Unlocking Digital Value: Efficiency as a Mechanism and CSR as a Catalyst in Firm Performance

Abstract

Given the rising scholarly interest in the antecedents and consequences of digital transformation, this study investigates how digital transformation affects firm performance and proposes that such effect is mediated by firm efficiency. We also propose and examine the moderating effect of corporate social responsibility (CSR). Using a dataset of 4,760 firm-year observations from U.S. publicly listed companies between 2011 and 2018, our findings demonstrate that digital transformation enhances firm efficiency, which in turn leads to improved firm performance. Moreover, the study finds that CSR strengthens the positive relationship between digital transformation and firm performance, suggesting that firms with higher CSR engagement can derive greater benefits from digital transformation. The results offer valuable insights for both academics and practitioners by highlighting the importance of integrating digital transformation initiatives with efficiency-driven strategies and socially responsible practices. These findings contribute to the literature on digital transformation, firm efficiency, and CSR by providing a comprehensive framework for understanding the interplay between these factors and their impact on firm performance.

Keywords: Digital transformation; firm performance; firm efficiency; CSR; market value

JEL codes: O33, M15, L25

1. Introduction

A growing consensus in the management and information systems literature acknowledges that digital transformation (DT) has emerged as a comprehensive enterprise-level reorganization of how companies identify opportunities, coordinate resources, and generate value (Appio et al., 2021; Correani et al., 2020; Guo et al., 2023; Holmström, 2022). Scholars are increasingly distinguishing between digitization, digitalization, and transformation (Hanelt et al., 2021; Nöhammer & Stichlberger, 2019; Saarikko et al., 2020; Vu et al., 2024). This distinction emphasizes the role of integrating digital resources into core routines rather than simply adopting new technologies in generating a feasible economic value (Verhoef et al., 2021). This view aligns with the resource-based view (RBV) and dynamic capabilities, emphasizing that technologies become meaningful when embedded into valuable, difficult-to-duplicate routines that enable firms to sense, seize, and adapt to environmental changes (Barney, 1991; Eisenhardt & Martin, 2000; Teece, 2007; Wade & Hulland, 2004). Despite the growing industry recognition of DT's significance, empirical research on its impact remains mixed, showing positive, null, or contingent effects across different contexts (Bharadwaj et al., 2013; Melville et al., 2004; Sambamurthy et al., 2003; Verhoef et al., 2021). These mixed results point out to the possibility that DT's influence may not be direct; instead, it functions through organizational mechanisms and specific boundary conditions.

We propose a mechanism-first perspective that emphasizes firm efficiency as the primary pathway through which digital transformation (DT) influences financial outcomes. Efficiency—defined as converting inputs into outputs with minimal waste—captures the actual value generated by technology-enabled coordination, information quality, and routine redesign (Banker et al., 1984; Demerjian et al., 2012). From an information-processing standpoint, digital

technologies expand processing capacity (e.g., analytics, cloud) and decrease coordination barriers across functions, thus aligning information supply with demand and reducing rework, delays, and slack (Galbraith, 1974; Melville et al., 2004). From a sociotechnical perspective, value emerges when digital tools are integrated into work systems—reconfiguring task sequences, exception handling, and learning—so that process integration and data-driven decision-making are embedded at scale (Orlikowski, 2000; Verhoef et al., 2021). In this framework, DT should bring firms closer to the best-practice frontier seen among peers, a movement that can be empirically measured using data envelopment analysis (DEA), which compares multi-input, multi-output production processes relative to a frontier (Banker et al., 1984). DEA-based measures have been shown to predict downstream outcomes in accounting and finance because they reflect how effectively firm routines convert resources into results (Demerjian et al., 2012).

Viewing efficiency as the key mechanism also explains why earlier studies often found inconsistency in a direct link between DT and performance. Efficiency is a major driver of both accounting-based and market-based results: companies that use assets more effectively achieve higher margins and asset turnover, earning recognition from investors who update their expectations about future cash flows and risks (Bloom et al., 2012; Demerjian et al., 2012). If DT improves efficiency through process integration, automation, and analytics, then performance gains should be driven by efficiency rather than technology alone. Modeling this pathway directly allows for clearer distinction between technology-focused stories and capability-based explanations (Bharadwaj et al., 2013; Melville et al., 2004; Verhoef et al., 2021).

A second source of heterogeneity relates to the boundary conditions under which DT creates value. We propose that corporate social responsibility (CSR) influences the

transformation of DT into performance by providing legitimacy, fostering stakeholder trust, and establishing complementary routines that mitigate transformation frictions. Institutional and stakeholder perspectives indicate that firms gain resources and cooperation when their actions align with social norms and key stakeholder interests (Freeman, 1984; Suchman, 1995). CSR boosts legitimacy and helps build reputational capital, which can lower financing costs, support labor cooperation during workflow redesign, and reduce external concerns about data governance, privacy, or workforce impacts—all of which are crucial for integrating digital tools into daily routines (Aguinis & Glavas, 2012; Barnett & Salomon, 2012; Cheng et al., 2014; Henisz et al., 2014). In capital markets, CSR disclosures and performance have been linked to lower costs of equity and debt, thereby increasing managerial bandwidth to endure the J-curve of transformation before benefits are realized (Dhaliwal et al., 2011; El Ghoul et al., 2011). Therefore, CSR should enhance DT's actual effects on performance, both directly and via the efficiency channel: where CSR is stronger, stakeholder support and governance complementarities make it more likely that digital investments are adopted, embedded, and translated into measurable operational and financial benefits.

Our study contributes to the literature in three distinct ways. First, we articulate and test a mechanism-focused framework where DEA-based firm efficiency mediates the DT-performance relationship. This approach combines information-processing, RBV, and dynamic-capabilities perspectives to explain when, how, and why DT "pays." Second, we theorize and test CSR as a boundary condition that enhances the conversion of DT into performance by boosting legitimacy and stakeholder cooperation, as well as providing governance supports that facilitate process change. Third, we align measurement with theory: a firm-level DT indicator consistent with transformation disclosures, a multi-input/multi-output DEA efficiency score, and both market-

and accounting-based performance outcomes in a panel design that considers dynamics and unobserved heterogeneity. Together, these choices enable us to move beyond techno-centric claims toward a clearer, mechanism- and context-based explanation of DT's economic value (Bharadwaj et al., 2013; Melville et al., 2004; Verhoef et al., 2021).

2. Literature Review and Theoretical Background

Digital transformation is defined as the purposeful integration of digital technologies into core organizational processes to reconfigure how the firm senses opportunities, orchestrates resources, and delivers value (Bharadwaj et al., 2013; Verhoef et al., 2021). While the direct link between digital initiatives and performance has yielded mixed evidence, theory strongly suggests that digital resources become consequential primarily through the operational capabilities they enable (Merín-Rodrigáñez et al., 2024; Sousa-Zomer et al., 2020). The resource-based view (RBV) posits that resources yield advantage only when they are translated into valuable, rare, inimitable, and non-substitutable (VRIN) capabilities embedded in organizational routines (Barney, 1991). Dynamic capabilities theory further clarifies that performance effects materialize when firms deploy, integrate, and reconfigure resources in response to environmental change (Helfat & Peteraf, 2003; Kotha et al., 2011; Mikalef et al., 2021; Teece, 1986, 2007). In this perspective, the performance consequences of digital transformation are not simply a function of technology acquisition; they arise from the ways these technologies reshape the efficiency with which inputs are converted into outputs across the firm's operating system (Aral & Weill, 2007; Camisón & Villar-López, 2014; Merín-Rodrigáñez et al., 2024; Vu et al., 2024). Efficiency enjoys a central role in this translation mechanism. In production economics, efficiency reflects the degree to which an organization achieves maximal output given a set of inputs, depending on the available

technology (Banker et al., 1984). In accounting and finance research, DEA-based efficiency measures have been shown to effectively predict subsequent performance, as they capture how efficiently firms deploy resources relative to their peers (Demerjian et al., 2012). Theoretically, digital transformation should improve efficiency by enhancing process integration, reducing information asymmetries, and enabling data-driven coordination across functions (Appio et al., 2021; Correani et al., 2020; Li et al., 2023). Advanced analytics and cloud architectures increase information processing capacity—thereby resolving bottlenecks that limit throughput—and provide near-real-time visibility over inventory, production schedules, and customer demand (Melville et al., 2004; Verhoef et al., 2021). Artificial intelligence and automation reduce slack and rework while improving the quality and timeliness of decisions, which in turn lowers unit costs and cycle times. Through the lens of organizational information processing theory (Miao et al., 2024; Sharma et al., 2024), digital transformation elevates the firm's ability to match information processing needs with information processing capacity; mismatches manifest as waste, whereas alignment manifests as efficiency (Galbraith, 1974; Rai et al., 2012).

A complementary sociotechnical view underscores that technology's effects emerge when digital tools are routinized within work systems (Orlikowski, 2000). As digital applications are embedded into procurement, production, logistics, and service processes, they reshape micro-routines—how tasks are sequenced, how exceptions are handled, and how learning is codified. When these routines become coordinated at scale, the aggregate outcome is observable as frontier-relative efficiency. Importantly, such effects are not purely technological; they depend on complementarities among practices—e.g., concurrent process redesign, employee upskilling, and governance for data quality (Brynjolfsson & Hitt, 2000; Melville et al., 2004). Firms that invest in technology without these complementary changes often fail to realize gains, which clarifies

why efficiency serves as the proximate mechanism: it is the organizational capability through which digital resources yield economic benefits.

The efficiency–performance linkage has been extensively researched and established. Efficient firms deploy inputs more productively, generate a given level of output at lower cost, and respond more quickly to demand variability—advantages that support higher profitability and stronger market valuations (Bloom et al., 2012; Demerjian et al., 2012). From an RBV standpoint, efficiency reflects a capability bundle that is difficult to imitate because it arises from organization-specific routines and accumulated know-how. From a finance perspective, increased efficiency reduces cash flow volatility and improves margins, which are the two factors investors reward with higher valuations. Thus, if digital transformation increases efficiency, and efficiency is a fundamental driver of both accounting-based and market-based performance, an indirect pathway from digital transformation to performance via efficiency should be expected.

The extent to which digital transformation yields performance benefits, however, is contingent on stakeholder perceptions and institutional support. Corporate social responsibility (CSR) engagement provides a critical contextual mechanism in this regard. Institutional theory emphasizes that organizations strive for legitimacy—congruence with social norms and stakeholder expectations—because legitimacy facilitates access to resources and mitigates resistance (DiMaggio & Powell, 1983). CSR can function as a legitimacy-building signal that the firm is committed to broader stakeholder welfare and long-term value creation (Aguinis & Glavas, 2019; Barnett & Salomon, 2012). In the context of digital transformation, CSR may attenuate concerns that technology adoption is extractive (e.g., worker displacement, privacy risks) by communicating prosocial intent and governance safeguards. Stakeholder theory similarly predicts that CSR improves trust, cooperation, and resource exchange with customers,

employees, suppliers, and communities, thereby reducing the frictions that often derail transformation programs (Wang et al., 2016).

CSR can also operate as a capability complement to digitalization. Firms with robust CSR processes often possess superior stakeholder engagement routines, transparent reporting infrastructures, and governance mechanisms for risk mitigation, which can facilitate the process changes required to translate digital tools into efficiency improvements. For example, CSR-aligned human capital practices may increase employee participation in process redesign and skill development, accelerating routinization of digital workflows. Externally, CSR can lower the cost of capital and improve investor sentiment, expanding managerial bandwidth to undertake complex transformation programs and to persist through the J-curve of temporary disruption prior to performance gains (Cheng et al., 2014). In short, CSR should amplify the realized returns from digital transformation—both on the efficiency-building pathway and on the ultimate performance outcomes—by enhancing stakeholder support, resource access, and governance quality.

Bringing these arguments together, the framework we propose posits that digital transformation is a precursor to improved firm performance primarily because it builds efficiency through process integration, data-driven coordination, and routinized sociotechnical change. We theorize that Efficiency is therefore the mediating conduit through which digitalization leads to its performance effects. At the same time, CSR strengthens these effects by providing legitimacy and complementary routines that reduce frictions and enhance the translation of digital investments into operational and financial outcomes.

3. Hypotheses Development

Contemporary theories agree that digital transformation (DT) creates value primarily by reconfiguring the firm's information-processing architecture and routines, not by technology adoption per se (Bharadwaj et al., 2013; Verhoef et al., 2021). From an information-processing perspective, organizations face variable and often rising information needs as product complexity, customer heterogeneity, and environmental turbulence increase. When information-processing capacity falls short, firms experience coordination failures, slack, and latency that manifest as technical and scale inefficiencies (Galbraith, 1974; Melville et al., 2004). DT expands and redistributes processing capacity via analytics, cloud infrastructures, and digital platforms that standardize data models, increase data timeliness, and create interoperability across functions. The resulting reduction in information asymmetries improves task allocation and exception handling, pushing the firm closer to the best-practice frontier.

A sociotechnical lens clarifies how these effects materialize in day-to-day work. Digital tools reconfigure micro-routines—how tasks are sequenced, how bottlenecks are surfaced and resolved, and how experiential learning is captured—only after they are embedded in practices and aligned with governance and skills (Orlikowski, 2000). DT initiatives that are accompanied by process redesign, data governance, and upskilling replace rework with right-first-time execution, substitute manual reconciliation with straight-through processing, and shorten cycle times through real-time visibility (Brynjolfsson & Hitt, 2000; Melville et al., 2004). Through the resource-based view (RBV), these routinized improvements constitute a capability that is valuable, imperfectly tradable, and path-dependent—hence unlikely to be quickly imitated (Barney, 1991). Dynamic capabilities further explain that DT enables sensing, seizing, and reconfiguring routines to match changing conditions, which is inherently efficiency enhancing

because it continuously aligns resource deployment with current opportunities and constraints (Teece, 2007).

Operationally, we propose that such gains should be captured by a multi-input, multi-output efficiency measure benchmarked against a peer frontier—precisely what DEA estimates (Banker et al., 1984). When DT reduces redundant inputs (e.g., duplicated labor hours, avoidable SG&A) for a given level of output or increases outputs (e.g., sales, gross profit) for a given input bundle, the firm's DEA score increases. Because DEA is relative to the frontier, its improvement indicates that digitalized firms adopt process configurations that are difficult for non-digital peers to match. In short, we expect DT to improve the conversion of input bundles into outputs by increasing informational quality and coordination density inside the firm, which is the definition of higher technical efficiency (Melville et al., 2004; Verhoef et al., 2021). Taken together, the arguments we present from information-processing theory, sociotechnical change, RBV, and dynamic capabilities literature lead to the prediction that DT causally raises firm efficiency. Accordingly, we posit that:

H1: Digital transformation positively affects firm efficiency.

Efficiency improvements translate into performance through multiple, reinforcing channels. First, from a production economics perspective, efficient firms achieve a given level of output with fewer inputs, directly lowering unit costs and raising operating margins; they also utilize assets more intensely, improving return on assets and related accounting metrics (Banker et al., 1984). Second, from a capabilities perspective, efficiency is an emergent property of routinized processes—standard work, pull systems, exception escalation, and continuous improvement—that cumulate and compound over time (Bloom et al., 2012). Because these

routines are organization-specific and learned by doing, they create persistence in performance advantages beyond transient cost cuts.

Finance theory offers complementary logic. Efficiency reduces cash-flow volatility by eliminating waste and dampening cycle-time variability; lower volatility and higher margins jointly increase the present value of cash flows and reduce required returns, leading to higher market valuations (Demerjian et al., 2012). Investors also view efficient operations as a signal of superior managerial capability and governance quality, further improving firms' access to capital and lowering financing costs—feedback effects that support growth and resilience (Bloom et al., 2012). Empirically, DEA-based measures and closely related operational proxies have repeatedly shown predictive validity for subsequent profitability and valuation because they summarize the firm's standing on the production frontier relative to peers (Demerjian et al., 2012; Melville et al., 2004).

Importantly, efficiency does not merely capture thrift; it embeds responsiveness. Firms closer to the frontier adjust factor proportions more quickly as demand, input prices, and technology shift, mitigating costly misalignments. This responsiveness manifests in superior performance both in tranquil periods (through higher steady-state margins) and in shocks (through faster reallocation and recovery). Therefore, theory predicts a robust, positive relationship between firm-level efficiency and both accounting- and market-based performance. Therefore, we hypothesize:

H2. Firm efficiency positively affects firm performance.

A mediation logic follows directly from the foregoing mechanisms. We argue that If DT enhances information-processing capacity and embeds data-driven, interoperable routines, and if those routines are what drive the efficient conversion of inputs into outputs, then the economic

value attributed to DT should operate primarily through efficiency rather than around it (Bharadwaj et al., 2013; Melville et al., 2004; Verhoef et al., 2021). In the RBV, technology is rarely a VRIN resource on its own; the VRIN properties arise when technology is fused with firm-specific processes, knowledge, and governance—manifest empirically as higher efficiency. Dynamic capabilities extend this by positing that digital investments become valuable as they enable continuous reconfiguration that keeps the firm nearer the moving frontier—again, an efficiency phenomenon (Teece, 2007).

Information-processing and sociotechnical perspectives jointly explain why an apparent "direct" link from DT to performance in some studies may be an artifact of omitted operational channels. DT projects often run in parallel with process redesign, data governance, training, and change-management—interventions whose proximate operational footprint is efficiency. When efficiency is omitted, the DT coefficient may carry both capability-realization effects (true value creation) and correlated improvements in operations (mechanism); once efficiency is included, the residual direct path should attenuate if efficiency is indeed the principal conduit. Put differently, efficiency is the integrator that captures how DT percolates through the organization to produce lower costs, better asset utilization, and faster cycles, all of which investors and accountants record as better performance (Banker et al., 1984; Demerjian et al., 2012). A formal mediation test that positions DEA-measured efficiency between DT and multiple performance proxies provides a stringent evaluation of this mechanism-centric account. Thus, we hypothesize that:

H3. Firm efficiency mediates the relationship between digital transformation and firm performance.

Digital transformation unfolds within a social and institutional context in which stakeholder endorsement and legitimacy materially affect execution. CSR—through environmental, social, and governance engagements—builds reputational capital and social approval that facilitate cooperation from employees, suppliers, customers, communities, and regulators (Aguinis & Glavas, 2012; Barnett & Salomon, 2012; Suchman, 1995). This cooperation matters for DT because transformation typically requires workflow redesign, reskilling, data sharing, and experimentation that can be disruptive or politically contested. Where CSR is stronger, internal stakeholders are more likely to grant the organization the "benefit of the doubt," engage in upskilling, and participate in process change; external stakeholders are more likely to view data governance and automation as responsibly managed, reducing resistance and oversight frictions that delay or dilute implementation (Henisz et al., 2014; Verhoef et al., 2021).

CSR also complements DT economically. Empirical research links stronger CSR to improved financing conditions—lower costs of equity and debt and better access to capital—because investors infer superior governance and lower nonfinancial risk (Cheng et al., 2014; Dhaliwal et al., 2011; El Ghoul et al., 2011). These financing advantages are especially valuable during DT's J-curve, when costs are front-loaded and benefits arrive with lags. From a complementarity perspective (Milgrom & Roberts, 1995), CSR and DT are mutually reinforcing practices: CSR's stakeholder engagement, transparency, and risk controls create a governance substrate on which digital tools can be embedded and scaled; digital tools, in turn, generate data that can strengthen CSR reporting and performance. The net effect is a steeper translation of DT into observable performance in high-CSR firms because execution frictions are lower and the

conversion of operational gains into market and accounting outcomes is faster and more complete.

Although CSR could, in principle, operate on multiple stages of the DT-efficiency--performance nexus, we propose that the most direct and observed moderation would be on the DT-performance path: firms with higher CSR realize greater performance gains from comparable levels of DT because CSR enhances legitimacy, reduces stakeholder resistance, and secures the financial and relational resources necessary for thorough implementation (Aguinis & Glavas, 2012; Barnett & Salomon, 2012; Cheng et al., 2014). In empirical terms, this implies that the marginal effect of DT on performance should be stronger at higher levels of CSR engagement. Thus, we posit that:

H4. CSR positively moderates the relationship between digital transformation and firm performance, such that the relationship is stronger when CSR engagement is higher.

4. Method

4.1 Data sources and sample description

To test the hypotheses, we collected data from multiple sources including firms' annual reports, COMPUSTAT, KLD, BOARDEX, and EXECUCOMP. We obtained firm performance data from COMPUSTAT, CEO data from EXECUCOMP, board and director information from BOARDEX, firms' digital transformation measures from annual reports, and the degree of CSR from KLD. We merged CEO and firm-level variables from 2011 to 2018 that is the period we measured the degree of digital transformation. We used the publicly listed S&P1500 firms for our sample because they represent about approximately 90% of the market capitalization of U.S. stocks and is a broad measure of the U.S. equity market. After matching with firm performance

and CEO data, the final sample includes 4,760 firm-year observations of 722 firms for the observed period.

4.2 Variables and measures

4.2.1 Firm performance

We measured firm performance as the market value of a firm, which is the current price of all the outstanding stocks of a firm measured at the end of a year. We selected market value as the measure of firm performance in this study because the objective of the firm should be to maximize shareholder value (i.e. market value of equity). We obtained the market value from COMPUSTAT and log-transformed for the analysis.

4.2.2 Firm efficiency

We adopted the measure of firm efficiency from Demerjian et al. (2012) that use data development analysis (DEA) by comparing the revenue generated by firms conditional on the inputs such as net PP&E, net R&D, purchased goodwill, other intangible assets, cost of inventory, and selling and administrative expenses (SG&A). We winsorized the value of firm efficiency at both the upper and lower 0.01 percentiles of the distribution to reduce the effects of extreme values. As the market value is measured at the end of the year, we did not lag the level of firm efficiency in the model.

4.2.3 Digital transformation

We measured the degree of digital transformation by analyzing keywords in annual reports related to digital transformation (e.g., ‘big data’, ‘blockchain’, ‘computing’, ‘artificial intelligence’, etc.)(Qi et al., 2022). Digital transformation is composed of multiple dimensions including AI application, big data analytics, cloud computing, blockchain, and application of digital technology. We counted the keywords for each dimension and calculated the relative

usage of the keywords compared to other firms. We log-transformed the total scores of the dimension as the degree of digital transformation.

4.2.4 CSR

We measured the degree of CSR using KLD data by computing a composite measure from the difference between the sum of CSR strengths and the sum of all concerns for a firm each year (Al-Shammari et al., 2022). We measured the difference between strength and concerns in four dimensions including employee relations and diversity, product, community relations and environmental policies and practices from the KLD data.

4.2.5 Control variables

We included various control variables in the CEO, board, and firm levels. CEO-relevant variables include CEO's short-term and long-term compensations, CEO duality, CEO ownership, CEO experience, and CEO gender as CEO factors. Female CEOs positively influence innovation (Javed et al., 2023; Prabowo & Setiawan, 2021) and firm performance (Khan & Vieito, 2013; Peni, 2014). Short-term compensation includes a portion of salary and bonus, which is given for performance incentives, out of total compensation. Short-term compensation positively influences firm performance (Banker et al., 2013). Long-term compensation is a portion of stock options and restricted stocks, which are known to increase CEOs' pay-for-performance incentives (Jensen & Murphy, 1990; Mahoney & Thorne, 2005). We obtained CEO experience from EXECUCOMP for each fiscal year of the dataset. The CEO experience is ranged between 1 and 62 years; 25% of the observations under 3 years, and 25% over 12 years. CEO experience has a positive relationship with firm performance (Peni, 2014). We also controlled board characteristics including board sizes, female director (%), and inside directors (%). Digital transformation is highly related to board characteristics such as the portion of female directors

and diversity (Chen & Hao, 2022). We measured the board size as the log-transformed number of directors. A firm with a large board tends to have lower performance due to poor communication and decision-making problems (Guest, 2009). Female and inside directors are the portion of female and inside directors out of the total number of board directors. A large portion of female directors positively influences firm performance (Peni, 2014). Having more inside directors is more likely to improve return on investment (Klein, 1998).

In the firm level, we controlled the firm's past performance and relevant activities such as R&D expenditure, advertising expenditure, market orientation, Tobin's Q, ROA, and firm size. We included firm activities and performance in the previous year as control variables because those activities in the previous year will influences the firm's market value of the current year. R&D and advertising expenditures also influence firm performance. The R&D intensity is the R&D expenses to total assets of each firm. Following Koh, et al. (2018), we replace the missing R&D investment with the 4-digit SIC industry average because the relative magnitude of the R&D coefficients is close to the industry average or on average between 0.5 percent of sales (Koh et al., 2018). We log-transformed advertising expenditure while replacing missing values with the industry average as we did for calculating R&D expenditure. Tobin's Q is the ratio between the market value of the firm over the replacement cost of its assets, log-transformed (Malshe & Agarwal, 2015). We also controlled ROA. We also included market orientation because it drives firm performance and digital innovation (Atuahene-Gima, 1996; Morgan et al., 2009; Schulze et al., 2022). We measured the degree of market orientation by counting the use of keywords related to market orientation in annual reports (Zachary et al., 2011). Keywords are extracted across five dimensions of market orientation, including customer orientation (e.g., 'consumer', 'patronize', 'subscribe', etc.), competition (e.g., 'adverse', 'aspire', 'challenge',

'combat', etc.), inter-functional coordination (e.g., 'associate', 'combined', 'incorporate', etc.), long-term focus(e.g., 'constant', 'durable', 'long term', etc.), and profitability (e.g., 'cost effective', 'benefit', 'gain', etc.). Firm size represents the logged, number of employees relative to the industry average.

In the industry level, we included industry competition because firms may drive a higher level of digital transformation under the pressure of industry competition (Jin & Pan, 2023). Following previous research (Ju & Zhao, 2009; Rubera & Kirca, 2017), we use the Herfindahl concentration index (one minus the Herfindahl index) to measure industrial competitiveness. As the Hirschman-Herfindahl index (HHI) uses the sum of the square of all firms' market shares in any given industry ranging from 0 (highly competitive) to 1 (less competitive), we reversed the coding (0= 'less competitive'; 1= 'highly competitive) in the model (Hirshleifer et al., 2013). Finally, we included dummies of years, firms, and 4-digit SIC industry sectors to control the fixed effects of each year, firm, and industry. Table 1 summarizes the variable measures and data sources.

Table 1. Variable measures and data sources

Variable	Measure	Data source
Firm market value	Log-transformed market value of a firm *i* measured at the end of a fiscal year *t*	COMPUSTAT
Firm efficiency	Efficiency scores via DEA with inputs (net PP&E, net R&D, purchased goodwill, other intangible assets, cost of inventory, and SG&A) and output (revenue) of a firm *i* at year *t*	COMPUSTAT
Digital transformation	Logged value of the sum of digital transformation of a firm *i* at year *t,* log-transformed	Annual report
CSR	A composite measure of four dimensions, including employee relations and diversity, product, community relations and environmental policies and practices from the KLD data, with the sum of strengths minus the sum of all concerns in each dimension (Al-Shammari, et al., 2019)	KLD
Short-term compensation	a portion of the sum of salary and bonus out of total CEO compensation of a firm each year	EXECUCOMP

Long-term compensation	A portion of the sum of restricted stock holding ($) and restricted stock grants out of the sum of total compensation and restricted stock value	EXECUCOMP
CEO duality	if a CEO is a chair of a board (1 = 'yes'; 0 = 'no')	EXECUCOMP
CEO experience	The number of years since the first year of working as a CEO at year *t*, log-transformed	EXECUCOMP
CEO female	The gender of a CEO; 1 = 'female', 0 = 'male'	EXECUCOMP
CEO ownership	The degree of ownership of a CEO, log-transformed, of a firm *i* at year *t*	EXECUCOMP
Board size	The number of directors in a board of a firm i at year *t* relative to the 4-digit SIC industry average	EXECUCOMP
Inside director, %	The percentage of inside directors in a board of a firm *i* at year *t*	EXECUCOMP
Female director, %	The percentage of female directors in a board of a firm *i* at year *t*	EXECUCOMP
Market orientation	The standardized sum of the word counts related to market orientation of a firm *i* at year *t* (Zachary et al. 2011)	Annual Report
R&D intensity	A portion of R&D expenditure out of total asset of a firm *i* in the pervious year *t-1*, log-transformed	COMPUSTAT
Advertising intensity	A portion of advertising expenditure out of total asset of a firm *i* in the previous year *t-1*, log-transformed	COMPUSTAT
ROA	Return on asset of a firm *i* in the previous year *t-1*	COMPUSTAT
Tobin's Q	the ratio between the market value of the firm over the replacement cost of its assets, log-transformed of a firm *i* at year *t-1*	CRSP/ COMPUSTAT
Firm size	The ratio of the number of employees of a firm *i* relative to the industry (4-digit SIC) average at year *t-1*	COMPUSTAT
Industry competition	Operationalized as 1-herfindahl-hirschman index (HHI)	COMPUSTAT
Year	Dummies of years from 2011 to 2018	COMPUSTAT
Firm	Dummies of firms	COMPUSTAT
Industry	Dummies of 4-digit SIC	COMPUSTAT

4.3 Model specification

We investigate the mediation effect of firm efficiency between digital transformation and firm market value. To examine the relationships among them more accurately, we specified the system of two equations that detailed the relationships as followings:

EQ1. $\text{Firm efficiency}_{it} = \alpha_0 + \alpha_1 \text{Digital Transformation}_{it} + \alpha_2 \text{CSR}_{it} + \alpha_3 \text{Short-term compensation}_{it} + \alpha_4 \text{Long-term compensation}_{it} + \alpha_5 \text{CEO ownership}_{it} + \alpha_6 \text{Duality}_{it} + \alpha_7 \text{CEO experience}_{it} + \alpha_8 \text{CEO female}_{it} + \alpha_9 \text{Board size}_{it} + \alpha_{10} \text{Inside director}_{it} + \alpha_{11} \text{Female}$

director $_{it}$ + α_{12}Digital $_{it}$ + α_{13}Market orientation $_{it}$ + α_{14}R&D intensity $_{it-1}$ + α_{15}Advertising intensity $_{it-1}$ + α_{16}Tobin's Q $_{it-1}$ + α_{17}ROA $_{it-1}$ + α_{18}Firm size $_{it-1}$ + α_{19}Industry competition $_{it}$ + Year + Firm + Industry + e_1,

EQ2. $\ln(\text{Market value})_{it} = \beta_0 + \beta_1[\text{Digital transformation}_{it} \times \text{CSR}_{it}] + \beta_2\text{Firm efficiency}_{it} + \beta_3\text{Digital transformation}_{it} + \beta_4\text{CSR}_{it} + \beta_5\text{Short-term compensation}_{it} + \beta_6\text{Long-term compensation}_{it} + \beta_7\text{CEO ownership}_{it} + \beta_8\text{Duality}_{it} + \beta_9\text{CEO experience}_{it} + \beta_{10}\text{CEO female}_{it} + \beta_{11}\text{Board size}_{it} + \beta_{12}\text{Inside director}_{it} + \beta_{13}\text{Female director}_{it} + \beta_{14}\text{Digital}_{it} + \beta_{15}\text{Market orientation}_{it} + \beta_{16}\text{R\&D intensity}_{it-1} + \beta_{17}\text{Advertising intensity}_{it-1} + \beta_{18}\text{Tobin's Q}_{it-1} + \beta_{19}\text{ROA}_{it-1} + \beta_{20}\text{Firm size}_{it-1} + \beta_{21}\text{Industry competition}_{it} + \text{Year} + \text{Firm} + \text{Industry} + e_2$,

where, for a firm *i* and the year *t*, ln(Market value) $_{it}$ is a firm *i*'s market value measured at the end of the year *t*, Digital transformation $_{it}$ is the degree of digital transformation, CSR is the degree of CSR activities as a composite score of four dimensions from KLD, Short-term compensation is the portion of salary and bonus out of total compensation a CEO, Long-term compensation is the portion of awarded and unvested stock value out of total compensation of a CEO, CEO ownership is the portion of shares owned by a CEO, Duality is when a CEO is a chair of the board of directors, CEO experience is the number of years since a CEO has served as a CEO, CEO female is when a CEO is a female, Board size is the log-transformed total number of directors, Inside director is the portion of inside directors out of total directors, Female director is the portion of female directors out of total directors, Digital is a dummy when a firm pursues a digital transformation at the year *t*, Market orientation is the degree of market orientation at the year *t*, R&D intensity is the degree of R&D intensity out of total asset at the previous year *t-1*, advertising intensity the degree of advertising intensity out of total asset at the

previous year *t-1*, Tobin's Q is the ratio between the market value of the firm over the replacement cost of its assets at the previous year *t-1*, ROA is the degree of return on asset at the previous year *t-1*, Firm size is the relative size of employees compared to the industry average in the previous year *t-1*, and Industry competition is a reversed value of HHI measured based on sales. Year, Firm, and Industry are dummies of each year, firm, and industry

4.4 Modeling strategy

To test our hypotheses including mediation effects, we used generalized structural equation model that simultaneously considers the direct and indirect effects of multiple interacting factors (e.g., Achbah et al., 2024). Endogeneity can occur from various sources such as simultaneity, potential omitted variables, and reverse relations. We included both firm-specific and industry-specific fixed effects to address any possible endogeneity that can be caused by unobserved time-invariant variables such as firm and industry characteristics (Papies, et al., 2017; Srinivasan & Hanssens, 2009). To reduce reverse causality where financially successful firms may drive a higher level of digital transformation, we created temporal distance from the dependent and explanatory variables by lagging all performance variables by one year (e.g., Boulding & Staelin, 1995; Fischer & Himme, 2017). To account for heteroskedasticity and correlated residuals, we use cluster-robust standard errors based on the Huber–White estimators (Wooldridge, 2009).

5. Results

5.1 Model-free analysis

Table 2 shows the variable descriptions and the correlations among the variables. Digital transformation has a positive relationship with firm efficiency ($\gamma = 0.076$, $p < .05$) and firm

market value ($\gamma = 0.044$, $p < .05$). Firm efficiency is also positively related to market value ($\gamma = 0.54$, $p < .05$). The results support our rationale for the hypotheses focusing on the mediating effect of firm efficiency between digital transformation and firm market value. In addition, CSR is positively related to digital transformation ($\gamma = 0.075$, $p < .05$), firm efficiency ($\gamma = 0.141$, $p < .05$), and firm market value ($\gamma = 0.291$, $p < .05$). The positive correlations are consistent with our hypothesis related to the moderating effect of CSR between digital transformation and firm market value. We also confirmed there is no serious multicollinearity issues with VIF (mean VIF = 1.73).

Table 2. Correlation matrix and descriptive statistics

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1 Market value	1																				
2 Firm efficiency	.55*	1																			
3 Digital transformation	.04*	.08*	1																		
4 CSR	.29*	.14*	.08*	1																	
5 Short-term compensation	-.46*	-.24*	-.01	-.13*	1																
6 Long-term compensation	.12*	.04*	.02	.004	-.20*	1															
7 CEO duality	.15*	.06*	-.01	.07*	.004	-.04*	1														
8 CEO experience	-.03*	-.03*	.01	-.05*	.07*	-.004	.34*	1													
9 CEO ownership	-.36*	-.17*	.06*	-.14*	.30*	-.10*	.22*	.44*	1												
10 CEO female	.01	.03*	.09*	.03*	-.03*	.01	-.03*	-.07*	-.04*	1											
11 Board size	.48*	.30*	-.02	.21*	-.17*	-.04*	.06*	-.13*	-.33*	-.001	1										
12 Inside director	-.01	.06*	.06*	.11*	-.01	-.03*	.07*	.001	-.02*	-.02	.03*	1									
13 Female director	.29*	.20*	-.03*	.15*	-.19*	-.01	.03*	-.13*	-.21*	.27*	.25*	-.23*	1								
14 Digital $_{0/1}$	-.12*	-.12*	-.28*	-.07*	.07*	-.05*	.01	.01	.01	-.03*	-.08*	-.02*	-.08*	1							
15 Market orientation	-.01	.04*	.19*	.002	.01	.04*	-.02*	.08*	.09*	-.01	-.05*	-.04*	-.03*	-.22*	1						
16 R&D intensity	-.09*	-.04*	.003	-.02	.06*	-.04*	-.01	-.02	.06*	.03*	-.04*	-.01	-.002	.01	-.01	1					
17 Advertising intensity	-.07*	-.02*	-.009	-.04*	.03*	-.01	-.03*	.002	.04*	-.002	-.11*	.01	-.05*	.03*	.01	-.001	1				
18 Tobin's Q	.25*	.23*	.10*	-.004	-.13*	.03*	-.01	.06*	.07*	.02*	-.15*	-.03*	.05*	-.14*	.17*	.03*	.04*	1			
19 ROA	.26*	.18*	.06*	.05*	-.14*	.07*	.02*	.05*	-.06*	.01	-.01	-.01	.04*	-.09*	.10*	-.04*	-.13*	.18*	1		
20 Firm size	.63*	.40*	.08*	.27*	-.28*	-.02*	.14*	-.09*	-.24*	.04*	.43*	.04*	.27*	-.14*	.02*	-.05*	-.02*	.01	.16*	1	
21 Industry competitiveness	.04*	.08*	.02	.02*	.002	.01	.01	.05*	-.02*	.002	.003	-.002	-.03*	.05*	-.04*	.02*	-.004	-.01	-.04*	-.11	1

Mean	8.42	.42	2.30	.68	.25	.32	.46	2.07	2.99	.05	2.41	.72	.17	.38	.3	.07	.08	1.13	6.32	.45	.99
Std. dev.	1.62	.17	.003	3.11	.21	.23	.5	.74	.78	.21	.19	.26	.12	.49	1.62	.22	.421	.31	0.01	.27	.01
Min	4.77	.11	2.30	-10.2	0	0	0	.69	2.33	.00	1.79	0	0	0	-5.65	0	0	.55	6.07	.001	.94
Max	13.89	.74	2.35	26.22	1	0.1	1	4.14	6.54	1.00	3.78	1	0.70	1	9.44	5.4	10.57	1.78	6.43	1.47	.99

n = 4,760; *p < .05

5.2 Estimation results

We used generalized structural equation model (GSEM) to estimate the hypothesized effects. Table 3 presents the results. The main effects without interaction terms are presented at Model 1 and Model 2 where two equations are simultaneously estimated. Digital transformation has a positive effect on the degree of firm efficiency (β = 2.781, p < 0.05) (see Model 1), which supports H1. Firm efficiency positively influences market value (β = 1.844, p < 0.01) (Model 2). In addition, CSR positively influence market value (β = 0.016, p < 0.01) (see Model 2) and moderates the relationships between digital transformation and firm performance (β = 1.269, p < 0.05) (see Model 4). The result support H3.

Table 3. Estimation results

	Main		Interaction	
DV	Firm efficiency	Market value	Firm efficiency	Market value
VARIABLES	Model 1	Model 2	Model 3	Model 4
Firm efficiency $_{it}$		1.844***		1.841***
		(0.164)		(0.163)
Digital transformation $_{it}$ × CSR $_{it}$				1.269**
				(0.642)
Digital transformation $_{it}$	**2.781****	-2.667	2.781**	-4.233
	(1.134)	(6.486)	(1.134)	(6.437)
CSR $_{it}$	-0.001	0.016***	-0.001	-2.910**
	(0.001)	(0.004)	(0.001)	(1.480)
Short-term compensation $_{it}$	-0.075***	-0.594***	-0.075***	-0.596***
	(0.021)	(0.133)	(0.021)	(0.132)

Long-term compensation $_{it}$	0.006	0.145*	0.006	0.149*
	(0.016)	(0.081)	(0.016)	(0.081)
CEO ownership $_{it}$	0.004	0.149***	0.004	0.149***
	(0.009)	(0.043)	(0.009)	(0.043)
CEO duality $_{it}$	0.010*	0.026	0.010*	0.026
	(0.006)	(0.029)	(0.006)	(0.029)
CEO experience $_{it}$	-0.025***	-0.164***	-0.025***	-0.165***
	(0.006)	(0.042)	(0.006)	(0.042)
CEO female $_{it}$	-0.014	-0.251**	-0.014	-0.252**
	(0.021)	(0.101)	(0.021)	(0.101)
Board size $_{it}$	0.103***	0.772***	0.103***	0.774***
	(0.028)	(0.145)	(0.028)	(0.145)
Inside director, % $_{it}$	-0.076**	-0.185	-0.076**	-0.180
	(0.031)	(0.154)	(0.031)	(0.154)
Female director, % $_{it}$	0.066*	0.435*	0.066*	0.432*
	(0.038)	(0.226)	(0.038)	(0.226)
Digital $_{it}$	-0.014	-0.160***	-0.014	-0.161***
	(0.010)	(0.053)	(0.010)	(0.053)
Market orientation $_{it}$	-0.0006	-0.018	-0.001	-0.018
	(0.003)	(0.014)	(0.003)	(0.014)
R&D intensity $_{it-1}$	-0.015	-0.270***	-0.015	-0.271***
	(0.014)	(0.104)	(0.014)	(0.103)
Advertising intensity $_{it-1}$	0.008	-0.247***	0.008	-0.249***
	(0.005)	(0.067)	(0.005)	(0.067)
Tobin's Q $_{it-1}$	0.094***	1.340***	0.094***	1.341***
	(0.017)	(0.085)	(0.017)	(0.085)
ROA $_{it-1}$	0.929***	1.915*	0.929***	1.866*
	(0.286)	(1.072)	(0.286)	(1.072)
Firm size $_{it-1}$	0.239***	3.611***	0.239***	3.607***
	(0.023)	(0.224)	(0.023)	(0.224)
Industry competition $_{it}$	3.489***	180.8	3.489***	180.1
	(0.707)	(176.3)	(0.707)	(176.8)
Constant	-15.74***	-182.2	-15.74***	-177.5
	(3.094)	(175.9)	(3.094)	(176.4)
Observations	4,760	4,760	4,760	4,760
Year Fixed Effect	YES	YES	YES	YES
Firm Fixed Effect	YES	YES	YES	YES
Industry Fixed Effect	YES	YES	YES	YES
Log-likelihood	-1499	-1499	-1497	-1497

SEs are clustered at the firm level.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

5.3 Robustness check

We checked the robustness of the model with four different performance measures including the change in market value from the previous year in a percentage, the change in sales from the previous year in a percentage, return on investment (ROI), and return on equity (ROE). Table 4 presents the results from Model 5 to Model 8. The findings in all performances are consistent with our model where firm efficiency mediates the relationship between digital transformation and each firm performance, and CSR positively moderates the relationship between digital transformation and firm performance.

Table 4. Robustness check: Other performances

	Model 5	Model 6	Model 7	Model 8
Performance DV	Market value %	Sales Chg %	ROI	ROE
VARIABLES				
Digital transformation $_{it}$ × CSR $_{it}$	0.042**	20.59*	20.18*	44.62*
	(0.020)	(10.91)	(10.73)	(26.88)
Firm efficiency $_{it}$	0.014**	20.27***	11.59***	16.64***
	(0.006)	(2.892)	(2.015)	(3.809)
Digital transformation $_{it}$	-0.417**	-233.5***	171.2	220.7
	(0.201)	(81.71)	(108.6)	(175.1)
CSR $_{it}$	-0.098**	-47.56*	-46.52*	-102.9*
	(0.046)	(25.17)	(24.72)	(61.95)
Short-term compensation $_{it}$	-0.025***	-7.550***	0.235	-0.548
	(0.005)	(1.756)	(1.163)	(2.296)
Long-term compensation $_{it}$	0.028***	3.603***	3.711***	2.417
	(0.003)	(1.096)	(0.769)	(1.685)
CEO ownership $_{it}$	0.001	-0.360	0.536	1.708*
	(0.001)	(0.588)	(0.402)	(0.947)
CEO duality $_{it}$	0.003**	1.524***	-0.013	-0.822
	(0.001)	(0.405)	(0.294)	(0.630)
CEO experience $_{it}$	-0.0007	-0.827*	-0.267	-0.530
	(0.001)	(0.456)	(0.333)	(0.746)
CEO female $_{it}$	-0.005	-0.534	0.705	0.431
	(0.004)	(0.902)	(1.081)	(2.467)
Board size $_{it}$	-0.007	-3.206*	-0.479	1.974

	(0.005)	(1.869)	(1.339)	(3.239)
Inside director, % $_{it}$	-0.020***	-4.711**	0.023	7.628**
	(0.006)	(2.160)	(1.391)	(3.327)
Female director, % $_{it}$	-0.006	-9.715***	-2.212	-2.044
	(0.007)	(2.790)	(2.401)	(4.581)
Digital $_{it}$	-0.001	0.312	0.146	-0.297
	(0.001)	(0.601)	(0.488)	(1.219)
Market orientation $_{it}$	0.0002	-0.080	0.006	0.042
	(0.0004)	(0.161)	(0.151)	(0.292)
R&D intensity $_{it-1}$	-0.003	-1.477	0.131	-0.127
	(0.004)	(1.293)	(1.755)	(1.451)
Advertising intensity $_{it-1}$	0.0005	0.668	0.304	0.508
	(0.002)	(0.753)	(0.474)	(1.180)
Tobin's Q $_{it-1}$	-0.012***	12.31***	16.46***	26.10***
	(0.003)	(1.226)	(1.156)	(2.631)
ROA $_{it-1}$	-0.191***	-137.9***	266.0***	356.3***
	(0.055)	(30.17)	(29.64)	(54.04)
Firm size $_{it-1}$	-0.018***	-10.78***	2.862*	12.47***
	(0.004)	(1.972)	(1.461)	(3.498)
Industry competition $_{it}$	7.988***	-2,679*	2,874	1,527
	(2.568)	(1,453)	(2,083)	(1,022)
Constant	-5.680**	4,062***	-4,930**	-4,302***
	(2.603)	(1,459)	(2,100)	(1,079)
Observations	4,760	4,760	4,760	4,760
Year Fixed Effect	YES	YES	YES	YES
Firm Fixed Effect	YES	YES	YES	YES
Industry Fixed Effect	YES	YES	YES	YES
Log-likelihood	11485	-16380	-12867	-17201

SEs are clustered at the firm level.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

5.4 Mediation analysis

To show the mediating role of firm efficiency between digital transformation and firm market value, we conducted a Sobel test which supported the mediation effects of firm efficiency (z = 2.315, $p < 0.05$). The results are also supported by Zhao, Lynch and Chen (2010)'s approach to test mediation ($\beta = 0.013$, $p = 0.365$ between DT and performance; indirect only). Without firm efficiency, digital transformation positively influences firm performance ($\beta = 5.21$, $p < 0.01$). When firm efficiency is introduced as a mediator, the direct effect of digital transformation

becomes insignificant. Table 5 shows the results of a bootstrapped mediation analysis, which supports that there is a full mediation where the indirect effect is positive ($\beta = 7.77$, $p < 0.01$, C.I. [4.26, 11.55]), while the direct effect was insignificant. The results support H2.

Table 5. Mediation effect

Effects	Coefficient	Bias	Bootstrap Std. Err	[95% Conf.	Interval]
Indirect effect	7.77***	-0.099	1.81	4.26	11.55 (P)
				4.29	11.81 (BC)
Direct effect	3.11	-0.188	4.72	-6.10	11.81 (P)
				-5.55	12.60 (BC)
Total effect	10.88**	-0.287	5.27	0.53	21.25 (P)
				1.31	22.68 (BC)

Bootstrap (1,000)
P: Percentile, BC: Bias-corrected
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

5.5 Conditional indirect effect

Table 6 presents the conditional indirect effect of DT on a firm's market value depending on the degree of CSR with a bootstrap method. As the results show, the indirect effect of DT increases when firms implement a higher level of CSR ($\beta = 6.21$, $p < 0.01$, C.I. [2.03, 10.92] for low CSR; $\beta = 8.57$, $p < 0.01$, C.I. [4.75, 12.91] for high CSR). The results confirm H3.

Table 6. Conditional indirect effects

CSR	Observed coefficient	Bias	Bootstrap std. err.	[95% conf.	interval]	
Low	6.21***	-0.057	2.242	2.03	10.92	(P)
				2.13	11.10	(BC)
Mean	7.39***	0.028	1.907	3.82	11.22	(P)
				3.84	11.22	(BC)
High	8.57***	0.112	2.136	4.75	12.91	(P)
				4.51	12.80	(BC)

Low = mean - one standard deviation; High = mean + one standard deviation
Bootstrap (1,000)
P: Percentile, BC: Bias-corrected
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

6. Discussion and implications

6.1 Theoretical Implications

This study provides several significant contributions to the literature on digital transformation, firm efficiency, and corporate social responsibility (CSR). First, our study extends the emerging literature on digital transformation by focusing more on the mediating mechanisms through which it may influence firm performance (Feliciano-Cestero et al., 2023). While past research has focused largely on the direct effects of digital transformation on organizational outcomes (Li et al., 2023; Merín-Rodrigáñez et al., 2024; Peng & Tao, 2022), our findings demonstrate that efficiency is a critical mechanism through which digital transformation drives better performance outcomes. This adds a new dimension to the understanding of how firms can leverage digital technologies to enhance their operational efficiency, providing empirical evidence that efficiency mediates the impact of digital transformation on performance (Tian et al., 2022). Second, this study integrates the recent insights and theoretical pillars from the resource-based view (RBV) on resource utilization and value creation (Barney, 2018; Lin & Wu, 2014) and the behavioral theory of the firm to argue that resource utilization, in the form of firm efficiency, is a key determinant of how well firms capitalize on their digital transformation efforts (Tian et al., 2022). This underscores the notion that firms with more efficient resource allocation processes are better positioned to maximize the returns from digital transformation initiatives (Sousa-Zomer et al., 2020). Thus, the study adds to the new version of the RBV by showing that the benefits of digital transformation are contingent upon the firm’s ability to manage and deploy its

resources efficiently. Third, by introducing CSR as a moderator, this research advances the literature on digital transformation and corporate non-market strategy. Prior studies have established the link between CSR and firm performance (Al-Shammari et al., 2022; Pekovic & Vogt, 2020; Tang et al., 2012), but this study shows how CSR can play a different role in contributing to firm performance indirectly by strengthening the effects of digital transformation on performance. This suggests that CSR contributes to better societal outcomes and enhances firms' ability to succeed in their digital initiatives. This theoretical contribution builds on recent work exploring how digital technologies and responsible corporate practices intersect to promote sustainability and value creation (Li et al., 2022; Zhong & Ren, 2023). Lastly, the study contributes to the growing body of research investigating the contingent effects of organizational strategies and governance mechanisms on firm outcomes. By focusing on the combined impact of digital transformation, firm efficiency, and CSR, this research offers a more comprehensive view of how these factors interact to shape firm performance. This multidimensional framework can inspire future studies to explore other potential moderators and mediators in the digital transformation-performance relationship, such as leadership styles, market dynamics, or organizational culture (Trantopoulos et al., 2017).

6.2 Practical implications

This study provides several valuable insights for managers and decision-makers in firms undergoing or planning digital transformation. First, the findings emphasize the importance of firm efficiency for firms that are embracing digital transformation initiatives. Managers should pay particular attention to the process of resource allocation and ensure that an optimization approach is in place throughout the organization to avoid any unnecessary wastes and inefficiencies. This is particularly important given that the costs associated with digital

transformation, such as technology implementation and organizational restructuring, can be substantial (Guo et al., 2023). In doing so, firms can alleviate these costs and realize greater financial benefits from their digital investments.

Second, the study suggests that CSR plays a critical role in strengthening the positive effects of digital transformation on firm performance. Therefore, firms aiming to enhance their digital capabilities should also consider investing in CSR activities, as these programs have the potential to foster an atmosphere that is conducive to digital transformation. CSR practices, such as improving employee well-being programs, community engagement policies, and sustainability programs, can strengthen stakeholder trust and enhance a firm's reputation, which in turn facilitates smoother adoption of digital technologies (Fang et al., 2023; Tuyen et al., 2023). Thus, managers should use CSR not just as an ethical obligation but as a strategic tool that can enhance the effectiveness of digital transformation.

Third, the findings suggest that firms with high visibility, either in terms of size or market power, may face higher stakeholder expectations when undertaking digital transformation. Managers in such firms should be mindful of these expectations and communicate their digital strategies and CSR efforts clearly to external stakeholders. By doing so, they can reduce potential resistance and gain support for their transformation initiatives, which is particularly important in industries where digital disruption is rapidly changing competitive dynamics (Vendrell-Herrero et al., 2017). Additionally, the study emphasizes that digital transformation is not a one-size-fits-all approach. Firms in different industries or with varying levels of efficiency and CSR engagement may experience different outcomes from their digital transformation efforts. Managers should, therefore, tailor their digital strategies to align with their firm's specific context, ensuring that they integrate both efficiency-enhancing and socially responsible practices

into their digital agendas (Peng & Tao, 2022). Moreover, firms with limited resources or lower levels of CSR engagement may need to take a more gradual approach to digital transformation, prioritizing incremental improvements in efficiency before attempting more ambitious digital initiatives (Appio et al., 2021; Li et al., 2023).

In conclusion, this study provides a robust framework for understanding how digital transformation influences firm performance through the lens of efficiency and CSR. Managers who focus on improving efficiency and engaging in CSR practices are more likely to achieve superior outcomes from their digital transformation efforts. The insights provided by this research can guide firms in navigating the complexities of digital transformation, ultimately leading to more sustainable and competitive performance.

6.3 Limitations and future studies

Like any other study, this study is not without limitations. First, the small sample size may limit the generalizability of the findings and therefore future studies should attempt to replicate the work with a larger sample context. Generalizability of the findings of any study is an important consideration that facilitates the adoption of research findings and also increases the confidence of practitioners in the research outcomes of the scientific community. Second, although firm efficiency is identified in this study as a mediator, firm performance may be impacted by digital transformation through other mechanisms. This relationship may also be mediated by factors like employee engagement, organizational culture, or innovation capabilities. These mediators could be investigated in future studies to offer a more thorough comprehension of the mechanisms by which performance is impacted by digital transformation.

Lastly, while CSR is introduced as an important moderator in the present study, future studies could possibly explore other external factors, such as industry competition, technological

turbulence, or regulatory pressures, as they may also impact potential performance impact of digital transformation. Exploring these moderating factors would offer valuable insights into the environmental conditions that support or hinder digital transformation efforts.

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