notable exception where the strategy fails to add value.
van der Merwe, Taft, Akinboade (2016)	South Africa (JSE)	2000-2011	One-year buy-and-hold portfolios of high F-score firms outperform five-year portfolios, suggesting relatively rapid price adjustment following positive financial disclosures.

Source: Author's elaboration.

This heterogeneous body of evidence—while predominantly supportive of the Piotroski F-score strategy's effectiveness—exhibits considerable cross-market variation that warrants systematic analysis. Such an evaluation, encompassing both theoretical explanations and practical implications, is provided in the subsequent sections of this article.

4. Methods

This article adopts the format of a targeted literature review. The objective of this approach is to provide a synthetic and critical assessment of key empirical studies on the Piotroski F-score strategy, without undertaking a formal statistical meta-analysis, while adhering to rigorous criteria in the selection and evaluation of sources.

The search strategy employed reputable international databases, primarily Scopus and Web of Science, which index peer-reviewed journals in finance, accounting, and related fields. Relevant studies were identified using targeted keywords, including "Piotroski F-score", "F-score", "Piotroski", in combination with terms such as "value investing", "fundamental analysis", "financial strength", "book-to-market", and "market anomalies". Boolean operators and truncation were applied where appropriate to capture variations and ensure comprehensive coverage.

Rigorous inclusion and exclusion criteria were applied to ensure the quality and relevance of the reviewed studies. Publications were selected for analysis if they met the following conditions: (1) conducted empirical tests of the effectiveness of the Piotroski F-score strategy or its modifications; (2) appeared in peer-reviewed academic journals or as doctoral/master's theses from reputable institutions; and (3) specified clearly defined sample periods and market contexts. Purely theoretical papers, non-academic publications, and studies lacking methodological rigor were excluded.

An initial search of the Scopus database using the specified keywords yielded 91 peer-reviewed publications directly addressing the Piotroski F-score strategy. A bibliometric analysis of the publication timeline reveals a marked upward trend in research interest in recent years. Although Piotroski's seminal 2000 paper laid the foundation, the majority of identified studies were published after 2015, with a pronounced surge in output between 2020 and 2025. This pattern reflects a renewed scholarly focus on classical fundamental analysis-based approaches and ongoing efforts to adapt the F-score to increasingly sophisticated and dynamic market environments.

A geographical analysis of author affiliations and examined markets reveals a marked shift in research emphasis. Whereas early studies predominantly focused on the U.S. market, contemporary contributions increasingly target emerging economies, particularly in Asia. Within the reviewed sample, investigations of India (e.g., Balasubramanian et al., 2019; Kolte et al., 2022), China (e.g., Jiang et al., 2020; Chen, Chu, 2024), Vietnam (Ho et al., 2023), and Malaysia (Hiau Abdullah et al., 2019) are especially prominent. This pattern suggests that straightforward financial heuristics, such as the Piotroski F-score, may prove particularly valuable in markets characterized by lower informational efficiency and greater information asymmetry.

A keyword and abstract analysis of the assembled publications identifies four primary thematic clusters that delineate the predominant directions in contemporary research on the Piotroski F-score strategy:

- **Integration with Modern Technologies (Artificial Intelligence and Machine Learning)**: The most rapidly evolving research stream involves fusing traditional fundamental analysis with advanced computational techniques. Increasingly, scholars are departing from the original binary structure of the Piotroski F-score in favor of hybrid and enhanced models. For instance, Gimeno et al. (2020) introduce a neural network-based variant (Neural F-Score) that outperforms the classic version in the eurozone context. Almeida and Neves (2022) employ evolutionary algorithms to optimize F-score-weighted portfolios, while Chen and Chu (2024) augment financial signals with sentiment analysis derived from text mining of auditors' reports. Similarly, Wu et al. (2025) integrate the F-score with big data analytics in the real estate sector, demonstrating improved predictive accuracy.
- **The Piotroski F-Score in the Context of Sustainable Development (Environmental, Social, and Governance – ESG)**: A second prominent research stream explores the interplay between firms' fundamental financial strength—as captured by the F-score—and their environmental, social, and governance (ESG) performance. Emerging studies suggest a positive association, indicating that financially robust companies tend to exhibit greater transparency in ESG reporting and higher overall ESG ratings.

This correlation implies that firms with superior financial quality may possess the resources and incentives to invest in sustainable practices, potentially reflecting aligned long-term stakeholder interests.

- **Financial Distress and Bankruptcy Risk Prediction**: A third key research direction extends the application of the Piotroski F-score beyond investment portfolio selection, positioning it as an early warning indicator for corporate financial distress and bankruptcy risk. Low F-scores, signaling deteriorating fundamentals, have proven effective in identifying firms vulnerable to default. This approach is frequently compared or combined with classic models such as Altman's Z-score. For example, Rahman et al. (2021) demonstrate the F-score model's predictive power for financial distress among U.S. firms, while Kolte et al. (2018) apply both F-score and Z-score analyses to the bankruptcy of Kingfisher Airlines, confirming their utility in diagnosing severe financial deterioration across manufacturing and service sectors.
- **Sectoral and Macroeconomic Specificity**: The fourth and final thematic cluster examines the performance of the Piotroski F-score strategy under varying industry-specific and macroeconomic conditions. Research in this area reveals substantial heterogeneity in effectiveness, driven by cyclical factors and sector characteristics. For example, Anderson et al. (2025) highlight the strategy's sensitivity to business cycle phases and monetary policy regimes, with predictive power strengthening during economic downturns when fundamental signals become more salient. Sector-focused studies further illustrate this context-dependence: Sen and Neogi (2025) analyze the Indian cement industry, showing how capital-intensive cycles and regulatory pressures influence the F-score's discriminatory ability, whereas Festa et al. (2021) demonstrate its adapted utility in the pharmaceutical sector, where intangible assets and innovation pipelines interact with traditional accounting signals. Collectively, these investigations emphasize the need to calibrate the F-score approach to industry idiosyncrasies and prevailing economic environments for optimal application.

In summary, the bibliometric evidence underscores the evolution of the Piotroski F-score from a straightforward tool designed to enhance value investing strategies into a versatile, multidimensional analytical framework. Contemporary scholarship not only affirms its robustness across diverse geographic markets—particularly in emerging economies—but also extends its application through integration with artificial intelligence and machine learning techniques, as well as incorporation of non-financial factors such as environmental, social, and governance (ESG) considerations.

The adopted analytical framework facilitates a systematic synthesis of the extant literature on the Piotroski F-score strategy. Studies were categorized along three primary dimensions: geographic market context, principal findings regarding the strategy's effectiveness, and—most crucially—the identified sources of the observed return premium. This structured approach enables a coherent discussion of the evidence and supports the derivation of robust, evidence-based conclusions.

5. Results and discussion

The empirical evidence portrays the Piotroski F-score as a highly predictive instrument whose effectiveness is significantly moderated by market-specific and structural factors. Based on the literature review, three primary areas emerge as critical for deeper analysis: (1) the strategy's universality and geographic limitations, including its varying performance across developed and emerging markets; (2) the underlying sources of the observed return premium, encompassing behavioral mispricing, informational inefficiencies, and risk-based explanations; and (3) the ongoing evolution of the strategy and its practical applications, particularly through extensions involving machine learning, ESG integration, financial distress prediction, and sector/macroeconomic conditioning.

One of the primary conclusions emerging from this review is the robust international effectiveness of the Piotroski F-score strategy. Its capacity to identify profitable investment opportunities—particularly among value stocks—has been consistently documented across a broad spectrum of markets, encompassing both developed economies and emerging markets (Walkshäusl, 2020). This cross-market resilience indicates that the F-score captures fundamental principles of financial statement analysis that transcend local institutional, regulatory, and informational differences, underscoring its value as a universally applicable tool in global equity investing.

This conclusion must, however, be tempered by notable exceptions that challenge the notion of unqualified universality. Evidence from the United Kingdom reveals the intriguing finding that the Piotroski F-score performs more effectively among growth stocks than traditional value stocks (Rathjens, Schellhove, 2011). Similarly, on the Polish market, the strategy failed to generate any significant value added over the examined period, with high F-score firms actually underperforming the broader value portfolio (Pilch, 2022, 2023). These anomalous results highlight potential moderating influences, including differences in informational efficiency, market microstructure, and investor behavior. In highly efficient and mature markets like the UK, basic accounting signals may be rapidly incorporated into prices, diminishing their predictive edge within the value segment. In contrast, the unique composition of listed firms in Poland during the sample period—potentially characterized by distinct ownership structures or sector concentrations—may have undermined certain core assumptions of the strategy. Overall, these findings caution against the mechanical cross-market application of the F-score without careful consideration of local contextual factors.

A central theoretical debate surrounding the Piotroski F-score concerns the economic origins of its abnormal returns. The accumulated empirical evidence predominantly supports the mispricing hypothesis, presenting an enduring challenge to the Efficient Market Hypothesis (EMH). Under this behavioral interpretation, the F-score premium arises from systematic investor expectation errors—particularly excessive pessimism toward distressed value firms—and the delayed incorporation of publicly available fundamental information into stock prices. Key studies, including Piotroski and So (2012) and Lopes and Galdi (2006), demonstrate that markets underreact to signals of financial improvement among high book-to-market stocks, allowing the F-score to systematically identify firms poised for positive earnings and price revisions. By exploiting this sluggish adjustment process, the strategy enables investors to capture returns that reflect the gradual correction of initial mispricing rather than compensation for heightened systematic risk.

In contrast, support for the risk-based explanation remains considerably weaker. The majority of studies find that conventional asset pricing models—such as the Fama-French three- or five-factor models—fail to fully account for the observed abnormal returns generated by the Piotroski F-score strategy (e.g., Walkshäusl, 2020). Furthermore, high F-score firms are, by construction, characterized by stronger fundamentals, including lower financial leverage, higher profitability, and improved operating efficiency—attributes that directly contradict the notion of elevated systematic risk exposure. One notable exception is the Australian market, where Hyde (2018) documents that much of the premium can be attributed to loadings on established risk factors (size, value, and momentum).

Over more than two decades, the Piotroski F-score has evolved from a specialized tool designed to refine value investing strategies into a broadly recognized indicator of firm fundamental strength. Contemporary extensions of the approach significantly expand upon the original framework, incorporating advanced methodologies and broader applications—as illustrated by the comparative overview in Table 3.

Table 3.
Comparison of the Original Piotroski F-Score Strategy and Contemporary Adaptations

Criterion	Original strategy (Piotroski, 2000)	Contemporary Adaptations
Stock Universe	Restricted to high book-to-market (B/M) firms	Extended to the broader market universe, including growth stocks and all listed firms, particularly on smaller or emerging markets.
Integration with Other Factors	Employed as a standalone selection filter	Frequently incorporated as a complementary signal in multifactor or hybrid strategies (e.g., combined with price momentum or machine learning models such as neural networks).
Consideration of Macroeconomic Environment	No explicit formal analysis	Increasingly accounts for macroeconomic regimes, business cycles, and monetary policy influences.
Selection Thresholds	Long positions in firms with F-scores of 8-9; short positions in firms with F-scores of 0-1	More flexible thresholds, commonly long positions in F-scores of 7-9 and short positions in F-scores of 0-2, to accommodate portfolio diversification and market-specific constraints.

Source: Author's elaboration.

Despite its conceptual appeal and empirical robustness, the Piotroski F-score strategy encounters substantial practical limitations in implementation. As Krauss et al. (2015) demonstrate, the strategy's performance is most pronounced among small-cap stocks, which typically exhibit low liquidity and elevated transaction costs. The findings of numerous studies indicate that the discriminatory power of the F-Score is inversely proportional to the size of the company. Hyde (2018) demonstrated that, in the Australian market, the monthly premium for small companies (1.36%) was almost twice as high as for large companies (0.85%). Drawing parallels with the Chinese market reveals analogous inferences. Deng's (2016) observations in this regard point to a discernible accumulation of premiums within companies exhibiting minimal analytical coverage. This finding aligns closely with the tenets of the investor neglect hypothesis. As Arbel and Strebel (1982) observe, the rarity of analysis of smaller entities means that price inefficiencies can persist for protracted periods. These frictions can materially erode—or even eliminate—theoretical gross returns, rendering the approach particularly challenging for large institutional investors constrained by scale and capacity concerns. Similar implementation hurdles, including bid-ask spreads and market impact costs, have been noted across various international markets, further underscoring the gap between theoretical efficacy and realizable net performance.

6. Summary

This comprehensive literature review conclusively demonstrates the enduring effectiveness and significance of the Piotroski F-score strategy. More than two decades after its introduction, the approach continues to serve as a cornerstone of contemporary fundamental analysis, exhibiting remarkable robustness and adaptability in identifying profitable investment opportunities across diverse market contexts.

The principal conclusions drawn from this literature review can be summarized as follows:

- **Broad Cross-Market Applicability**: Empirical research consistently affirms the Piotroski F-score as a globally robust tool, with Walkshäusl (2020) providing compelling evidence across 35 developed and emerging markets. The strategy's effectiveness has been validated in highly diverse settings, including the United States, Germany, the Nordic countries, China, India, Turkey, and South Africa. This widespread resilience suggests that the nine underlying fundamental signals effectively capture improvements in financial health, transcending local institutional, regulatory, and informational differences.
- **Size and Liquidity Effects**: A recurring finding across studies is that the Piotroski F-score strategy generates the strongest returns among small- and medium-sized firms, particularly those characterized by low liquidity and limited (or absent) analyst

coverage. This pattern indicates that the F-score is most effective in segments where informational inefficiencies are prevalent, allowing it to exploit investor underreaction to publicly available fundamental signals in less-followed stocks.

- **Enhancement of Complementary Investment Strategies**: The Piotroski F-score functions not only as an effective standalone selection criterion but also as a powerful overlay for augmenting other investment approaches. Empirical evidence indicates that incorporating the F-score as an additional filter substantially improves the risk-adjusted performance of portfolios constructed on accounting-based anomalies (Pätäri et al., 2022) and hybrid strategies combining value characteristics with price momentum (Kupiainen, 2024). This synergistic effect underscores the F-score's versatility in refining broader fundamental and multifactor frameworks.
- **Sensitivity to Macroeconomic Conditions**: The predictive power of the Piotroski F-score strategy, as well as the underlying financial health signals it measures, exhibits notable sensitivity to prevailing macroeconomic conditions. Anderson et al. (2021) document that macroeconomic factors—particularly monetary policy—exert a substantially stronger influence on firms' fundamental signals (and thus F-scores) during economic recessions than expansions. This finding underscores the heightened salience of financial strength indicators in adverse environments, where external economic pressures amplify the discriminatory power of the F-score in separating resilient firms from vulnerable ones.
- **Role in Identifying Mispricing**: The core strength of the Piotroski F-score lies in its ability to detect systematic errors in investor expectations, consistent with the behavioral evidence presented in Piotroski and So (2012). By distinguishing fundamentally robust value firms—whose improvement potential is often underappreciated by the market—from financially deteriorating growth stocks that may be overvalued, the F-score enables investors to exploit mispricing opportunities. In particular, it serves as an effective safeguard against "value traps," allowing for more informed portfolio decisions that prioritize genuine financial recovery over superficial undervaluation.

More than two decades after its initial publication, the Piotroski F-score remains a robust and versatile cornerstone in the toolkit of fundamental investors. Its capacity to generate substantial value added through a straightforward yet powerful analysis of financial statement data has been consistently validated across a wide array of global equity markets, affirming its enduring relevance and practical utility in contemporary investment practice.

Regarding future research directions, the literature points to several promising areas. First, there is considerable scope for further developing F-score modifications through machine learning and artificial intelligence techniques, potentially yielding more adaptive and predictive variants. Second, additional studies are needed to examine in greater detail how macroeconomic regimes—including business cycles and monetary policy shifts—as well as transaction frictions (such as liquidity constraints and costs) influence the strategy's net profitability in real-world settings. Finally, deeper behavioral investigations into the psychological mechanisms underlying slow information diffusion would strengthen the theoretical underpinnings of the mispricing anomalies that the Piotroski F-score effectively exploits.

Acknowledgements

Supported by funds from the Ministry of Science under the "Regional Excellence Initiative" Program.

Ministerstwo Nauki i Szkolnictwa Wyższego

Regionalna Inicjatywa Doskonałości

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