

Advancements and Challenges in Asset Pricing: Revisit on CEOs' Characteristic and Firm Digitalization

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ABSTRACT

Over the last decade, asset pricing research has significantly expanded beyond traditional risk-based paradigms to incorporate insights from behavioral finance, machine learning applications, and firm-specific factors. This paper examines how CEO characteristics—specifically age, international experience, hometown identity, duality, and gender—together with firm digitalization (including digital transformation levels, IT investments, and AI adoption), shape corporate risk profiles and valuation. Recent advances in extended factor models, such as Fama–French extensions and mispricing factors, have enhanced our ability to explain return anomalies, while machine learning techniques help address the “factor zoo” problem by identifying previously overlooked predictors. Empirical evidence suggests that CEO demographics and backgrounds can influence strategic decision-making, thereby affecting asset pricing outcomes. Meanwhile, digital transformation has emerged as a crucial driver of intangible assets and operational efficiency; however, standard valuation approaches often struggle to fully capture these intangible benefits. Challenges remain in measuring and integrating CEO and digitalization variables into asset pricing models, due to issues related to data availability, endogeneity, and the transient nature of technological advantages. Future research should refine measurement strategies, develop dynamic modeling frameworks, and explore interactions among leadership attributes, digital capabilities, and traditional risk factors to better capture the complexity of modern asset pricing.

Keywords: Asset pricing, CEO characteristics, digital transformation, behavioral finance.

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Introduction

Over the past decade, asset pricing research has advanced significantly, expanding classical models and incorporating new perspectives. Traditional theories assumed that markets were efficient and that returns reflected fundamental risks, but recent work has increasingly considered behavioral influences and employed novel analytical tools (Nanayakkara et al., 2019). At the same time, firm-specific factors such as leadership characteristics and digital transformation have emerged as important determinants of corporate value, raising questions about how they affect asset pricing (Gu et al., 2020; Hou et al., 2015).

This literature review synthesizes findings from the past ten years on three interrelated fronts: (1) advancements in asset pricing models (including factor model extensions, behavioral finance insights, and machine learning approaches), (2) the impact of CEO characteristics (e.g., age, international experience,

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hometown identity, dual leadership roles, and gender) on firm value and asset pricing, and (3) the influence of firm digitalization (digital transformation levels, IT investments, and AI adoption) on asset pricing, firm performance, and valuation. However, the existing literature tends to examine CEO characteristics and firm digitalization separately, leaving limited understanding of how these human-capital and technological factors can be integrated into asset pricing frameworks. This gap is important because CEO characteristics may shape strategic choices and risk-taking, while digitalization can alter firms' intangible assets, productivity, innovation, and competitive advantages, potentially creating new channels through which firm risk and expected returns are determined.

Therefore, this review aims to synthesize recent evidence on these developments, identify the challenges of incorporating CEO characteristics and firm digitalization into asset pricing models, and highlight directions for future research on their potential interactions. The remainder of this paper is organized as follows: Section 2 reviews recent advancements in asset pricing. Section 3 discusses challenges and limitations. Section 4 concludes and outlines directions for future research

Recent Advancements in Asset Pricing

1. Extended Factor Models: Fama–French and Beyond

Classical asset pricing models, such as the Capital Asset Pricing Model (CAPM) and the Fama–French three-factor model, have been extended in recent years to better capture cross-sectional return patterns. A landmark contribution was the five-factor model introduced by Fama and French (2015), which added profitability and investment factors to the traditional market, size, and value factors. This new model was shown to improve explanatory power for stock returns by accounting for firms' operating profitability and asset growth, thereby addressing anomalies that were unexplained by the earlier three-factor model (Fama & French, 2015). Around the same time, Hou et al. (2015) proposed the “q-factor” model based on investment theory, which includes market, size, investment, and return-on-equity factors to capture a broad set of return anomalies.

Researchers have also explored adding momentum and sentiment-based factors. While momentum was established earlier, its inclusion alongside value and size remains a key extension. Additionally, mispricing factors grounded in behavioral finance have been introduced. For example, Stambaugh and Yuan (2017) constructed two such mispricing factors that aggregate information from numerous return anomalies; their four-factor model (market, size, and two mispricing factors) was shown to better explain a wide array of anomalies than conventional factor models. Notably, investor sentiment has been found to predict these mispricing factors' returns, especially on the short (overpriced) side, consistent with the idea that waves of optimism or pessimism can drive systematic mispricing.

2. Behavioral Finance and Asset Pricing

In parallel, behavioral approaches to asset pricing have steadily gained prominence, offering a counterpoint to purely rational frameworks. Behavioral asset pricing models relax the assumption of fully rational investors and allow for persistent mispricing due to biases and costly arbitrage. Recent literature reviews document how psychological biases (e.g., overconfidence, representativeness, and loss aversion) and heuristics have been incorporated to explain asset price patterns. Two foundational claims of behavioral

finance are: (1) investors are not always rational, and (2) arbitrage is limited. These propositions help explain why certain return anomalies (e.g., momentum crashes and bubbles) can persist.

For instance, aggregate investor sentiment indices have been shown to predict stock returns, with high optimism often foreshadowing lower subsequent returns for sentiment-driven stocks, implying that the correction of mispricing eventually takes place. Although behavioral finance has enriched asset pricing by acknowledging that factors such as sentiment and cognitive limitations can create systematic return patterns beyond traditional risk-based explanations, a major challenge remains: formally integrating these behavioral elements into pricing models in a manner that achieves broad consensus (Nanayakkara et al., 2019).

3. Machine Learning in Asset Pricing

Perhaps the most novel development in the last ten years is the application of machine learning (ML) and big data techniques to asset pricing (Giglio et al., 2022). Researchers have increasingly used ML algorithms to identify return predictors, model complex nonlinear relationships, and address the so-called “factor zoo” problem—the proliferation of hundreds of proposed predictive factors. ML methods such as tree ensembles, neural networks, and penalized regressions can handle high-dimensional data and capture intricate interactions among firm characteristics (Gu et al., 2020).

For instance, Gu et al. (2020) demonstrate that nonlinear ML models can substantially improve the out-of-sample prediction of stock returns compared to linear factor models, suggesting the existence of previously overlooked nonlinear patterns. ML algorithms have also been used to automatically select relevant factors from a large set of firm attributes, providing a data-driven way to navigate the factor zoo and reduce the risk of overfitting by focusing on predictors that add incremental power (Giglio et al., 2022). These advancements enhance both the rigor and the robustness of asset pricing tests, but they also introduce challenges such as interpretability and the risk of data mining. In summary, recent developments in factor modeling, behavioral insights, and machine learning significantly broaden the scope of asset pricing, signaling a paradigm that synthesizes risk-based and mispricing-based explanations using cutting-edge empirical methods.

4. CEO Characteristics and Firm Value

In line with upper echelons theory, a growing body of scholarship recognizes the importance of top executives’ personal attributes in shaping organizational outcomes and, by extension, the pricing of the firm’s securities. This section reviews how five CEO attributes—age, international (overseas) experience, hometown identity, dual leadership roles, and gender—affect firm value and asset pricing mechanisms.

5. CEO Age and Risk-Taking

CEO age has been linked to differences in corporate strategy and risk profiles. A consistent finding is a negative relationship between CEO age and corporate risk-taking. Older CEOs tend to adopt more conservative policies, investing less in risky growth endeavors such as R&D, pursuing more diversifying acquisitions, and maintaining lower operating leverage (Serfling, 2014). Conversely, younger CEOs may be more willing to engage in bold, high-variance projects, potentially seeking to prove themselves or accelerate firm growth.

In an influential study, Serfling (2014) reports that a portfolio long in firms led by younger CEOs and short in firms led by older CEOs yields positive risk-adjusted returns, implying that investors do not fully price the effect of CEO age on corporate risk-taking. Overall, the literature suggests that older CEOs favor stability and capital preservation, while younger CEOs embrace growth strategies that entail higher risk. This

has potential implications for asset pricing, as age-related risk preferences may affect a firm's systematic risk—and thus its expected cost of capital—in ways not captured by conventional models.

6. CEO International (Overseas) Experience

Globalization has elevated the importance of CEOs' international exposure. Overseas experience (gained through working or studying abroad) can broaden a CEO's perspectives, knowledge base, and professional networks, thereby influencing strategic decision-making and change. Research indicates that CEO international experience is positively associated with strategic renewal and firm performance. One underlying mechanism is that diverse forms of global exposure equip CEOs with cross-cultural skills and broader market insights, helping firms to expand internationally or pursue innovation more successfully (Le & Kroll, 2017). Further studies, particularly in emerging markets, show that globally experienced CEOs may be more inclined to invest in higher-risk innovation activities, such as increased investment in research and development (R&D), especially when they also hold the position of board chair (CEO duality) (Le & Kroll, 2017). From an asset pricing perspective, these findings suggest that investors might view a CEO's overseas experience as an intangible resource that can enhance firm growth and potentially alter the firm's risk–return profile. However, systematic empirical evidence of how markets incorporate such global experience into asset prices remains limited, underscoring an important avenue for future research.

7. CEO Hometown Identity

A growing line of inquiry examines whether hometown identity—i.e., a CEO's strong identification with their place of origin, particularly when the firm is headquartered in or near that same area—affects corporate decision-making. Recent evidence from Chinese firms indicates that hometown-identifying CEOs tend to be more risk-averse, maintaining lower leverage, reducing earnings management, and pursuing more prudent investment policies. The phenomenon of being “too scared to make mistakes at home” suggests that hometown-affiliated CEOs prioritize stability and local reputation concerns, leading to reduced corporate risk-taking (Chen et al., 2024).

Interestingly, this hometown effect is moderated by other CEO characteristics, such as CEO gender and international exposure, implying that multiple traits may interact in shaping corporate behavior. While hometown identity can lower default risk and foster more sustainable firm performance, it may also lead firms to forgo lucrative, higher-return projects. Firms led by such CEOs might therefore exhibit lower cash flow volatility, potentially affecting how investors price the firm's equity. If markets overlook or misinterpret the risk-reducing benefits of hometown identity, short-term stock mispricing could arise.

8. CEO Duality (CEO–Chairman Dual Role)

CEO duality occurs when one individual holds both the CEO and the board chair positions. This practice has generated debate in corporate governance for decades. Recent empirical work continues to find a generally negative association between CEO duality and firm performance, supporting the agency theory perspective that uniting these roles reduces board independence. In a study of Chinese listed firms, Mubeen et al. (2021) show that firms with CEO dual leadership structures often exhibit weaker performance.

However, some research suggests that the impact of duality can be context-dependent. For instance, larger firms or those with robust corporate social responsibility (CSR) practices may mitigate potential governance risks and thus avoid underperformance (Mubeen et al., 2021). From an asset pricing perspective, CEO duality may elevate perceived governance risk, which can translate into a higher cost of equity capital

if investors discount firms that lack balanced oversight. While some stewardship theory arguments propose that unified leadership can streamline decision-making, the dominant view in the literature remains that CEO duality is a governance concern more likely to erode firm value unless counterbalanced by strong governance mechanisms.

9. CEO Gender

Firms with female CEOs often display more conservative financial and risk-management policies. Faccio et al. (2016) find that companies run by female CEOs tend to have lower leverage, less volatile earnings, and a lower probability of financial distress. A related stream of work notes that while there is no systematic performance gap once relevant controls are included, women in top executive positions can reduce excessive risk-taking, contributing to more stable long-term performance (Perryman et al., 2016).

Although some historical data suggest that female CEOs might face a “glass cliff” phenomenon, being appointed during periods of organizational crisis, recent evidence indicates that capital markets generally do not penalize firms for appointing female CEOs, and any initial investor skepticism is short-lived. In short, female-led firms often exhibit lower overall risk profiles, which can be reflected in a lower cost of capital if investors come to appreciate the added stability. Nevertheless, empirical sample sizes remain limited due to the underrepresentation of women in CEO roles globally. As more data become available, future research is likely to further refine our understanding of how gender diversity in top leadership interacts with asset pricing.

10. Firm Digitalization and Asset Pricing

The digital revolution has fundamentally changed how businesses operate, innovate, and generate value, especially over the past decade, with the proliferation of data, artificial intelligence (AI), and internet-enabled services. This section examines how firm-level digitalization—encompassing broad digital transformation initiatives, information technology (IT) investments, and AI adoption—affects firm performance and valuation, as well as the challenges of incorporating digitalization-related variables into asset pricing models.

11. Digital Transformation and IT Investments

Digital transformation entails integrating digital technologies into all facets of a business, altering how firms deliver value to customers and optimize internal operations. Scholars increasingly attempt to measure firms’ digitalization levels using proxies (e.g., the occurrence of digital terms in annual reports or surveys of digital capabilities) and link them to performance outcomes. Evidence suggests that digital transformation can enhance productivity and profitability by improving resource allocation and enabling innovation (Wang & Xia, 2024).

However, the relationship is not always straightforward. Certain firms experience an initial decline in accounting returns due to the substantial upfront costs of IT infrastructure and organizational restructuring efforts. Over the longer term, successful digital transformations can yield higher growth and a more sustainable competitive advantage (Wang & Xia, 2024). These effects underscore the challenge of valuing digital initiatives using traditional measures—digital assets are often intangible (e.g., software, data, algorithms) and may not be fully captured on firms’ balance sheets. Indeed, intangible assets now comprise the majority of market value for many firms (Ocean Tomo, 2020), which complicates efforts to incorporate digital investment into standard asset pricing models that rely heavily on book values or tangible asset measures.

12. Artificial Intelligence Adoption and Firm Valuation

Among emerging digital technologies, artificial intelligence (AI) stands out for its transformative potential. AI adoption can influence firm performance through innovation and growth opportunities. For instance, Babina et al. (2024) find that firms investing more in AI experience higher growth in sales, employment, and market value, with product innovation serving as an important mechanism. These findings suggest that AI adoption may create significant growth opportunities and competitive advantages for firms that are able to integrate the technology effectively.

However, the benefits of AI adoption may vary across firms because the realization of AI-related value depends on firms' technological capabilities, organizational resources, and ability to integrate AI into existing business processes. From an asset pricing perspective, AI adoption may therefore affect firm valuation through changes in expected future cash flows, growth opportunities, and perceived firm-specific risk. At the same time, uncertainty surrounding the implementation and economic returns of rapidly evolving AI technologies may make the valuation of AI-related investments more difficult.

Overall, AI adoption represents an increasingly important firm-level characteristic that may influence innovation, growth, and market valuation. Nevertheless, standard asset pricing frameworks may not fully capture the economic value of AI-related intangible capabilities because such capabilities are often difficult to measure consistently. Future research should therefore develop more reliable measures of AI adoption and examine how AI-related capabilities interact with traditional risk factors, firm characteristics, and expected returns across different industries and institutional contexts

Challenges and Limitations

While CEO characteristics and firm digitalization undeniably shape firm outcomes, incorporating them into asset pricing poses multiple challenges. First, measurement issues remain pervasive. Although CEO traits such as age or gender are easily observed, attributes like international experience or hometown identity can be difficult to measure consistently. Likewise, there is no universal benchmark for a firm's digital maturity, which complicates systematic comparison across firms.

Second, endogeneity and causality are major concerns. CEO attributes may correlate with unobserved firm-specific characteristics; similarly, firms that invest in digital transformation could differ systematically from those that do not. Properly identifying the causal impact of these variables requires rigorous identification strategies, such as natural experiments or event studies around CEO changes and information technology (IT) investment announcements.

Third, traditional asset pricing models focus on stable, systematic risk factors, whereas CEO and digital variables tend to be more firm-specific, time-varying, and susceptible to rapid obsolescence. A young CEO ages, and a firm's level of digitalization evolves quickly, making it difficult to treat these attributes as persistent sources of priced risk. Additionally, as more factors are added to a model, the risk of statistical overfitting increases in the absence of a clear economic rationale to guide factor selection.

Finally, practical adoption remains an obstacle. Many investors lack timely and granular data on CEO backgrounds or internal digital initiatives, and these factors may already be partially reflected in observable performance measures. Nonetheless, researchers are increasingly exploring ways to integrate such elements,

potentially by embedding them as features in machine learning–based asset pricing frameworks (Gu et al., 2020).

Conclusion

This literature review shows that modern asset pricing has expanded beyond traditional risk-based explanations by incorporating behavioral finance, machine learning, and firm-specific factors. The synthesis indicates that CEO characteristics—including age, international experience, hometown identity, duality, and gender—can influence corporate risk-taking, strategic decisions, and firm value, while digital transformation, IT investment, and AI adoption increasingly affect innovation, operational efficiency, intangible assets, and valuation.

The main contribution of this review is to broaden the asset pricing perspective from conventional risk factors toward organizational-level determinants, particularly CEO characteristics and firms' digital capabilities. By bringing these two dimensions together, the review highlights an important research gap: existing studies have largely examined managerial characteristics and digitalization separately, providing limited understanding of their interactions and their implications for asset pricing. Future research should therefore develop more integrated and dynamic frameworks to examine how CEO characteristics and digital capabilities jointly influence firm risk, expected returns, and market valuation.

Future Research Directions

Future research should further integrate CEO characteristics, firm digitalization, and traditional asset pricing factors within a unified framework, with greater attention to how leadership attributes influence digital strategies, risk-taking, innovation, and expected returns. Methodologically, studies should develop more precise measures and employ dynamic models, panel-data approaches, natural experiments, event studies, and machine learning techniques to address measurement, endogeneity, causality, and nonlinear relationships while minimizing overfitting and data-mining risks.

From a practical perspective, researchers should examine how investors and corporate decision-makers incorporate CEO characteristics, digital transformation, IT investment, and AI adoption into risk assessment and firm valuation. Future studies should also investigate interactions between CEO traits and digital capabilities, such as whether internationally experienced or younger CEOs facilitate more effective AI adoption, and how capital markets price these managerial–technological complementarities. Such research may contribute to a more comprehensive understanding of how human capital and digitalization shape modern asset pricing.

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