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Data Asset Disclosure and ESG Rating Divergence

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Abstract: This study examines whether and how data asset disclosure affects ESG rating divergence. Based on a sample of A-share listed companies in China from 2007 to 2023, this study empirically examines the impact of data asset disclosure on ESG rating divergence using a fixed-effect model and multiple robustness tests. The results indicate that data asset disclosure significantly reduces ESG rating divergence. Mechanism tests indicate that data asset disclosure reduces ESG rating divergence through enhancing information transparency, improving green disclosure practices, and lowering earnings management. Heterogeneity tests find that the mitigation effect of data asset disclosure is more pronounced in non-state-owned enterprises and institutional firms with lower investor ownership. This study offers empirical evidence for firms aiming to reduce ESG rating divergence via strategic data disclosure.

Keywords: Data asset disclosure, ESG rating divergence, Information transparency, Corporate governance, Chinese A-share Market

1. Introduction

Data has emerged as a critical production factor in the digital economy era, reshaping business models and operational efficiency. As a new type of asset with economic value for enterprises, data asset is an important form of data factor assetization. On the one hand, data assets are becoming a key factor for enterprises to differentiate themselves from the competition. On the other hand, the development of data assets can also enhance the operational efficiency of enterprises and promote the application of emerging technologies such as artificial intelligence and big data.

In recent years, China has attached great importance to the marketization of data factors and has already issued relevant policies to regulate data resource management. On August 21, 2023, China's Ministry of Finance issued the Interim Provisions on Accounting Treatment of Enterprise Data Resources, which states that starting from January 1, 2024, enterprises are required to account for data resources that meet the requirements on their balance sheets and promote the capitalization of data assets. This policy framework not only encourages enterprises to strengthen the management of data assets and enhance their internal data governance system but also alleviates the existing information asymmetry problem to a certain extent and improves the accuracy of the market as well as investors' assessment of the capital value of enterprises. More scholars focus on data assets and their economic consequences in academia, but the existing research is still relatively scarce. Therefore, this paper aims to study the economic consequences of data assets, focusing on the impact of data assets on corporate disclosure and ESG.

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Growing global emphasis on sustainability and responsible investing has elevated the importance of ESG (Environmental, Social, and Governance) frameworks in corporate practices. Pollman[1] highlights that the use of ESG is wide-ranging, including as a factor influencing investment analysis, a tool for risk management, a measure of corporate social responsibility and sustainability, and a measure capable of reflecting a company's or investor's ideological preferences. Based on the critical nature of ESG among global investors, regulators, and core corporate stakeholders, ESG divergence among different rating agencies has become increasingly pressing. Several practical challenges may arise from ESG rating divergence. For companies, ESG rating divergence may undermine stakeholder trust, reduce investor confidence, increase financing costs and risks, and contribute to stock price volatility. Rating divergence will increase the risk of information asymmetry for investors, potentially distorting portfolio allocation and diminishing returns. In addition, the differences caused by different rating agencies will reduce market transparency, cause efficiency problems in the capital market, and hinder the development of green finance. Prior research identifies three primary drivers of divergence in Environmental, Social, and Governance (ESG) ratings: inconsistent evaluation standards among rating agencies, information asymmetry between firms and rating agencies, and subjective judgments in assessing qualitative indicators. This study will explore the determinants of ESG rating divergence and examine how they interact with the digital economy. This paper focuses on three research questions:(1) How does data asset disclosure affect ESG rating divergence? (2) What are the channels and mechanisms through which data asset disclosure affects ESG rating divergence? (3) How do internal and external factors of firms impact the relationship between data asset disclosure and ESG rating divergence?

How data asset disclosure affects ESG rating divergence is an empirical question. On the one hand, data asset disclosure can reduce ESG rating divergence. Firstly, data asset disclosure can enhance the information transparency of enterprises, and the information asymmetry between enterprises and rating agencies can be mitigated, thus reducing the possibility of divergence in ESG ratings. Secondly, according to the signaling theory, enterprises can voluntarily disclose high-quality information to send positive signals to the market about the sustainable development of the enterprise, which aims at proving the high level of ESG management. As a credible signal, data asset disclosure is conducive to enhancing the trust of rating agencies and other investors and easing divergence. Thirdly, from the perspective of earnings management, corporate disclosure of data assets can restrain earnings management in multiple dimensions, indirectly affecting the accuracy and consistency of ESG ratings and reducing ESG rating divergence.

On the other hand, data asset disclosure is also likely to enhance ESG rating divergence. First of all, massive data may cause information overload, which may exceed the information processing capacity of rating agencies and lead to rating deviation. Secondly, enterprises may selectively disclose positive data beneficial to their development, exacerbating the risk of miscalculating corporate indicators by rating agencies. Finally, as the current disclosure standards and rating standards are not entirely unified, different rating agencies may rely on their methodology for ESG ratings; a large amount of data may instead amplify the evaluation differences caused by agencies due to differences in indicator weights and differences in calculation methods. Therefore, this paper will focus on the mechanism of data asset disclosure on ESG rating divergence and study the relationship between the two.

This paper has two main reasons for studying the research problem in the Chinese scenario. Firstly, since 2020, China has gradually focused on developing data elements and has introduced regulations related to data assets, which provides a policy framework to support the research in this paper. Secondly, the data disclosed by data assets are available in Chinese databases, which provides data support for further research.

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Based on the data of Chinese A-share listed companies from 2007 to 2023, this study chose data asset disclosure as the independent variable in this paper, which is calculated by the frequency of data asset keywords in the annual report and used to measure the disclosure intensity. The dependent variable is ESG rating divergence, which is measured using the polarization of ratings across rating agencies. This study finds that data asset disclosure can significantly reduce ESG rating divergence, and the finding remains robust after being tested by several methods, including replacing the dependent variable, adding additional control variables, using the sample matching method, and the PSM method. The mediating mechanism study finds that information transparency, green disclosure, and earnings management are the three main channels of this effect. The study shows that data asset disclosure enhances information transparency, reducing information asymmetry and judgmental discrepancies among ESG rating agencies. At the same time, data asset disclosure helps to enhance the green awareness of company management and strengthen the level of green disclosure of enterprises, which enables ESG rating agencies to have a better understanding of the ESG situation of the enterprise and alleviate the disagreement; moreover, by combining with the study of Jones model, this paper finds that the lower the surplus manipulation in corporate financial statements, the lower the ESG rating divergence. Further, this paper also explores whether there are heterogeneous differences in the impact of data asset disclosure on ESG rating divergence. After grouping firms by two dimensions, the nature of firm ownership and internal and external monitoring, the regression results show that the effect is more significant among non-state-owned firms and firms with a low proportion of institutional investors.

This study contributes to the literature in three ways. First, this study expands the literature on the economic consequences of data asset disclosure. As an emerging concept in recent years, most scholars' research on the economic consequences of data assets at this stage focuses on the impact on corporate financial performance and innovation. However, this paper systematically examines the impact of data asset disclosure on non-financial performance indicators, fills the research gap of data assets in ESG governance, and provides new perspectives for the subsequent scholars' research on the social value of relevant data elements. Second, this paper deepens the empirical evidence on the factors influencing ESG rating divergence. Existing literature primarily advances relevant research from the methodological differences of rating agencies, and this paper innovatively proposes the theoretical idea of information transparency and ESG ratings, verifies the impact of relevant information asymmetry issues on rating divergence, and provides new evidence for subsequent research. Finally, this paper provides operational insights at the policy formulation and corporate practice levels. The study explains the critical impact of data asset disclosure on ESG rating divergence. It identifies the preferred future improvement routes for non-state-owned firms and firms with low institutional investor ownership. The conclusions of this paper provide a solid theoretical basis for future regulators to refine the data asset disclosure guidelines further and for enterprises to optimize their disclosure strategies further, which will help the precision of ESG rating system governance in practice.

2. Literature review

2.1. Conceptual definition of data assets and literature related to data assets

As a new type of production factor in the digital economy era, the conceptual definition of data assets is evolving in the academic world. Prior studies have proposed multidimensional definitions from various perspectives. Xu et al. [2] trace this development process and point out that, with the advancement of digital technology, people's perceptions of data value are also changing. With the progress of digital transformation, enterprises' understanding of the value of data has gradually deepened, and data is no longer just a product of technical support but a key element that is directly

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involved in enterprise strategic decision-making, innovation, and profit model change. In the past few years, the definition of data assets has gradually shifted from "information resources" to "strategic assets." Existing studies generally consider data assets to be the collection of electronic data resources with economic ownership attributes, quantifiable value, and the ability to create economic benefits. According to Hu et al.[3], data assets refer to data resources owned or controlled by an enterprise that can bring future economic benefits and are recorded in physical or electronic form, such as documents, electronic data, etc.

Existing research on data assets mainly focuses on the value and economic impact of data assets, and some scholars also focus their sights on the economic consequences of information disclosure on data assets. The valuation of data assets remains an unresolved challenge in academia. Existing studies generally agree that the value of data assets is highly dynamic and uncertain and is affected by factors such as data quality, usage scenarios, and market demand. Gao et al.[4] point out that although data assets are economically significant, standardized accounting practices are still underdeveloped. Studies have explored the impact of data asset disclosure and firms' financial metrics elsewhere. For example, Sun and Du[5] point out that disclosing information about data assets reduces stock price synchronization and suggests that such transparency enhances the market's information environment. Zhao et al.[6] mention that data assets may contribute to over-investment, particularly in non-state-owned enterprises, by exacerbating financing constraints and potentially encouraging real earnings management. Meanwhile, disclosing firms' data assets positively impacts bank loan acquisition, suggesting that transparent disclosure can enhance firms' credibility with financial institutions[7]. The literature on data assets and their disclosure is still developing, with limitations remaining in valuation, accounting treatment, and economic impact. This study examines the economic consequences of data asset disclosure, particularly its effect on non-financial performance.

2.2. Economic consequences and drivers of ESG rating divergence

ESG, an important framework for measuring corporate sustainability, has evolved in the early 21st century to become a core element of global investment decisions and corporate strategy. Environmental (E) focuses on corporate responses to climate change, resource utilization, and pollution management; Social (S) involves employee rights, community relations, and supply chain management; and Governance (G) focuses on board structure, transparency of executive compensation, and anti-corruption mechanisms[8]. Berg et al.[9] point out that, at present, the mainstream global ESG rating agencies (e.g., MSCI, Sustainalytics, Refinitiv, etc.) score companies by constructing a multidimensional indicator system. However, the rating results often have significant differences. Their studies imply that when ESG rating indexes are used as a target by stakeholder groups, including investors, rating divergence will become an important influence on the further development of the ESG system. Currently, there are two main research paths on ESG rating divergence; the first focuses on the economic consequences of rating divergence. Lyon and Montgomery[10] suggest that enterprises may adopt "selective disclosure" or "greenwashing" rather than materially improving ESG practices to cater to specific rating criteria. This strategy may enhance the rating of a particular agency in the short term, but in the long term, it can damage corporate reputation and investor trust. Ilhan[11] finds that greater rating divergence increases information asymmetry, making it more difficult for investors to assess ESG performance accurately and contributing to heightened stock price volatility. Zhou et al.[12] point out that ESG rating disagreement has a positive effect on corporate green innovation has a positive effect, and this effect is more significant in companies with higher independent director resource advantage and greater media attention. Meanwhile, there is a negative correlation between ESG rating divergence and surplus management, and its mechanism is related to the agency problem[13]. Liao and Wu[14] also

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mention that ESG rating divergence adversely affects investor sentiment, decreasing investor evaluation and confidence in the company.

Another group of studies on ESG ratings divergence is the drivers of its emergence. Firstly, the causes of ESG rating divergence are fundamental, and there are three leading causes currently mainstreamed in academia: differences in rating agency methodologies, subjectivity in assessment criteria, and geographic bias. Among them, Differences in indicator selection, weighting schemes, and data sources constitute the core reasons for rating divergence. For example, MSCI focuses on industry-specific risks, while Sustainalytics emphasizes the impact of controversial events [15]. Meanwhile, Christensen[16] points out that the qualitative characteristics of ESG issues (e.g., "community relations" or "ethical culture") are difficult to quantify, and different organizations may interpret the same behavior very differently. For example, a company's commitment to a carbon reduction target may be seen as 'leadership' by one organization but criticized as 'lack of concrete action' by another. Moreover, Arayssi et al.[17] show that ESG rating systems are primarily designed based on developed markets, which may ignore the specificities of emerging markets, and that the stage-by-stage improvement of firms in developing countries may be a significant factor in the divergence.

Currently, the existing literature explains the multiple impacts of ESG rating divergence on the market and the complex causes. However, some limitations remain, such as the lack of relevant analysis of real-time policies and the study of emerging markets. Focusing on the drivers of ESG rating divergence is conducive to mitigating divergence and reducing the problems caused. Therefore, this paper will explore the association between data asset disclosure and divergence in the context of China's data asset listing to provide reliable empirical evidence for mitigating ESG rating divergence.

3. Hypotheses development

This paper hypothesizes that data asset disclosure can significantly reduce ESG rating divergence for three reasons. Firstly, data asset disclosure can enhance firms' information transparency and reduce ESG rating divergence by alleviating the information asymmetry problem between firms and rating agencies. Akerlof's[18]information asymmetry theory posits that incomplete disclosure creates information gaps, leading to divergent perceptions among market participants. At present, the level of information disclosure of individual companies varies, and most companies focus more on the disclosure of traditional assets in their annual reports. In the context of ESG ratings, incomplete information disclosure may force rating agencies to rely on alternative sources, such as third-party data and media reports, increasing the possibility of bias in ESG ratings. As a new type of asset, the disclosure of data assets improves the information disclosure system of enterprises to a certain extent. For example, it can provide more information about the operation, governance, and social responsibility of enterprises. Christensen et al.[19] pointed that such reporting has the potential to improve information to investors and other stakeholders, so that the rating agencies can obtain more complete and standardized data, and reduce the information discrepancy between the enterprises' external rating agencies and internal information. When all rating agencies have access to the same information, their criteria for judging firms' ESG performance converge, which reduces rating divergence due to different access to information[20]. In addition, Flammer[21] also points out that the EU Corporate Sustainability Reporting Directive (CSRD) requires firms to disclose more detailed sustainability information. This move has helped reduce information differences between ratings and improve the consistency of ESG ratings. Therefore, based on information asymmetry theory, data asset disclosure can reduce ESG rating divergence, and data asset disclosure can reduce the information gap between internal and external firms by unifying the data sources of the rating agencies, thus improving the assessment accuracy of different rating agencies and reducing the occurrence of ESG rating divergence.

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Secondly, in an era of evolving digital economies, firms are increasingly aware of the strategic value of data assets. Compared to passive disclosures driven by regulatory mandates, companies are now more inclined to voluntarily disclose high-quality data, especially ESG-related data, to signal their commitment to sustainability and governance standards. By making such voluntary disclosures, companies demonstrate their importance on transparency and accountability and enhance their image and reputation in the capital market through signaling mechanisms in an asymmetric market environment. According to signaling theory[22], information owners (i.e., firms) can influence external stakeholders' judgments of their values and behaviors by proactively releasing credible and distinguishable signals in information asymmetry. In the context of ESG ratings, companies' voluntary disclosure of quantifiable data assets, especially information related to environmental performance, social responsibility, and governance structure, constitutes a positive signal for rating agencies and investors to demonstrate their ESG management capabilities. This voluntary disclosure behavior reflects the green awareness of corporate management, which helps companies occupy a favorable position in external assessments and significantly reduces the reliance of rating agencies on subjective judgments. Ben-Amar and Belgacem[23]point out that as an important dimension for measuring corporate ESG performance, information transparency has become the core of the rating agencies' assessment of corporate one of the variables. On this basis, Flammer[21] further suggests that corporate transparency constitutes a signal whose connotation is reflected in the degree of information disclosure and the firm's identification with and commitment to the Sustainable Development Goals. When companies voluntarily disclose consistent and standardized ESG-related data to the market, rating agencies can conduct assessments based on a unified source of information, thus reducing their reliance on subjective judgments and improving the consistency and comparability of ratings. Thus, enterprises' active disclosure of data assets has evolved into a strategically oriented communication mechanism under the framework of signaling theory beyond the scope of mere information disclosure. The disclosure of data assets not only enhances the reliability of the rating results but also further contributes to the market's objective perception of corporate ESG performance, which helps to reduce ESG rating divergence.

Thirdly, earnings management is a key intermediary mechanism connecting data asset disclosure and ESG rating divergence. Data asset disclosure can effectively restrain earnings management by improving the verifiability of disclosed information, thereby increasing the credibility and consistency of ESG ratings. Firstly, Healy and Palepu[24] point out that when management possesses an information advantage, it is easy to mislead external stakeholders through surplus management behavior, forming information noise and reducing the interpretability of information. In the ESG rating environment, such distortionary behavior may cause inflated environmental inputs or socially responsible behaviors to be misjudged as real performance by rating agencies, bringing cognitive bias to ESG rating agencies in identifying corporations' actual social responsibility performance[25]. In addition, trust theory[26] also suggests that if a firm engages in repeated earnings management, rating agencies will erode their trust in its disclosures and instead rely on subjective judgments and internal standards, thus exacerbating cognitive bias among rating agencies. On this basis, data asset disclosure can alleviate the above problems, mainly through the following ways: On the one hand, data asset disclosure can provide more detailed and structured information, such as data governance inputs and data performance indicators, which can help to enhance the verifiability and traceability of the information, and thus make it more challenging to implement earnings management, indirectly constituting an inherent constraint on earnings management[24][27]; on the other hand, detailed data disclosure enhances the market's ability to identify corporate operating performance, which helps investors and analysts to detect potential financial manipulation, thus forming a more powerful external monitoring mechanism[28], and the external supervisory pressure brought about by it also enhances the corporate behavioral constraints,

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which can be achieved from the source. The external supervisory pressure it brings also enhances corporate behavioral constraints, curbing the motivation of earnings management from the source. In this context, data asset disclosure improves the overall quality of financial and non-financial information. It reduces information noise and cognitive bias by compressing the operating space for earnings management, which not only helps to restore the trust of rating agencies in corporate transparency but also provides support for them to carry out ESG evaluations based on relative objectivity and uniformity, thus effectively alleviating the problem of rating divergence.

On the other hand, data asset disclosure has the potential to enhance ESG rating divergence as well. First, massive data may cause information overload, leading to a biased rating profile. Information overload theory[29] suggests that when market participants receive too much information, their ability to process the information effectively may be reduced, leading to different conclusions based on the same data by different participants. When conducting ESG ratings, the more data disclosed, the greater the rating divergence is likely to be, rather than convergence, due to differences in data screening and processing by different rating agencies[9], this is likely to exacerbate the problem of ESG rating divergence. Second, firms may selectively disclose positive data in their favor, exacerbating the risk of misjudgment of corporate metrics by rating agencies. ESG ratings are not a completely objective process, and stakeholder theory[30]suggests that different stakeholders have different criteria for evaluating a firm's performance. Thus, depending on their focus, the same data set may lead to different conclusions. Therefore, after the disclosure of data assets, it is likely that ESG rating divergences will be exacerbated due to the selective focus of firms or rating agencies. Finally, as the current disclosure standards and rating standards are not fully harmonized, different rating agencies may base their ESG ratings on their methodologies, and a large amount of data may instead amplify the agencies' evaluation divergence due to differences in indicator weights and differences in calculation methods. Flammer[21] points out that when the data asset disclosure covers more ESG information, the rating agencies may be able to rate it due to differences in scoring methods differences, leading to a widening of rating divergence instead. Thus, increased data asset disclosure may lead to greater bias in the applicability of methodologies by rating agencies, resulting in increased rating divergence.

In summary, the theoretical mechanisms suggest that data asset disclosure has the potential to reduce ESG rating divergence. Therefore, this study put forward the following hypotheses:

H1: Data asset disclosure can significantly reduce corporate ESG rating divergence.

4. Research design

4.1. Sample and data sources

This study selects A-share listed companies in China from 2007 to 2023 as the research sample. The financial and insurance sectors, ST/*ST/PT firms, and firms with missing data are excluded to avoid the potential influence of outliers and special samples. Meanwhile, all the continuous variables are shrunken before and after the 1% level to minimize the influence of the outliers, and finally, 21,390 observations are obtained. The required data are extracted from the annual report information disclosed by listed companies and the CSMAR database.

4.2. Empirical model

To evaluate the research hypothesis H1, this paper constructs the following benchmark regression model:

$$\mathrm{ESG}range4_{i,t} = \alpha_0 + \alpha_1 DataAssets_{i.t} + \alpha_2 Controls + \sum Industry + \sum Year + \varepsilon$$

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Where i and t represent firms and years, respectively, and $ESGrange4_{i,t}$ is the explanatory variable representing firms' ESG rating divergence as measured by the extreme difference in ESG scores of different rating agencies for the same firm. $DataAssets_{i,t}$ is the core explanatory variable, standing for firms' data asset disclosure, which is calculated using the percentage of data asset-related keyword frequency in the total word frequency of the annual report. *Controls* are the control variables, *Industry and Year* represent industry and year fixed effects, respectively, and ε is the random error term.

4.3. Variable definitions

The core explanatory variable is data asset disclosure (DataAssets). Scholars are still exploring the measurement of corporate data assets disclosure, and the current mainstream measurement method is text analysis. This paper measures DataAssets by organizing the word frequencies of data asset keywords disclosed in the annual reports of listed companies based on the text mining method and calculating the percentage of data asset keywords in the total word frequencies of the annual reports.

The core explanatory variable is ESG rating divergence (ESGrange4). Since rating agencies have different scoring methodologies, standardization is required before comparisons can be made. The current academic treatment of ESG ratings focuses on measuring ESG rating divergence by calculating the standard deviation of firms' ratings by different rating agencies within the same year[12]. Drawing on the idea of Capizzi et al.[31], Wang[32], and others who utilize the statistical dispersion of rating divergence data to measure ESG rating divergence, this paper adopts the extreme deviation of different rating agencies' ratings of firms within the same year to measure ESG rating divergence, and at the same time adopts ESG rating divergence computed in terms of standard deviation as a robustness test.

The control variables refer to the direction of previous research and control for a series of important factors that may affect the divergence of corporate ESG ratings, including company size (Size), gearing ratio (Lev), net return on total assets (ROA), cashflow ratio (Cashflow), growth rate of operating income (Growth), number of directors (Board), the number of years the company has been listed (ListAge), institutional investor investment ratio (INST), and whether the firm is losing money (Loss). Firm industry fixed and year-fixed effects are also controlled to improve the accuracy of the regression.

Table 1 shows these descriptions.

Table 1: Variable definitions

Variable name	Description
ESGrange4	Range value of the ESG rating score a firm received for firm performance
Size	Natural logarithm of a firm's total assets
Lev	Total liabilities divided by total assets
ROA	Total profit divided by total assets
Cashflow	Net cash flow from operating activities divided by total assets
Growth	Growth rate of gross operating come
Board	Natural logarithm of a firm's scale of board
ListAge	Listed years of firms
INST	Percentage of shareholding by institutional investors
Loss	Whether the firms have a loss
Year	Year-fixed effect
Firm	Firm-fixed effect
DataAssets	Proportion of data asset keyword frequency in the annual report

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5. Empirical results

5.1. Descriptive statistics and correlation analysis

The descriptive statistics of the relevant variables are shown in Table 2. The mean value of ESGrange4 is 1.155, and the standard deviation is 1.282, indicating a significant difference in the ESG rating divergence of the selected sample of firms. The firms are subjected to the apparent phenomenon of divergence in the ESG ratings of the agency ratings, which lays the foundation of the research in this paper. The mean value of DataAssets is 0, and the maximum is only 0.008, which suggests that, in the overall sample, the firms have an overall low level of data asset disclosure. Among the control variables, the mean values of Company Size and ListAge are 22.27 and 2.076, respectively, which indicates that larger and longer-listed companies dominate the sample. The other control variables show the expected distribution, which provides a solid foundation for further analysis.

Table 2: Summary statistics

variable	N	mean	sd	min	p25	p50	p75	max
ESGrange4	21878	1.155	1.282	0	0	1	2	6
DataAssets	21878	0	0	0	0	0	0	0.00800
Size	21878	22.27	1.297	19.72	21.34	22.08	22.99	26.43
Lev	21878	0.414	0.202	0.0540	0.252	0.405	0.560	0.906
ROA	21878	0.0410	0.0720	-0.398	0.0150	0.0400	0.0750	0.254
Cashflow	21878	0.0490	0.0680	-0.180	0.0110	0.0480	0.0880	0.257
Board	21878	2.107	0.196	1.609	1.946	2.197	2.197	2.708
ListAge	21878	2.076	0.939	0	1.386	2.197	2.890	3.367
INST	21878	0.373	0.238	0	0.166	0.377	0.560	0.882
Growth	21878	0.179	0.438	-0.660	-0.0200	0.111	0.279	4.330
Loss	21878	0.114	0.318	0	0	0	0	1

Table 3 presents the correlation matrix, revealing a weakly positive association between DataAssets and ESGrange4 (ρ=0.025), though this preliminary result requires further multivariate analysis. This result initially suggests that data asset disclosure may be associated with ESG divergence. However, correlation analysis is a more general statistical analysis method that does not consider the contemporaneous effects of other factors and cannot be used as a final result, so a more precise model will be further used later in this paper to study the relationship between the main variables. Meanwhile, the correlation table shows a low correlation between the control variables, indicating that the multicollinearity problem is not serious.

Table 3: Correlation matrix

	ESGrange4	DataAssets	Size	Lev	ROA	Cashflow	Board
ESGrange4	1						
DataAssets	0.025***	1					
Size	0.283***	-0.00300	1				
Lev	0.104***	-0.062***	0.479***	1			
ROA	-0.074***	-0.012**	-0.025***	-0.386***	1		
Cashflow	0.083***	-0.031***	0.063***	-0.152***	0.368***	1	
Board	0.031***	-0.049***	0.240***	0.156***	0.00700	0.044***	1
ListAge	0.173***	-0.027***	0.394***	0.395***	-0.288***	-0.00800	0.115***
INST	0.151***	-0.047***	0.458***	0.214***	0.049***	0.116***	0.180***

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Table 3: (continued)

Growth	-0.069***	0.011**	0.047***	0.027***	0.237***	0.026***	-0.00800
Loss	0.089***	0.011**	-0.050***	0.197***	-0.646***	-0.176***	-0.033***
	ListAge	INST	Growth	Loss			
ListAge	1						
INST	0.393***	1					
Growth	-0.053***	0.013**	1				
Loss	0.146***	-0.047***	-0.178***	1			

5.2. Baseline regression analysis

Table 4 presents the regression results of the benchmark model of this study, where Column (1) shows the results without introducing control variables, whereby the regression coefficients of DataAssets versus ESGrange4 are significant at the 10% level when considering only industry fixed effects and vintage year fixed effects, indicating that more data asset disclosure significantly reduces ESG rating divergence. Column (2) shows the results of introducing control variables while considering industry-fixed and year-fixed effects. At this point, the regression coefficient of DataAssets with ESGrange4 is significant at the 1% level. As a result, after controlling for firm size, financial leverage, and other factors, the result that an increase in data asset disclosure reduces ESG rating divergence is still significant, which strongly supports the central hypothesis H1.In addition, in terms of control variables, the smaller the size, the higher the level of debt, the lower the level of cash, and the higher the proportion of institutional investors, the higher the degree of ESG rating divergence of the firms, a result which conforms to the expectations.

Table 4: Baseline regression results

VARIABLES	(1) ESGrange4	(2) ESGrange4
DataAssets	-93.024*	-182.385***
	(-1.95)	(-3.34)
Size		-0.076**
		(-2.55)
Lev		0.288***
		(3.00)
ROA		-0.356*
		(-1.85)
Cashflow		0.554***
		(4.76)
Board		0.120
		(1.56)
ListAge		0.259***
		(7.16)
INST		0.064
		(1.06)
Growth		-0.068***
		(-4.65)
Loss		0.005
		(0.18)
Constant	1.382***	1.910***
	(358.57)	(2.96)
Observations	27,492	21,390

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Table 4: (continued)

R-squared	0.652	0.704
Firm FE	YES	YES
Year FE	YES	YES

Robust t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5.3. Robustness tests

5.3.1. Alternative dependent variable

Considering the measurement issues for the explanatory variables, this paper uses the ESG rating divergence in standard deviation, ESGdif4, to conduct robustness tests to rule out potential effects. The regression results are shown in Table 5 column (1); after replacing the measure of ESG rating divergence, the coefficient of DataAssets is still significantly negative, and the results remain robust.

5.3.2. Additional control variables

Since DataAssets can be affected by control variables at the corporate governance level of firms, and to reduce the endogeneity problem caused by omitted variables, this paper adds the proportion of independent directors (Indep) and the proportion of shares held by the top five shareholders (Top5) as control variables in the regressions to test the robustness of the regression results. The results of Table 5 Column (2) show that DataAssets' regression coefficients are still significantly negative at the 1% level, and the results of the central hypothesis still hold.

5.3.3. Propensity Score Matching (PSM)

In order to mitigate the interference of significant differences in covariates on this paper's findings and improve the credibility of the results, this paper chooses the propensity score matching method (PSM) to match the samples with 1:1 nearest neighbors. Among them, the control variables in the benchmark regression are selected as covariates. The samples larger than the mean of DataAssets are taken as the treatment group, and the rest are the control group. Meanwhile, after completing the PSM matching, a balancing test is conducted to confirm whether the matched samples exclude the potential selection bias. The standardized bias of the covariates is significantly reduced after matching, all of which are less than 10%. Most of the means between the experimental and control groups do not differ significantly after matching, and the samples have been effectively matched. The results of the PSM regressions are shown in Column (3) of Table 5; the regression coefficient of DataAssets is -2.481, which is significant at a 1% level, and the conclusion of the main paper still holds.

5.3.4. Entropy balancing

To further reduce endogeneity and address the shortcomings of the standard propensity score matching (PSM) method, this paper employs a unique method called entropy matching to ensure that covariate imbalances are ameliorated after matching. Among other things, this paper divides the sample into two groups based on the median of the DataAssets. It marks observations above the median as 1 for the treatment group and the rest as the control group. Subsequently, entropy balancing is used to weigh the treatment and control groups to balance the covariates and specify the third-order moments. This paper uses the weights generated by entropy balancing to perform high-dimensional fixed effects regressions and control for firm and year effects. The entropy-matched regression results are shown in Column (4), and the central hypothesis of this paper remains strongly significant.

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Table 5: Robustness tests

VARIABLES	(1) ESGdif4	(2) ESGrange4	(3) ESGrange4	(4) ESGrange4
	Alternative Dep Var	Extra Control	PSM Sample	Entropy Sample
DataAssets	-0.840**	-1.793***	-2.481***	-2.039***
	(-2.53)	(-3.27)	(-3.24)	(-3.72)
Size	-0.136***	-0.062**	-0.065*	-0.077**
	(-7.24)	(-2.08)	(-1.65)	(-2.35)
Lev	0.370***	0.268***	0.373***	0.266**
	(5.72)	(2.79)	(2.75)	(2.42)
ROA	-0.139	-0.361*	-0.529*	-0.285
	(-1.07)	(-1.88)	(-1.90)	(-1.34)
Cashflow	0.323***	0.553***	0.579***	0.730***
	(4.07)	(4.75)	(3.47)	(5.28)
Board	0.065	0.124	0.133	0.111
	(1.27)	(1.30)	(1.31)	(1.33)
ListAge	0.310***	0.211***	0.213***	0.326***
	(12.92)	(5.56)	(4.39)	(8.11)
INST	-0.033	0.117*	0.056	0.045
	(-0.84)	(1.91)	(0.67)	(0.69)
Growth	-0.032***	-0.063***	-0.066***	-0.082***
	(-3.40)	(-4.28)	(-3.07)	(-4.92)
Loss	0.001	0.002	-0.016	0.020
	(0.05)	(0.06)	(-0.37)	(0.61)
Indep		-0.002		
		(-0.01)		
Top5		-0.563***		
		(-3.46)		
Constant	2.809***	1.993***	1.730**	1.943***
	(6.92)	(2.88)	(2.05)	(2.72)
Observations	21,390	21,390	11,104	21,390
R-squared	0.650	0.705	0.744	0.711
Firm FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES

Robust t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5.4. Mechanism analysis

In order to explore the mechanism paths through which data asset disclosure reduces ESG rating divergence and to provide more relevant evidence for the mechanism tests in this paper, this paper explores the three aspects of information transparency (kv_r), corporate green disclosure (Oral), and earnings management indicators (DisAcc). Each mediator is regressed separately to assess whether it mediates the relationship between DataAssets and ESG rating divergence.

The specific results of the mediation mechanism are shown in Table 6. Column (1) shows that data asset disclosure is significantly and positively related to corporate information transparency. In contrast, increased information transparency can significantly reduce ESG rating divergence,

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indicating that data asset disclosure can reduce ESG rating divergence by increasing corporate information transparency. Column (2) shows the relationship between data asset disclosure and corporate green disclosure. The regression results show that corporate data asset disclosure can indirectly reduce ESG rating divergence by increasing corporate green disclosure, and the mediating mechanism is established. Meanwhile, in order to verify whether corporate earnings management is also one of the mechanisms by which data asset disclosure reduces ESG rating divergence, this paper selects the earnings management variable (DisAcc) in the Jones model, such as the manipulable accrued profits of corporations, as a measure to verify whether the mechanism exists. Column (3) proves the regression results, which show that data asset disclosure is significantly negatively correlated with the earnings management indicator and that data asset disclosure can reduce ESG rating divergence by reducing firms' earnings management.

Table 6: Mechanism test

VARIABLES	(1) kv_r	(2) Oral	(3) DisAcc
DataAssets	0.312***	0.818***	-0.082***
	(4.56)	(2.96)	(-2.69)
Size	-0.024***	0.061***	0.008**
	(-11.35)	(4.89)	(2.57)
Lev	-0.021**	-0.057	-0.010
	(-2.37)	(-1.44)	(-1.01)
ROA	0.056***	0.065	1.118***
	(2.95)	(0.98)	(56.44)
Cashflow	-0.049***	-0.021	-1.206***
	(-4.26)	(-0.42)	(-58.25)
Board	-0.009	0.009	0.005
	(-1.33)	(0.27)	(0.85)
ListAge	-0.052***	0.009	0.009***
	(-13.31)	(0.59)	(3.43)
INST	0.145***	0.031	0.003
	(20.98)	(1.23)	(0.65)
Growth	0.013***	-0.006	-0.003
	(8.73)	(-0.93)	(-0.66)
Loss	-0.000	0.025**	0.012***
	(-0.02)	(2.17)	(4.95)
Constant	0.728***	-0.906***	-0.177***
	(15.30)	(-3.26)	(-2.75)
Observations	35,510	21,361	32,641
R-squared	0.534	0.655	0.555
Firm FE	YES	YES	YES
Year FE	YES	YES	YES

Robust t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5.5. Heterogeneity analysis

To further explore whether the effect of data asset disclosure on ESG rating divergence varies across firm types, this study conducts heterogeneity analysis from two perspectives: ownership structure and institutional ownership.

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5.5.1. Ownership type

Data as a strategic asset for emerging development is important in operating both state-owned enterprises (SOEs) and non-state-owned enterprises (non-SOEs). However, divergence based on property rights structure, institutional constraints, and governance model has a significant impact in analyzing the results of data asset disclosure to reduce ESG rating divergence. Therefore, based on the nature of firms' property rights, this paper divides the firms into two groups: state-owned enterprises (SOE==1) and non-state-owned enterprises (SOE==0), and conducts regression analyses for each. Columns (1) and (2) of Table (7) demonstrate the results of this analysis, which shows that the impact of data asset disclosure on reducing ESG rating divergence is not significantly correlated among state-owned firms but is significantly negatively correlated. This result may be because SOEs receive more government regulation, and their social responsibility goals emphasize more national strategies than non-SOEs'; they have advantages in data transparency but less integration ability and innovation drive in data assets. Non-SOEs face higher market competition, incentivizing them to leverage data disclosure for ESG credibility, whereas SOEs prioritize compliance over innovation. At the same time, non-SOEs are relatively more flexible in data asset disclosure and ESG governance, and their data disclosure is driven by investor and stakeholder pressures. In addition, non-SOEs can innovate quickly in data to improve ESG performance and gain market favor. From the results, the effect that data asset disclosure can reduce ESG rating divergence is more pronounced among non-state-owned firms.

5.5.2. Institutional ownership

Institutional investors can be defined as specialized financial institutions that collectively manage savings on behalf of small investors to achieve specific objectives in terms of acceptable risk, return maximization, and bond maturity[33]; they typically have more resources and expertise to provide more in-depth analysis and oversight of firms. At the corporate governance level, institutional investors can improve the external regulation of firms and enhance corporate governance. Therefore, the proportion of institutional investors' investment in firms (INST) is selected for heterogeneity analysis in this paper. Columns (3) and (4) of Table 7 demonstrate the results of this regression: this effect of data asset disclosure being able to reduce the divergence of ESG ratings is insignificant in firms with high institutional investor shareholding, while it is more significant in firms with low institutional investors. The possible reasons for this result are that firms with high institutional investor ownership have strong monitoring and governance capabilities, high levels of data disclosure, and elevated levels of information transparency, which leads to their relatively low ESG rating divergence. In contrast, compared with firms with high institutional investor ownership, firms with low institutional investor ownership lack external monitoring and have higher disclosure ambiguity, which may result in greater ESG rating divergence. Therefore, the effect is more pronounced in firms with low institutional investor shareholding.

Table 7: Heterogeneity test results

VARIABLES	(1) ESGrange4	(2) ESGrange4	(3) ESGrange4	(4) ESGrange4
	SOE==1	SOE==0	INST High	low INST
DataAssets	-0.552	-1.699***	-0.524	-2.471***
	(-0.43)	(-2.94)	(-0.58)	(-3.80)
Size	0.015	-0.096***	0.042	-0.216***
	(0.29)	(-2.64)	(0.94)	(-4.75)
Lev	0.393**	0.200*	0.151	0.448***
	(1.97)	(1.83)	(1.05)	(3.22)

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Table 7: (continued)

ROA	1.064**	-0.604***	-0.155	-0.404
	(2.54)	(-2.78)	(-0.46)	(-1.60)
Cashflow	0.667***	0.526***	0.601***	0.484***
	(3.51)	(3.65)	(3.71)	(2.68)
Board	0.142	0.130	0.187*	0.112
	(1.14)	(1.33)	(1.73)	(0.99)
ListAge	0.341***	0.145***	0.343***	0.214***
	(3.01)	(3.39)	(5.81)	(4.28)
INST	0.036	0.138**	0.001	0.231**
	(0.26)	(2.02)	(0.01)	(2.26)
Growth	-0.053**	-0.065***	-0.081***	-0.043*
	(-2.15)	(-3.66)	(-4.13)	(-1.86)
Loss	0.043	-0.006	-0.032	0.011
	(0.91)	(-0.16)	(-0.75)	(0.26)
Constant	-0.626	2.607***	-0.998	4.956***
	(-0.51)	(3.32)	(-1.03)	(5.22)
Observations	6,550	14,771	10,440	10,433
R-squared	0.731	0.702	0.730	0.703
Firm FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES

Robust t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

6. Conclusions and policy implications

As a strategic asset in the era of the digital economy, the economic consequences of data assets are worth exploring. With the deepening of research in recent years, the economic consequences of data asset disclosure have been increasingly emphasized. At the same time, ESG rating divergence, as a significant issue in the study of the level of corporate ESG, how to minimize its negative impact in making decisions by companies and investors, etc., is also very worthy of consideration. Therefore, this paper combines data asset disclosure and ESG rating divergence to study the impact of data asset disclosure on non-financial performance indicators, filling the research gap of data assets in the ESG governance field and providing innovative ideas for subsequent research.

Using data from A-share listed companies in China from 2007 to 2023, this study empirically examines the impact of data asset disclosure on ESG rating divergence. The findings demonstrate that increased data asset disclosure significantly reduces ESG rating divergence. This result stays robust after a series of tests, including alternative dependent variables, additional control variables, propensity score matching (PSM), and entropy balancing. Mechanism analysis shows that information transparency, green disclosure, and earnings management variables are the main channels of this effect, and the study indicates that data asset disclosure can improve information transparency, enhance the level of green disclosure of enterprises, and reduce manipulable accruals in corporate financial statements to mitigate ESG rating divergence. Heterogeneity analysis yields that the adverse effect of data asset disclosure on ESG rating divergence mainly exists in non-state-owned enterprises and enterprises with low institutional investor shareholding. These findings highlight the importance of internal governance and external monitoring in shaping the effectiveness of disclosure practices.

This study offers several practical implications for key stakeholders. First, listed companies and management should prioritize the disclosure of data assets directly related to core ESG issues (e.g., carbon emissions, supply chain management, and data security) to increase the transparency of information companies disclose. Firms should also disclose quantifiable metrics (e.g., data security

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investment and carbon footprint reduction enabled by data analytics) to align with global ESG frameworks like SASB. Moreover, management should raise green awareness and enhance companies' degree of green disclosure to mitigate ESG rating divergence. At the same time, firms should enhance the interpretation of complex data algorithms in their disclosures to reduce the subjective interpretation differences between rating agencies. In addition, non-state-owned enterprises should take advantage of disclosure flexibility to enhance market competitiveness by highlighting the role of data assets in innovative ESG practices, such as digitally inclusive finance and green supply chains. Secondly, for investors and asset management institutions to optimize ESG investment decisions, they should first focus on the quality of data asset disclosure, including whether corporate data asset disclosure is quantitative and the breadth of ESG coverage. At the same time, the focus should be on identifying surplus management problems in companies and focusing on manipulability indicators in their statements to prevent selective disclosure behavior. Finally, improving the regulatory framework for data asset disclosure is a top priority for policymakers and regulators. Policymakers can disclose mandatory key indicators, such as data governance inputs, ESG benefits of data applications, and other core indicators, into the scope of mandatory disclosure to avoid selective disclosure behavior.

Meanwhile, according to the differentiated characteristics of industries, differentiated data asset disclosure requirements should be designed for different industry characteristics. At the same time, Regulators should mandate standardized templates for data asset disclosure, requiring firms to report metrics such as data governance expenditures, ESG-related data applications, and third-party audit results. They can also promote the implementation of the standards set by policymakers and ensure that enterprises disclose according to the requirements utilizing regular reviews and on-site spot checks to prevent corporate surplus manipulation and other behaviors. This study demonstrates that data asset disclosure is critical to mitigate ESG rating divergence, particularly in market-driven firms with low institutional oversight. For all parties, data assets are expected to become a new cornerstone of ESG governance and promote the standardization of ESG ratings across the industry through standardized disclosure to alleviate the information asymmetry divide and incentivize policies to drive high-quality disclosure.

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