The Dilemmas and Opportunities of Value Investing Paradigms in the Age of Technological Disruption

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Abstract. With the widespread adoption of emerging technologies such as the Internet, big data, and artificial intelligence, traditional value investment theories are encountering unprecedented challenges and opportunities. These technologies are reshaping information asymmetry, market efficiency assumptions, and enterprise valuation models. The rapid advancement of digital technology is fundamentally transforming traditional theories and practices of value investing, leading to the emergence of new evaluation frameworks. Therefore, this paper examines how digital technology impacts and reshapes the logic of value creation, systematically analyzing the limitations of value investing in the digital age and proposing three innovative approaches. The study highlights the dual nature of digital technology's influence on value investing: while it accelerates value discovery, it also introduces potential systemic risks. By providing a cognitive framework for value assessment in the era of technological civilization, this research offers valuable insights for investors, regulators, and academics, addressing the gap in existing theories within the digital context. This framework will enhance the technological adaptability of the capital market, promoting the stability and development of financial markets and lays a robust foundation for future research.

1 Introduction

The essence of value investing lies in identifying undervalued stocks and overvalued glamour stocks that are mispriced, generating abnormal returns as their prices revert to intrinsic values. Since the 2007 financial crisis, concerns about the obsolescence of value investing have intensified, with a notable increase in reports [1]. This raises the critical question of the factors contributing to the perceived failure of the value investment strategy.

On one hand, the performance of value investing has been suboptimal due to the adverse effects of the macroeconomic environment. In a context characterized by heightened global economic volatility, sluggish economic growth, and increased policy uncertainty, many traditional value stocks have underperformed relative to expectations. Meanwhile, the extensive dissemination on social media and news media has magnified market panic,

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exacerbated irrational investor behavior and thereby undermined confidence in value investing.

On the other hand, rapid technological advancements challenge traditional valuation frameworks, which heavily rely on basic financial metrics and static moat theories to assess long-term competitiveness. Such reliance can lead to significant distortions in valuing firms, particularly technology-driven enterprises. Conservative accounting practices often fail to capture intangible assets, resulting in misleading book values and ratios such as price-to-earnings and price-to-book [1]. Additionally, emerging valuation metrics face quantification challenges. For instance, Tesla's market premium attributed to its autonomous driving technology cannot be accurately assessed using traditional discounted cash flow models (DCF). Furthermore, the pace of technological change has outpaced the protective mechanisms of static moats. While the moat theory holds in stable industries, in technology-intensive sectors, competitive advantages tend to erode more quickly. The average lifespan of S&P 500 companies has decreased from 60 years in the 1960s to less than 20 years today [2]. Kodak serves as a prime example: despite holding patents in film technology, its overreliance on established markets left it unprepared for digital disruption, ultimately leading to bankruptcy due to path dependence [3]. Similarly, Nokia's inability to transition its feature phone dominance into smartphone competitiveness, due to its closed ecosystem and software deficiencies, highlights the challenges faced by firms in rapidly evolving markets [4].

Considering these challenges, it is evident that the traditional value investment strategy faces significant limitations in a digitally driven economy. To remain relevant, value investing must evolve by integrating new valuation techniques that more accurately account for intangible assets and the dynamic nature of competitive advantages. By adapting to the realities of technological innovation, value investors can continue to identify undervalued opportunities within an increasingly complex market environment. Therefore, this paper aims to summarize the limitations of value investing in a digitally driven economy and provide insights into adapting this strategy to technological innovation.

2 The value system in digital era

In the digital era, the traditional value system is undergoing transformative changes. Pioneering technological innovations, exemplified by big data and artificial intelligence, have fundamentally altered the underlying mechanisms of value creation and creatively revealed new dimensions of valuation. This section begins with an overview of technological innovation and its value transmission pathways, discussing the evolution of value system.

2.1 Overview of technological innovation

In "Theory of Economic Development," Schumpeter posited that innovation is a novel combination of production factors and conditions. Unlike the experimental and inventive phases, this concept focuses on introducing technological advancements into the economic domain, which facilitates revolutionary creative destruction within the economic structure. By integrating the characteristics of the digital age and referencing the model of disruptive innovation, this paper develops a three-dimensional technological framework that encompassing enabling, disruptive, and integrative dimensions [5].

First, enabling technologies optimize the allocation of production factors and minimize waste, thereby achieving Pareto Optimality and enhancing economic operational efficiency. Enterprise value is amplified through the technological leverage effect, as these technologies can substantially improve enterprise performance and generate returns that surpass initial

investments. For instance, leveraging big data with machine learning algorithms can reduce supply chain management errors, leading to significant reductions in inventory costs [6].

Second, disruptive technologies fundamentally change the industry landscape and pose significant challenges to traditional enterprises. They generally follow a cyclic mechanism of initial penetration, exponential growth, and competitive lock-in, entering the mainstream market from the low-end segment and creating new markets. As a representative, blockchain technology can effectively reduce the cost of contract execution through the automatic execution of smart contracts. Particularly, its decentralized nature disrupts the conventional reliance on intermediaries in transactions [7].

Third, integrative technologies denote interdisciplinary modular technology clusters based on integrated benefits and associated system risks. Upon the successful completion of technological collaboration and ecosystem development, the synergistic effects of enterprise technologies frequently exhibit exponential growth trends rather than simple linear accumulation [8].

2.2 Value transmission pathways of technologies

Although technology itself does not directly create value, the value chain behind it can bring huge potential returns to companies. Therefore, dissecting this transformation link and its key nodes has become the key to measuring technology and predicting the future value changes of enterprises. After reviewing relevant literature, this paper proposes the transmission path as shown in Fig. 1 and Fig. 2.

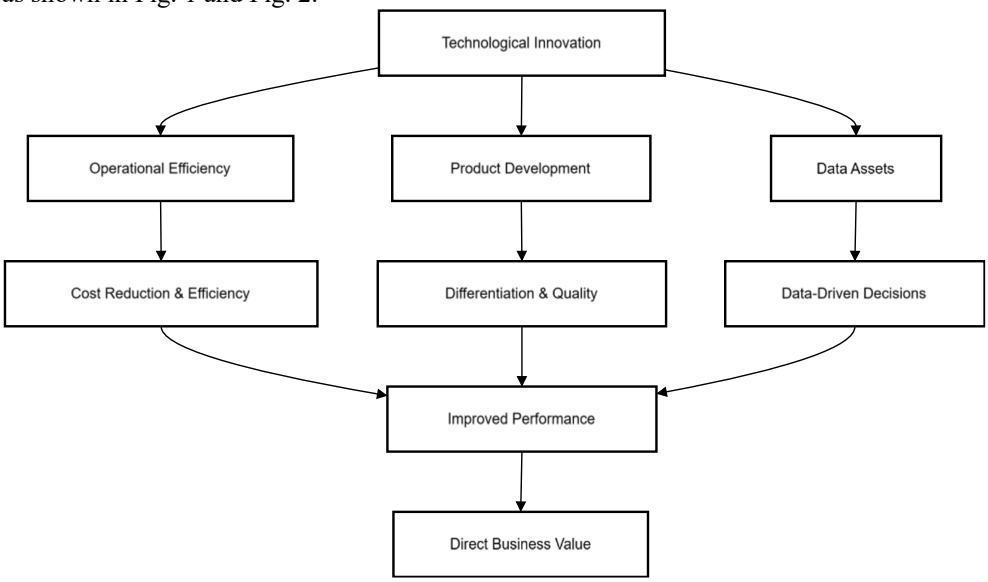

Fig 1. Technology value transformation link part 1

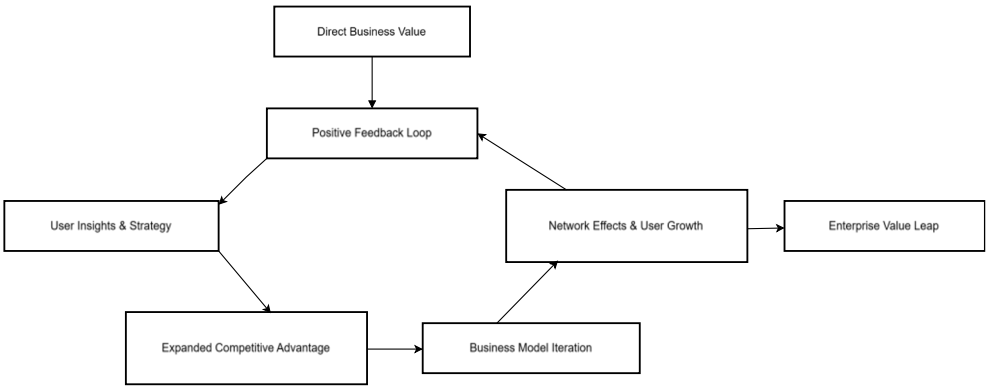

Fig 2. Technology value transformation link part 2

Technological innovation first affects operational efficiency, product development, and data assets three levels: through the principle of cost reduction and efficiency improvement, it enhances the utilization rate of production factors, directly influencing the performance indicators of enterprises; binding technology with products, emphasizing differentiation and high-quality creation, achieving commercial value; through algorithmic data mining, building user profiles to assist in enterprise strategy formulation, indirectly expanding the advantageous range. The deconstruction and reorganization of the above themes have changed the logic of value creation, transmission, and acquisition, driven the iteration of business models and formed new markets [9]. In addition, the user scale and product services form a self-reinforcing positive feedback loop under the influence of network effects, further consolidating the value chain and promoting the leap in enterprise value [10].

Technological innovation not only reshapes the evaluation logic of the value system but also gives rise to new cognitive blind spots: The impact of technology on traditional valuation models has led to pricing deviations, and the rapid iteration cycle of technology has further exacerbated investment risks. These contradictions reveal the limitations of the traditional value investment framework in explaining the digital era, therefore, how to effectively capture new opportunities has become the core proposition for value investment to adapt to the digital age.

3 The dilemma and opportunity of the traditional evaluation framework

The concept of value investing was first introduced by Benjamin Graham. As the pioneer of this investment philosophy, he elaborated on the core principle of value investing, namely the "margin of safety," in his seminal works "Security Analysis" and "The Intelligent Investor." The margin of safety involves identifying undervalued stocks through rigorous quantitative analysis of financial data and holding them for an extended period until the market accurately reflects the intrinsic value of the company. Notable proponents of value investing, such as Warren Buffett, have demonstrated the robustness of this theory in subsequent practices. Quantitative analysis of a company's fundamentals offers investors a solid foundation for accurately assessing enterprise value. It is believable that the core principles of value investing maintain significant relevance and widespread acceptance within the investment community. However, in the digital era, the limitations of value investing—its reliance on historical financial data while overlooking industry innovation and future growth potential—have become increasingly evident. Particularly in Internet and high-

tech sectors, value investing may undervalue companies' potential and result in missed investment opportunities.

3.1 The malfunction of traditional indicators

In the digital era, the growth trajectory of enterprise value is increasingly diverging from the assumptions of value investment principles established during the industrial era. Traditional metrics fail to adequately capture the non-linear dynamics of technological value creation and the pivotal transformations within enterprises, thus complicating the reasonable adjustment of valuations.

Using Amazon as an example, during its initial market expansion phase, the company made substantial investments in platform development, logistics infrastructure, AWS cloud services, and other strategic areas. These investments resulted in lower net profits or even losses, leading to short-term financial metrics that did not accurately reflect the company's true performance. This highlights the limitation of traditional P/E ratios in capturing market value appreciation and growth potential driven by technological barriers. Conversely, the 271% increase in AWS revenue between 2016 and 2020 and the 44% rise in online retail market share in 2020 provide strong support for Amazon's high valuation [11, 12].

Furthermore, the gross profit margin can be misleading. Despite its widespread use in measuring corporate profitability, this metric has notable limitations when applied to digital enterprises. Netflix, for instance, allocates a significant portion of its revenue to high-cost content creation and copyright acquisitions. Consequently, its relatively low gross profit margin may provide investors with a skewed perspective, failing to fully capture the brand advantages it has established and the potential for future long-term revenue growth.

3.2 The absence of measurement for intangible assets

The current accounting standards (GAAP and IFRS) typically expense R&D, data optimization, algorithm refinement, and brand development costs in the current period's income statement. This approach, which focuses on quantifying tangible assets, has significant limitations. Since the 1970s, the value of intangible assets among S&P 500 companies has surged, accounting for approximately 90% of their total value (OCEAN TOMO, 2020). Consequently, the core assets of technology firms are not adequately captured under traditional accounting practices.

The scarcity and non-substitutability of resources are crucial for sustaining a competitive advantage [13]. Google's proprietary search algorithm exemplifies such strategic resources that are difficult to replicate. By leveraging user data analysis, Google can precisely match advertisements with user intent, making advertising revenue one of its primary revenue streams. Additionally, Google maintains a dominant position in the global search engine market, holding a 92.08% market share as of 2023 [14]. Google's stock price, which rose from $85 at its IPO to over $700, underscores the market's recognition of the value of its intangible assets [15]. However, traditional valuation models struggle to accurately predict this growth potential.

Similarly, when focusing on other asset types, such as ecosystems, traditional assessment frameworks exhibit similar limitations. Unlike Microsoft's strategy, Apple has shifted its business focus to mobile smart devices and digital content. Apple has constructed an integrated ecosystem through hardware, software, and digital services, while enabling external developers to contribute to the ecosystem. This vast user base generates a powerful network effect, reinforcing the ecosystem in a self-sustaining cycle [16]. In 2019, per capita spending by U.S. users on the App Store reached $100 (Sensor Tower). Moreover, Apple's

brand value has consistently ranked first globally for multiple years (Brand Finance). Such ecological synergy and brand value are not accurately reflected in the balance sheet.

3.3 The excessive speed of technological iteration and cross-border attacks

Warren Buffett's moat theory posits that an enterprise's ability to continuously create value hinges on its possession of a robust competitive advantage. Historically, these advantages have enabled firms to withstand external shocks and maintain high profitability and market share. However, in the digital age, particularly in technology-intensive sectors, this defensive barrier has become increasingly vulnerable. A classic example is the semiconductor industry, where early adherence to Moore's Law—predicting a doubling of chip performance every 18 months—led to rapid technological iteration, significantly undermining the stability of leading positions. Even as Moore's Law has shown signs of reaching its limits, the emergence of new integrated architectures and technologies suggests ongoing opportunities for companies to catch up [17]. Intel, failing to adapt to industry trends such as heterogeneous computing, has seen its process technology fall behind, resulting in its market capitalization being surpassed by TSMC by over 200%.

Furthermore, the vulnerability of the traditional assessment system is also rooted in its inability to anticipate the blurring of industry boundaries. By leveraging e-commerce platforms, Amazon's acquisition of Whole Foods Market in 2017 then rapidly integrates supply chain and logistics capabilities, thereby overcoming structural barriers in traditional retail such as inefficiencies in delivery [18]. This move facilitated the convergence of physical stores and digital operations. However, the existing evaluation framework failed to adequately predict these risks of cross-domain integration of technologies, leading to the breakdown of the static moat theory that was based on a single dimension. As a result, other grocery retail giants, such as Kroger and Walmart, which heavily relied on brand equity, experienced significant stock price declines following this cross-industry disruption.

3.4 New Opportunities in the Digital Age

To address the systemic flaws inherent in the value investment system, it is imperative to update both its theoretical foundations and practical applications. In recent years, the growing body of research on quantitative intangible assets, coupled with the emergence of fintech, has presented new opportunities for value investing. Therefore, enhancing this investment tool should focus on multi-dimensional innovations driven by digital technology. Specifically, first, through data-driven optimization of value assessment, leverage big data analytics to improve the accuracy of predictions for traditional financial metrics; second, broaden the evaluation framework by incorporating new indicators such as Daily Active Users (DAU) to more comprehensively capture the value of light-asset technology firms; finally, reconstruct the risk premium model by leveraging advancements in information technology to mitigate corporate risk exposure. These technological advancements have significantly enhanced the precision and responsiveness of assessments, infusing new vitality into the traditional evaluation framework.

4 Current Status and Future Prospects

The failure of the traditional assessment framework fundamentally reflects the disconnection between the value logic of the industrial era and the technological realities of the digital age. This section will examine the current advancements in valuation model innovation and explore future directions for their development.

Given the limitations of traditional models in explaining asset pricing, scholars have increasingly turned to new factor models to provide a more comprehensive explanation of market performance. Notably, the HML factor (High Book-to-Market Ratio) has exhibited significantly lower performance since 2000 compared to the period from 1993 to 2000, prompting a re-evaluation of the Fama-French three-factor model and leading to the development of the five-factor model. The new model incorporates the RMW factor (Profitability Factor) and the CMA factor (Investment Factor), which better explain market returns [19]. The five-factor model demonstrates superior performance across all indicators compared to the three-factor model. Specifically, in the 5×5 sorting, the five-factor model explains the cross-sectional variance of expected returns for Size-Inv, Size-B/M, and Size-OP portfolios more effectively, with improvements of 28%, 25%, and 6%-12% respectively. Furthermore, for the LHS portfolios within the 2×4×4 classification, particularly in the Size-B/M-OP combinations, the unexplained cross-sectional variance is significantly lower, often less than half of that observed under the three-factor model [19]. Concurrently, the investment community is exploring alternative approaches. For example, AI-driven models are being used to conduct deep analyses of market data, predict stock trends, and assess enterprise value. Additionally, there is a push to integrate the ESG risk discount factor into mainstream models to establish a more robust connection with corporate value. By integrating multidimensional data and dynamic risk factors, the model can more comprehensively capture market dynamics and corporate behaviors, thereby addressing the limitations in explanatory power and adaptability. However, despite significant progress in technology-enabled valuation innovations, challenges remain, including the ambiguity surrounding digital property rights and valuation biases introduced by algorithmic black boxes. These issues highlight existing regulatory gaps and theoretical blind spots within the value assessment system, underscoring the need for interdisciplinary collaboration to address these obstacles.

5 Conclusion

This article examines the impact of technological innovation on value investment theory. By re-analyzing the fundamental principles of value creation and distribution, it highlights the limitations of traditional evaluation frameworks in the current era. Drawing on relevant cutting-edge research, this paper proposes a novel approach to reconstructing these frameworks. While both old and new systems aim to achieve abnormal returns, the integration and penetration of digital technologies into production have disrupted the stable growth patterns observed in the industrial era, shifting the focus from identifying undervalued assets to capturing value transformations driven by technology. Consequently, this article develops a three-tiered technical structure—disruptive, enabling, and integrative—to elucidate the mechanisms of value transmission.

Based on the technical value chain, the limitations of the traditional assessment framework have become increasingly apparent. On one hand, the rapid pace of technological iteration far outstrips the defensive capabilities of enterprises, rendering the moat theory inadequate in explaining sustained competitive advantage. The contrasting fates of Kodak and TSMC exemplify this issue: Kodak's bankruptcy can be attributed to its path dependency, which caused it to miss the digital camera revolution, while TSMC's rise is due to its strategic adoption of advanced technologies such as heterogeneous computing, leading to a significant increase in market value. On the other hand, intangible assets like data and algorithms form a complex value combination, whose synergistic effects (such as network effects) drive superlinear value growth. For instance, Metcalfe's Law posits that the value of a network grows proportionally to the square of its users.

Finally, based on current mainstream research trends, this paper proposes three key transformation directions. First, the transition from static to dynamic analysis, leveraging big data analytics for real-time monitoring of financial metrics. Second, the shift from tangible to intangible assets, emphasizing the measurement and valuation of intangible assets. Third, the evolution from single-dimensional to multi-dimensional assessment, incorporating a broader range of value factors to provide a comprehensive evaluation of enterprise value.

Although this paper systematically examines the impact of technological innovation on value investment, it acknowledges certain limitations. First, the case studies primarily focus on industry technology leaders, which may overlook the unique characteristics and challenges faced by small and medium-sized enterprises (SMEs). Additionally, the data sources are predominantly derived from existing public industry reports and academic papers, leading to potential gaps in comprehensive data support for some cases. Second, while this paper outlines the development directions of value investment based on current mainstream research trends, it is important to note that consensus has not yet been reached on certain research conclusions, such as the effectiveness of ESG investments. In addition to the inherent systematic issues of the assessment framework, the investment community lacks an adaptive environment for digitalization. Global financial regulatory policies are complex and fragmented, with a notable lag in addressing emerging challenges such as digital privacy, algorithmic transparency, and property rights definition. To meet these challenges, the future value assessment system must integrate multidimensional factors from complexity science, law, and ethics. This integration is not only essential for enhancing existing valuation models but also represents a fundamental reconceptualization of traditional value investment theories. Therefore, it can effectively promote the stability and sustainable development of capital markets, provide investors with more precise decision support, and drive financial markets toward a smarter and more orderly future.

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