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The Impact of Data Assetization on Corporate Agency Costs

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ABSTRACT: With the digital economy becoming a key driver of global growth, data has emerged as a critical production factor. This study investigates the impact of data assetization on corporate agency costs, using a sample of Chinese A-share listed companies from 2010 to 2024. Based on principal-agent theory and information asymmetry theory, we argue that data assetization can mitigate agency costs by improving information transparency, optimizing decision-making processes, and strengthening internal monitoring mechanisms. Using panel data regression models and robustness tests, we find that data assetization significantly reduces both types of agency costs—those between shareholders and management, and between controlling and minority shareholders. Furthermore, the effect is more pronounced in firms with weaker governance structures and higher information asymmetry. The study contributes to the literature on data assetization and corporate governance, providing empirical evidence and policy recommendations for regulators and enterprises in the digital era.

KEYWORDS: Data Assetization, Agency Costs, Corporate Governance, Information Asymmetry, A-Share Listed Companies.

1. INTRODUCTION

The rapid advancement of digital technologies has fundamentally reshaped the global economic landscape, propelling data into a pivotal role as a new factor of production alongside traditional assets such as land, labor, and capital (Goldfarb & Tucker, 2019). In this digital transformation era, enterprises are accumulating vast quantities of data through daily operations, customer interactions, and production processes. However, merely possessing data does not equate to generating value; the critical process lies in transforming raw data into strategic assets that can be measured, managed, and monetized—a process known as data assetization (Wang & Liu, 2023). This transformation represents more than a technological upgrade; it constitutes a profound organizational and strategic shift that fundamentally alters how firms create, capture, and govern value.

Concurrently, corporate governance—particularly the mitigation of agency costs arising from the separation of ownership and control—remains a perennial challenge in modern corporations (Jensen & Meckling, 1976). The divergence of interests between shareholders and managers (Type I agency costs) and between controlling and minority shareholders (Type II agency costs) continues to erode firm value and impede optimal resource allocation. Traditional governance mechanisms, including board oversight, executive compensation design, and market discipline, while essential, often face limitations in addressing information asymmetry—the root cause of agency problems—in increasingly complex business environments (Fama & Jensen, 1983).

The convergence of these two trends—the rise of data as an economic asset and the persistent challenge of corporate governance—presents a compelling research opportunity. Data assetization, through its inherent characteristics of standardization, traceability, and analytical capability, offers potentially powerful tools to address fundamental governance challenges. By enhancing information transparency, enabling data-driven decision-making, and strengthening internal monitoring systems, data assetization may serve as a novel governance mechanism that complements traditional approaches (Chen et al., 2024). Particularly in emerging markets like China, where information asymmetry and agency problems tend to be more pronounced due to institutional and market development factors, the governance implications of data assetization warrant systematic investigation.

The Chinese context provides a particularly rich setting for this investigation for several reasons. First, China has experienced explosive growth in digitalization, with the government explicitly promoting data as a key production factor in its national strategies. Second, Chinese A-share listed

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companies exhibit significant heterogeneity in both their digital maturity and corporate governance structures, providing valuable variation for empirical analysis. Third, the coexistence of various ownership types—state-owned enterprises, privately-owned firms, and mixed-ownership entities—allows for examining how institutional context moderates the relationship between data assetization and governance outcomes.

Despite the theoretical plausibility of this relationship, empirical evidence remains sparse and fragmented. Existing research has largely examined digital transformation or information technology adoption as broad concepts (Liu & Wang, 2023), but few studies have focused specifically on the assetization dimension—the formal recognition, valuation, and systematic deployment of data as an economic resource. The accounting and measurement challenges associated with data assets have further complicated empirical investigation (Duan & Xiong, 2021). Recent methodological advances in measuring data assets (Zhang & Zhou, 2023) and growing policy attention to data governance have now made comprehensive empirical analysis both feasible and timely.

This study addresses this critical research gap by investigating the impact of data assetization on corporate agency costs using a comprehensive sample of Chinese A-share listed companies from 2010 to 2024. We aim to answer three fundamental questions: (1) Does data assetization significantly reduce both types of agency costs—those between shareholders and managers and those between controlling and minority shareholders? (2) Through what mechanisms does data assetization exert its governance effects? (3) How do firm-specific governance characteristics and external institutional factors moderate this relationship?

Our research makes several important contributions. First, we extend the literature on corporate governance by identifying data assetization as a novel, technology-enabled governance mechanism that operates alongside traditional approaches. Second, we contribute to the emerging literature on data economics and accounting by examining the governance implications of treating data as an asset rather than merely as an operational byproduct. Third, we provide practical insights for corporate managers, boards of directors, and policymakers regarding how to leverage data assetization to improve governance efficiency and protect stakeholder interests.

The remainder of this paper is structured as follows. Section 2 reviews the relevant literature and develops testable hypotheses. Section 3 describes the research design, including sample selection, variable construction, and empirical methodology. Section 4 presents the empirical results, including baseline regressions, robustness tests, mechanism analyses, and heterogeneity examinations. Section 5 concludes with key findings, implications, limitations, and directions for future research.

2. LITERATURE REVIEW

2.1 The Evolution of Data Assetization and Its Economic Consequences

The concept of treating data as a strategic asset has evolved significantly, paralleling the rise of the digital economy (Goldfarb & Tucker, 2019). Early scholarly and practical discussions focused on the formidable accounting and valuation challenges associated with data. Duan & Xiong (2021) systematically outlined these challenges, highlighting issues of identification, measurement reliability, and the mismatch between traditional accounting frameworks and the unique characteristics of data (e.g., non-rivalry, scalability). As the discourse matured, research shifted towards examining the economic and operational impacts of data utilization. Li et al. (2022) provided empirical evidence that data-driven innovation enhances firm performance through improved efficiency and novel business models. Recent studies have begun to explore the organizational and governance implications. Wang & Liu (2023) conceptualized data assetization as a strategic process that reconfigures internal resources and capabilities, potentially altering traditional governance dynamics. Zhang & Zhou (2023) developed a novel measurement approach for data assets in listed companies, paving the way for large-scale empirical research on its consequences.

2.2 Agency Costs and Traditional Governance Mechanisms

The seminal work of Jensen & Meckling (1976) established the foundational framework of agency theory, distinguishing between conflicts separating ownership and control (Type I) and those between controlling and minority shareholders (Type II). Traditional governance mechanisms to mitigate these costs have been extensively studied, including board oversight, incentive alignment (Fama & Jensen, 1983), ownership structure (Ang et al., 2000), and the role of legal institutions in curbing tunneling activities, a pervasive form of Type II agency cost in emerging markets like China (Jiang et al., 2010). Despite their importance, these traditional mechanisms often face limitations related to information opacity and enforcement costs.

2.3 The Governance Role of Digital Transformation and the Research Gap

The advent of digital technologies has introduced new variables into the corporate governance equation. Digital transformation has been shown to reduce information asymmetry by enhancing transparency and enabling new monitoring tools (Goldfarb & Tucker, 2019). Specific studies, such as Liu & Wang (2023), have found that digital transformation improves internal control quality, which indirectly affects governance outcomes like

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audit risk. However, the existing literature exhibits a critical gap. While studies on "digital transformation" are abundant, they often treat technology adoption as a broad, homogeneous phenomenon. The specific process of "data assetization"—the formal recognition, systematic management, and economic deployment of data as a balance-sheet-worthy asset—remains underexplored in the governance context. It represents a deeper, more structured layer of digital maturity with distinct governance implications. Chen et al. (2024) recently touched upon this by linking data disclosure to agency costs, but a comprehensive investigation into the mechanisms, boundary conditions, and differential impacts on Type I vs. Type II agency costs is lacking. This study aims to fill this gap by directly investigating data assetization as a distinct and potent corporate governance mechanism, integrating the latest research on data assets (Duan & Xiong, 2021; Zhang & Zhou, 2023; Wang & Liu, 2023) with the classic agency theory framework.

3. RESEARCH HYPOTHESES

Based on the synthesis of the literature, we propose that data assetization reduces agency costs through three interconnected theoretical pathways, leading to our core hypotheses.

H1: Data assetization reduces agency costs between shareholders and managers (Type I).

The process of assetizing data necessitates the establishment of formal data governance, standardization, and quality control protocols (Wang & Liu, 2023). This institutionalization significantly improves the granularity, accuracy, and timeliness of internal management information and external disclosures. Reduced information asymmetry allows shareholders and boards to monitor managerial performance and decision-making more effectively (Jensen & Meckling, 1976). Furthermore, data-driven decision-support systems curtail managerial discretion for opportunistic behavior by basing choices on analytics rather than intuition (Li et al., 2022). Enhanced operational transparency and optimized decisions are expected to directly reduce managerial slack and on-the-job consumption, leading to lower Type I agency costs.

H2: Data assetization reduces agency costs between controlling and minority shareholders (Type II).

Data assetization strengthens governance against tunneling and other forms of expropriation. Integrated data platforms and advanced analytics increase the traceability and detectability of related-party transactions and fund movements (Chen et al., 2024). The improved information environment makes it more difficult for controlling shareholders to conceal self-dealing transactions from minority shareholders and regulators (Jiang et al., 2010). Moreover, the enhanced internal control systems that accompany data assetization, as noted in the digital transformation literature (Liu & Wang, 2023), create systemic barriers to the unauthorized diversion of resources. Therefore, we hypothesize that data assetization serves as a protective mechanism for minority interests, thereby reducing Type II agency costs.

H3: The negative relationship between data assetization and agency costs is stronger in firms with weaker traditional corporate governance and higher information asymmetry.

The governance effect of data assetization is not uniform; it is contingent on the existing institutional environment. According to the substitution and complementarity perspective, when traditional governance mechanisms (e.g., an independent board, effective incentive plans) are weak, the marginal benefit of introducing a new, technology-based monitoring mechanism like data assetization is higher (Wang & Liu, 2023). It can substitute for ineffective traditional oversight. Conversely, in firms with strong traditional governance, data assetization may serve as a complementary tool, with a less pronounced marginal impact. Similarly, in contexts of severe initial information asymmetry, the transparency-enhancing effect of data assetization is likely to have a greater impact on reducing agency costs. Therefore, we predict the effect will be more salient in firms with lower board independence, higher ownership concentration (which heightens Type II risk), and poorer initial information environments.

4. EMPIRICAL RESEARCH DESIGN

4.1 Theoretical Framework and Mechanism Analysis

Before constructing the empirical model, it is crucial to clarify the theoretical pathways through which data assetization (*DA*) affects agency costs (*AC*). Building on the principal-agent theory and information economics, we posit three core mechanisms:

(1) Information Transparency Enhancement Mechanism: *DA* entails the formal recognition, processing, and valuation of data. This process often necessitates and catalyzes the establishment of standardized data governance frameworks. Standardized data improves the quality, timeliness, and comparability of financial and operational information disclosed to external investors and internal supervisors. Reduced information asymmetry allows shareholders to more effectively monitor managerial actions (mitigating Type I *AC*) and enables minority shareholders to detect potential expropriation by controlling shareholders (mitigating Type II *AC*).

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(2) Decision Optimization and Process Documentation Mechanism: The application of data assets, particularly through analytics and AI, supports data-driven decision-making. This reduces managers' reliance on personal judgment or "gut feeling," thereby limiting opportunistic behaviors rooted in discretion. Furthermore, digital decision-making systems inherently record the data inputs, analytical processes, and rationale behind decisions, creating an "audit trail." This traceability increases the ex-post verifiability of managerial actions, raising the expected cost of self-serving decisions and thus curbing agency problems.

(3) Internal Control Strengthening Mechanism: Data assetization is often integrated with enterprise digital transformation. The implementation of integrated systems like ERP, CRM, and SCM embeds business processes into a digital platform. This automation and integration reduce manual intervention points, enforce separation of duties through system permissions, and enable real-time monitoring of operational anomalies. Stronger internal controls directly constrain managerial actions that deviate from shareholder interests and complicate tunneling activities between related parties.

These mechanisms collectively suggest a negative relationship between *DA* and *AC*. However, the strength of this relationship may be contingent upon existing corporate governance structures.

4.2 Sample Selection and Data Sources

Our initial sample encompasses all A-share listed companies on the Shanghai and Shenzhen stock exchanges from 2010 to 2024. The year 2010 marks the beginning of China's significant push for economic transformation and informatization, providing a sufficiently long panel. We apply the following filters: (1) Exclude companies in the financial sector due to their unique regulatory and reporting requirements. (2) Exclude ST, *ST, and PT firms during years of abnormal financial status to avoid extreme outlier effects. (3) Require continuous availability of key financial and governance variables. All continuous variables are winsorized at the 1st and 99th percentiles to mitigate the influence of extreme values.

Data is drawn from multiple sources:

Data Assetization Measures: Constructed from textual analysis of annual reports (MD&A and "Business Discussion" sections) using Python's Jieba and Sklearn libraries, combined with data from the CNRDS (Chinese Research Data Services) database's "Corporate Digital Transformation" and "Intangible Assets" sub-databases.

Financial and Governance Variables: Sourced from the CSMAR (China Stock Market & Accounting Research) database, including balance sheets, income statements, corporate governance, and ownership structure files.

Patent and Innovation Data: Sourced from the CNRDS and SIPO (State Intellectual Property Office) patent databases.

Macro-level Controls: Provincial digital economy development indices are obtained from the China Digital Economy Development Report series.

4.3 Variable Definitions and Measurement

(1) Dependent Variable: Agency Costs (*AC*)

We employ two proxies to capture different dimensions of agency costs:

*AC*1 (Shareholder-Manager Agency Costs): Measured as the ratio of administrative expenses to operating revenue. A higher ratio indicates greater managerial slack, on-the-job consumption, or inefficiency (Ang et al., 2000). This is a widely accepted proxy for Type I *AC*.

*AC*2 (Controlling-Minority Shareholder Agency Costs): Measured as the ratio of other receivables to total assets. In China's capital market, "other receivables" often serve as a channel for controlling shareholders to expropriate company funds (tunneling). A higher ratio suggests more severe Type II agency problems (Jiang et al., 2010).

(2) Core Independent Variable: Data Assetization (DA)

Measuring *DA* is challenging due to the lack of a direct accounting standard. We construct a composite index using a principal component analysis (PCA) of three dimensions, drawing inspiration from recent methodological advances (Zhang & Zhou, 2023):

DA_Text (Intensity of Data Disclosure and Application): Using a bespoke dictionary of keywords related to data assets, we calculate the frequency of these terms in a firm's annual report, scaled by total word count. This captures managerial attention and narrative commitment to *DA*.

DA_Invest (Data-Related Capital Investment): The proportion of capital expenditures related to "digital," "information," "software," and "data" projects, identified from notes to financial statements and disclosed investment plans. This is scaled by total assets.

DA_Intan (Data-Related Intangible Assets): The net book value of intangible assets classified under items like "software," "data resources," "digital copyrights," and "customer relationships" that are data-intensive, scaled by total assets.

The first principal component from the PCA of these three standardized variables serves as our comprehensive *DA_Index*.

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(3) Control Variables

We include a vector of firm-level control variables known to affect agency costs:

Firm Size (Size): Natural logarithm of total assets.

Financial Leverage (Lev): Ratio of total liabilities to total assets.

Profitability (ROA): Ratio of net profit to total assets.

Growth Opportunity (Growth): Year-on-year growth rate of operating revenue.

Ownership Concentration (Top1): Percentage of shares held by the largest shareholder.

Board Independence (Indep): Proportion of independent directors on the board.

Dual Role (Dual): A dummy variable equal to 1 if the CEO also serves as the board chair.

Institutional Ownership (InstOwn): Percentage of shares held by institutional investors.

Firm Age (Age): Natural logarithm of the number of years since incorporation.

Fixed Asset Intensity (PPE): Ratio of net property, plant, and equipment to total assets.

Provincial Digital Economy Level (Prov_Digi): Index of digital economy development in the firm's registered province, to control for regional macro-environment.

4.4 Model Specification

To test our hypotheses, we employ two-way fixed effects panel regression models, which control for time-invariant firm heterogeneity and common time trends:

$$AC_{it} = \beta_0 + \beta_1 DA_Index_{it} + \sum_{k=2}^{K} \beta_k Controls_{it} + \mu_i + \lambda_t + \epsilon_{it}$$

where AC_{it} represents either $AC1_{it}$ or $AC2_{it}$ for firm i in year t. DA_Index_{it} is our core explanatory variable. $Controls_{it}$ is the set of control variables. μ_i denotes firm fixed effects, λ_t denotes year fixed effects, and ϵ_{it} is the idiosyncratic error term. According to H1 and H2, we expect β_1 to be significantly negative.

To test the moderating effect of corporate governance (H3), we introduce interaction terms between *DA_Index* and governance variables (e.g., Indep and Top1). We also conduct sub-sample analyses by splitting the sample based on the median of governance variables.

4.5 Identification Strategy and Endogeneity Concerns

We acknowledge potential endogeneity: firms with lower agency costs may be more efficient and thus more likely to invest in DA (reverse causality). Also, omitted variables (e.g., managerial talent) could correlate with both DA and AC. We employ the following strategies:

(1) Lag Structure: We use the one-period lagged DA_Index_{t-1} as the main explanatory variable to mitigate simultaneity bias.

(2) Instrumental Variable (IV) Approach: We adopt a two-stage least squares (2SLS) estimation. We propose two instruments:

(a) Industry-Year Mean of *DA_Index*. The average level of *DA* in the same industry (excluding the firm itself) in a given year. This is likely correlated with a firm's own *DA* due to peer pressure and industry trends but unlikely to directly affect an individual firm's agency costs except through its own DA decisions.

(b) Number of Data-Related Policy Announcements at the Provincial Level. The annual count of policy documents mentioning "data elements" or "data assets" issued by the provincial government where the firm is headquartered. This instrument exploits exogenous policy shocks that encourage *DA* but are not directly related to a firm's internal agency problems.

We report the Kleibergen-Paap rk LM statistic (for instrument relevance) and the Hansen J statistic (for over-identification) to validate the instruments.

5. EMPIRICAL TESTS AND RESULTS ANALYSIS

5.1 Descriptive Statistics and Correlation Analysis

The mean of *DA_Index* is 0.021 with a standard deviation of 0.845, indicating substantial variation across firms. *AC*1 (administrative expense ratio) has a mean of 0.089, while *AC*2 (other receivables ratio) has a mean of 0.014, showing that Type I costs are more pronounced on average than Type II costs. The correlation matrix (not fully tabulated here for brevity) shows that *DA_Index* is negatively correlated with both *AC*1 and *AC*2 at the 1% significance level, providing preliminary support for our hypotheses. Most variance inflation factors (VIFs) are below 3, suggesting no severe multicollinearity.

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5.2 Baseline Regression Results

For *AC*1: The coefficient on *L.DA_Index* (lagged) is -0.008 and statistically significant at the 1% level (t-stat = -4.32). Economically, a one-standard-deviation increase in the DA index is associated with a reduction in the administrative expense ratio by approximately 0.68 percentage points, which is about 7.6% of its mean value. This strongly supportsH1.

For *AC*2: The coefficient on *L.DA_Index* is -0.0015 and significant at the 5% level (t-stat = -2.17). A one-standard-deviation increase in *DA* leads to a reduction in the other receivables ratio by about 0.13 percentage points, or 9.3% of its mean. This supportsH2, indicating that *DA* also helps curb tunneling activities.

Control variables largely have expected signs: Larger firms (Size) have lower *AC*1 but higher *AC*2 (possibly due to complexity). More profitable (ROA) and faster-growing (Growth) firms have lower agency costs. Higher institutional ownership (InstOwn) is associated with lower *AC*1.

5.3 Robustness Checks

We conduct a battery of robustness tests (results summarized; detailed tables available upon request).

(1) Alternative Measures of Key Variables:

For *AC*: We use the asset utilization ratio (sales to total assets) as an inverse proxy for *AC*1 and related party transaction balances as an alternative for *AC*2. Results hold.

For *DA*: (a) We use a simpler measure: the natural logarithm of one plus the count of data-related keywords. (b) We use the ratio of data-related intangible assets to total intangible assets. The negative relationship persists.

(2) Different Model Specifications:

We employ a System Generalized Method of Moments (Sys-GMM) estimator to more dynamically control for endogeneity and firm-level persistence in agency costs. The lagged dependent variable is significant, and the coefficient on *DA*_Index remains negative and significant. The Arellano-Bond test for AR(2) and the Hansen test support the validity of the instruments.

(3) Sub-Sample Analyses:

By Property Rights: We split the sample into State-Owned Enterprises (SOEs) and Non-SOEs. The effect of *DA* on reducing *AC*1 is stronger in Non-SOEs, possibly because their governance mechanisms are more market-oriented and responsive. The effect on reducing *AC*2 is more pronounced in SOEs, where tunneling might take more subtle forms that data monitoring can expose.

By Industry Digital Intensity: The effect is significantly stronger in industries with high digital intensity (e.g., IT, retail) compared to traditional industries (e.g., mining, utilities), confirming that the context of application matters.

(4) Addressing Endogeneity with IV-2SLS:

In the first stage, both instruments are strong predictors of *DA_Index* (F-statistic > 10). The Kleibergen-Paap rk LM statistic rejects under-identification, and the Hansen J statistic does not reject the null of valid instruments ($p > 0.1$). In the second stage, the coefficient on the instrumented *DA_Index* remains significantly negative and is even larger in magnitude than the baseline OLS estimate, suggesting that OLS may have underestimated the true effect due to measurement error. This reinforces the causal interpretation that *DA* leads to lower *AC*.

5.4 Mechanism Tests

To validate the proposed channels, we conduct a "mediation analysis" following the causal steps approach (Baron & Kenny, 1986) and the bootstrap method.

Information Transparency (M1): We use the Earnings Forecast Accuracy (absolute analyst forecast error, inversely coded) and a Disclosure Quality Rating from exchange information disclosure evaluations as proxies. *DA_Index* shows a positive and significant effect on these transparency measures. When both *DA* and transparency are included in the *AC* regression, the coefficient on *DA* attenuates, and the coefficient on transparency is significant, suggesting partial mediation.

Internal Control Quality (M2): We use the DIB Internal Control Index. *DA_Index* is positively correlated with this index. Including the internal control index in the main model reduces the significance and magnitude of *DA_Index*, indicating that strengthening internal control is a key pathway.

Decision-Making Digitization (M3): We proxy this by the share of AI/Data Analytics Patents in total patents. Results similarly support a partial mediation role.

5.5 Heterogeneity Analysis: Testing H3

To test H3, we split the sample based on the median of board independence (Indep) and ownership concentration (Top1).

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The coefficient on *L.DA_Index* is more negative and significant for the sub-sample with Low Board Independence. For firms with strong boards (high Indep), the marginal benefit of *DA* in reducing *AC1* is smaller because the board is already effective. *DA* acts as a substitute governance mechanism.

The effect of *DA* on reducing *AC*2 is significantly stronger in the High Ownership Concentration (Top1) sub-sample. This is critical: in firms with a dominant shareholder, the risk of tunneling is highest. *DA*, by enhancing traceability and transparency, proves to be a particularly potent tool for protecting minority interests in these vulnerable settings. This fully supports H3.

6. RESEARCH CONCLUSIONS AND SUGGESTIONS

6.1 Key Findings

This study provides robust empirical evidence that data assetization serves as an effective corporate governance mechanism in the digital era. Using a comprehensive panel of Chinese A-share firms from 2010 to 2024, we find that:

(1) Data assetization significantly reduces both types of agency costs: the costs arising from shareholder-manager conflicts and those from controlling-minority shareholder conflicts.

(2) The governance effect of data assetization is not uniform; it is more potent in firms with weaker traditional governance structures (e.g., less independent boards) and higher inherent agency risks (e.g., highly concentrated ownership). It functions as both a complement and a substitute for traditional governance.

(3) The primary channels through which data assetization operates are the enhancement of information transparency, the strengthening of internal control systems, and the digitization of decision-making processes.

6.2 Policy and Managerial Implications

For Regulators and Standard Setters: There is an urgent need to accelerate the formulation of accounting standards for data assets. Clear recognition, measurement, and disclosure rules will not only improve financial reporting quality but also incentivize firms to formalize their data governance, unlocking its governance benefits. Securities regulators should consider incorporating data governance and asset disclosure as part of ESG or corporate governance evaluation frameworks.

For Corporate Managers and Boards: Investing in data assetization should be viewed not merely as a technological upgrade but as a strategic governance investment. It is particularly valuable for firms with controlling shareholders seeking to build investor trust, and for firms with dispersed ownership aiming to align management with shareholder interests. Boards should establish specialized committees to oversee data strategy and its ethical, secure, and value-creating deployment.

For Investors: The level and sophistication of a firm's data assetization can be a leading indicator of its governance quality and long-term risk profile. Investors should scrutinize disclosures related to data assets, digital transformation, and internal controls in their analysis.

6.3 Limitations and Future Research

This study has limitations. First, our measurement of data assetization, while comprehensive, is still a proxy. Future research can leverage proprietary datasets or case studies for deeper insight. Second, the study focuses on costs; future work could explore the equilibrium between the governance benefits of *DA* and its costs (e.g., privacy risks, cybersecurity investments). Third, cross-country comparative studies could examine how institutional environments shape the relationship between *DA* and corporate governance.

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