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Research on the Impact of Supply Chain Concentration on Corporate ESG Rating Divergence

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Abstract: *This study selects A-share listed companies in China from 2009 to 2023 as the research sample to investigate the impact of supply chain concentration on corporate ESG rating divergence. The study finds that supply chain concentration has a significantly positive correlation with corporate ESG rating divergence. Supply chain concentration further influences ESG rating divergence by affecting information transparency, verifying the mediating role of information transparency. Behavior related to analysts' earnings forecasts plays a negative moderating role between supply chain concentration and ESG rating divergence. Heterogeneity tests reveal that the positive impact of supply chain concentration on ESG rating divergence is more pronounced in state-owned enterprises.*

Keywords: *Supply Chain Concentration, Information Transparency, Analyst Earnings Forecast Behavior, Corporate ESG Rating Divergence*

1. Introduction

On May 27, 2024, China's Ministry of Finance released the "Corporate Sustainability Disclosure Standards -- Basic Standards (Draft for Comments),"This shows that reporting ESG information is moving from being a voluntary optional to a mandatory optional. As key players in achieving sustainable development, companies need to improve their ESG performance by integrating green and sustainable practices into daily operations and management. However, a significant problem exists: the lack of a unified ESG measurement standard leads to vastly different ESG ratings for the same company across different rating agencies. This inconsistency hinders corporate decision-making and investor assessment. Identifying ways to reduce this divergence is a critical issue.

A company's supply chain is crucial for acquiring key resources and important information, playing an increasingly important role in building competitive advantage[1]. Higher concentration can help companies build long-term, stable relationships with key partners[2]. However, an ancient principle holds true: too much of anything is risky. If a company focuses too much on a few partners, it might miss opportunities to collaborate with other potentially valuable partners. Losing a key long-term partner could be devastating. On the other hand, working with many different partners spreads the risk and makes the company stronger against market changes. Yet, the critical question is whether a company has the capacity to manage numerous stable relationships effectively. Therefore, how supply chain concentration affects corporate ESG rating disagreement needs to be verified through further theoretical analysis and empirical research.

2. Literature Review

2.1 Research on Economic Consequences of Supply Chain Concentration

Supply chain concentration enhances enterprises' new quality productive capacities through mechanisms such as alleviating financing constraints, reducing operational costs, and curbing managerial short-termism[3]. However, excessive concentration may trigger the hold-up problem: When digital enterprises' supply chain relationships become overly concentrated, dependence on "major suppliers" or "key customers" weakens bargaining power, gradually diminishing negotiation leverage and ultimately suppressing R&D intensity[4]. This paradox is equally evident in impacts on CSR performance: Higher customer concentration significantly worsens corporate social responsibility performance[5]. As a key structural feature of corporate supply chain networks, the economic

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consequences of supply chain concentration exhibit marked duality and complexity. For instance: Supplier concentration negatively impacts corporate innovation, while customer concentration exerts positive effects[6]. But now there is existing critical research gap. Current studies inadequately address nonlinear relationships, dynamic effects, and moderating mechanisms of supply chain concentration.

2.2 Research on Influencing Factors of Corporate ESG Rating Divergence

This part is internal factors. Corporate decisions, internal control quality, and strategic orientations significantly impact ESG rating divergence, including digital transformation strategies[7], executives' green cognition[8], supply chain digitalization[9], internal control quality[10]. These factors enhance information transparency, reduce asymmetry, and improve ESG rating accuracy, thereby mitigating divergence. Another part is external factors. ESG rating divergence stems not only from internal operations but also from complex external elements—particularly rating agencies and ESG reports. ESG report assurance reduces divergence by improving disclosure quality[11]. Poor ESG report readability impedes accurate assessments and increases inter-agency disagreement[12].

3. Theoretical Analysis and Hypothesis Development

Based on Information Asymmetry Theory and Stakeholder Theory, when supply chain concentration increases, it means enterprises become increasingly reliant on resources from a smaller number of upstream and downstream partners within the supply chain. This highly concentrated structure signifies that enterprises form deeply integrated strategic alliances with their partners in areas such as raw material procurement, production collaboration, and product distribution. Building on this, the relationship between the core firm (the "chain leader") and its partners extends beyond mere business transactions into deeper realms like collaborative technological innovation, data sharing, and process integration, gradually evolving into a relationship characterized by "symbiotic interests" and a "community of shared destiny." Consequently, when disclosing information, core firms face a dual consideration: meeting disclosure requirements while avoiding excessive disclosure that could compromise competitive advantages and trade secrets. Therefore, they tend to obscure or completely avoid disclosing sensitive data involving proprietary technology or confidential information. With limited information available, rating agencies are forced to rely on substitute indicators for their analysis. Since different rating agencies already exhibit differences in their assessment and analysis of raw data, the secondary processing of information only amplifies the divergence in corporate ESG ratings across agencies. This creates a vicious cycle of "information asymmetry-increased rating divergence -more cautious corporate disclosure."Based on the above analysis, the following hypotheses are proposed.

Hypothesis H1:Supply chain concentration has a significant positive correlation with corporate ESG rating divergence.

Hypothesis H2:Higher supply chain concentration is significantly associated with an increase in corporate ESG rating divergence by exacerbating information asymmetry.

When a firm faces potential risks, analysts forecasting its earnings pay closer attention to the status of the core firm's upstream and downstream supply chain relationships. On one hand, this heightened caution during forecasting can lead to more accurate predictions, providing the market with more reliable data and reference points. As critical intermediaries between investors and listed companies, analysts systematically collect, integrate, and deeply analyze corporate proprietary data and operational dynamics, providing actionable decision-making bases for market participants[13]. This influx of information into the market reduces information asymmetry between the firm's insiders and outsiders, thereby reducing corporate ESG rating divergence. On the other hand, as part of the external monitoring mechanism, analysts focusing on supply chain risks during earnings forecasts may pressure firms to voluntarily disclose more ESG information or optimize supply chain management. This reduces uncertainty in the basis for ratings, thereby lowering information asymmetry and consequently reducing corporate ESG rating divergence. Based on the above analysis, the following hypothesis is proposed.

Hypothesis H3:Analysts' earnings forecast behaviors play a negative moderating role in the relationship between supply chain concentration and corporate ESG rating divergence.

ISSN 2616-5902 Vol. 7, Issue 7: 56-63, DOI: 10.25236/AJBM.2025.070708

4. Research Design

4.1 Sample Selection

The study sample comprises all A-share listed companies from 2009 to 2023, examining the impact of supply chain concentration on corporate ESG rating divergence. Financial and real estate industries, delisted companies, ST/*ST firms, and samples with missing variables were excluded. The final sample includes 14,650 observations. Data for the dependent variable (corporate ESG rating divergence) were sourced from China Research Data Service Platform (CNRDS), Wind, China Securities Index (CSI), FTSE Russell, Bloomberg, and RKS Ratings. Data for the explanatory variable (supply chain concentration) and control variables were obtained from the CSMAR and Wind databases.

4.2 Variable Definitions

4.2.1 Dependent Variable

The dependent variable is corporate ESG rating divergence (ESG_cv). Following Avramov et al. (2022)[14], ESG ratings from CNRDS, Wind, CSI, FTSE Russell, Bloomberg, and RKS were converted into numerical scores. Companies rated by at least two agencies were included. For each company, pairwise standard deviations of rankings across agencies were calculated, and the average of all pairwise deviations was used as the final ESG rating divergence measure.

4.2.2 Explanatory Variable

The explanatory variable is supply chain concentration (SC), calculated as the sum of two ratios:Procurement from the top five suppliers as a percentage of total procurement. Sales to the top five customers as a percentage of total sales.

4.2.3 Mediating Variable

The mediating variable is information transparency, measured by the opacity index (Opaque), defined as the sum of the absolute values of discretionary accruals over the past three years. This methodology draws from Hutton et al. (2009) and Wang Yaping et al. (2009)[15-16]. Higher values indicate greater information asymmetry and lower transparency.

$$Opaque_{i,t} = Abs(DisAcc_{t-1}) + Abs(DisAcc_{t-2}) + Abs(DisAcc_{t-3}) \quad (1)$$

4.2.4 Moderating Variables

Moderating variables reflect analyst earnings forecast behavior, constructed based on Wang Yutao et al. (2012) and Ma Yongqiang et al. (2024)[17-18].

Analyst Forecast Error (FERR): Absolute difference between the mean of analysts' latest earnings forecasts for firm i in year t (FEPS) and its actual earnings (MEPS), scaled by absolute actual earnings. Higher values indicate lower forecast accuracy.

$$FERR_{i,t} = \frac{Abs[Mean(FEPS_{i,t}) - MEPS_{i,t}]}{Abs(MEPS_{i,t})} \quad (2)$$

Analyst Forecast Dispersion (FDISP): Standard deviation of analysts' latest earnings forecasts for firm i in year t, scaled by absolute actual earnings. Higher values reflect greater forecast divergence.

$$FDISP_{i,t} = \frac{Std(FEPS_{i,t})}{Abs(MEPS_{i,t})} \quad (3)$$

Analyst Earnings Forecast Optimism Bias (FOPT): This is measured as the difference between the mean of all analysts' latest earnings forecasts (FEPS) for listed firm i in year t and the firm's actual earnings (MEPS) in the same period, divided by the absolute value of actual earnings. Analyst optimism bias refers to the systematic tendency of financial analysts to overestimate future performance when forecasting corporate financial metrics (e.g., profits, revenues, or stock prices). A positive FOPT value indicates that analysts' earnings forecasts exceed the firm's actual earnings, reflecting higher analyst optimism.

$$FOPT_{i,t} = \frac{[Mean(FEPS_{i,t}) - MEPS_{i,t}]}{Abs(MEPS_{i,t})} \quad (4)$$

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4.2.5 Control Variable

The following control variables were selected: Firm Size (Size), Cash Flow (Cashflow), CEO-Chair Duality(Dual), Ownership Percentage of the Largest Shareholder(Top1), TobinQ, State-Owned Enterprise (SOE) , Big Four Auditor (Big4).

4.3 Regression Model

To examine the impact of supply chain concentration on corporate ESG rating divergence, model (5) is constructed as follows:

$$ESG\_cv_{i,t} = \alpha_0 + \alpha_1 SC_{i,t} + \alpha_2 Controls_{i,t} + \sum YEAR_{i,t} + \sum INDUS_{i,t} + \varepsilon_{i,t} \quad (5)$$

5. Empirical Results Analysis

5.1 Descriptive Statistics

Table 1: Descriptive Statistics.

Variable	Obs	Mean	Std.	Min	Max
ESG_cv	14650	0.219	0.118	0	0.693
SC	14650	27.278	16.661	0.13	100
Opaque	14650	0.168	0.122	0.004	1.271
FERR	14650	0.69	1.662	0.001	16.1
FDISP	14650	0.441	1.066	0	12.94
FOPT	14650	0.573	1.693	-0.779	16.1
Size	14650	22.902	1.297	19.702	26.44
Cashflow	14650	0.059	0.069	-0.224	0.283
Dual	14650	0.239	0.427	0	1
Top1	14650	0.346	0.152	0.076	0.758
TobinQ	14650	2.08	1.35	0.789	16.647
SOE	14650	0.446	0.497	0	1
Big4	14650	0.097	0.296	0	1

Table 1 presents descriptive statistics for key variables. The mean value of ESG_cv is 0.219, with a minimum of 0 and maximum of 0.693. This wide range indicates substantial heterogeneity in the stability of ESG management mechanisms across firms. For SC, with a high standard deviation of 16.661, reflecting extreme variation in firms' dependence on key customers/suppliers.

5.2 Baseline Regression

Table 2 presents the test results for the relationship between supply chain concentration and corporate ESG rating divergence. Both columns report results incorporating year and industry fixed effects. Column (1) includes control variables alongside the explanatory and dependent variables, revealing that supply chain concentration is significantly positive at the 1% level. Building on column (1), column (2) further implements firm-level clustered standard errors, showing a significantly positive relationship at the 5% level. These results collectively indicate that as supply chain concentration increases, corporate ESG rating divergence expands, thus validating Hypothesis H1.

Table 2: Tests on the Relationship Between Supply Chain Concentration and Corporate ESG Rating Divergence.

	(1) ESG_cv	(2) ESG_cv
SC	0.000***	0.000**
	(3.382)	(2.573)
_cons	0.240***	0.240***
	(9.964)	(7.113)
Controls	Yes	Yes
year fe	Yes	Yes
Industry fe	Yes	Yes
Cluster	No	id
N	14650	14650
r2_a	0.084	0.084
F	34.542	15.938

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

ISSN 2616-5902 Vol. 7, Issue 7: 56-63, DOI: 10.25236/AJBM.2025.070708

5.3 Robustness Tests

5.3.1 Augmenting Fixed Effects and Altering Standard Error Clustering

To mitigate potential bias from unobserved factors in time and industry fixed effects, this study conducts robustness checks following Asante-Appiah and Lambert[19] through enhanced fixed effects specifications and modified standard error clustering. Specifically, column (1) introduces control variables with two-way time-industry fixed effects and firm-level clustered standard errors; column (2) augments this baseline by adding province fixed effects; columns (3) and (4) respectively replicate columns (1) and (2) while shifting standard error clustering from firm-level to year-level. Critically, all four specifications demonstrate statistically significant positive coefficients for supply chain concentration (significant at the 5% level), confirming that heightened supply chain concentration amplifies ESG rating divergence. These robust findings align with our baseline regression conclusions, thereby support for Hypothesis H1 again.

Table 3: Robustness Tests.

	(1) ESG_cv	(2) ESG_cv	(3) ESG_cv	(4) ESG_cv	(5) ESG_cv
SC	0.000**	0.000**	0.000**	0.000**	
	(2.573)	(2.515)	(2.427)	(2.522)	
lag_SC					0.000**
					(2.121)
_cons	0.240***	0.240***	0.240***	0.240***	0.272***
	(7.113)	(6.876)	(8.420)	(8.324)	(9.850)
Controls	Yes	Yes	Yes	Yes	Yes
year fe	Yes	Yes	Yes	Yes	Yes
Industry fe	Yes	Yes	Yes	Yes	Yes
Province fe	No	Yes	No	Yes	No
Cluster	id	id	year	year	No
N	14650	14650	14650	14650	10493
r2_a	0.084	0.088	0.084	0.088	0.075
F	15.938	10.356	.	.	22.943

t statistics in parentheses
$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

5.3.2 Endogeneity Test

To address time lags between supply chain concentration disclosure and ESG ratings, the paper ues the regression by replacing the explanatory variable with its one-period lagged value while maintaining two-way time-industry fixed effects. As shown in column (5) of Table 3, the coefficient for lagged supply chain concentration remains statistically significant and positive at the 5% level, thereby confirming the robustness of our core finding that heightened supply chain concentration amplifies ESG rating divergence.

6. Further Analysis

6.1 Mechanism Analysis Based on Information Asymmetry

This paper employs Wen Zhonglin's three-step method for testing mediation effects to examine the mediating mechanism. Building upon model (5), models (6) and (7) are constructed.

$$Opaque_{i,t} = \beta_0 + \beta_1 SC_{i,t} + \beta_2 Controls_{i,t} + \sum YEAR_{i,t} + \sum INDUS_{i,t} + \varepsilon_{i,t} \quad (6)$$

$$ESG\_cv_{i,t} = \gamma_0 + \gamma_1 SC_{i,t} + \gamma_2 Opaque_{i,t} + \gamma_3 Controls_{i,t} + \sum YEAR_{i,t} + \sum INDUS_{i,t} + \varepsilon_{i,t} \quad (7)$$

Table 4 presents the regression results for the mediation mechanism test, where columns (1), (2), and (3) correspond to the regression results for models (5), (6), and (7), respectively. Column (1) shows that supply chain concentration is significantly positive at the 1% level. Column (2) shows that supply chain concentration is significantly positive at the 1% level, suggesting that higher supply chain concentration is associated with lower information asymmetry, meaning higher information transparency. In column (3), supply chain concentration is significantly positive at the 1% level, and information transparency is significantly positive at the 10% level, indicating a significant positive

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correlation between information asymmetry and corporate ESG rating divergence.This also demonstrates that after including the mediating variable, the significant positive correlation between supply chain concentration and ESG rating divergence persists, thereby reconfirming Hypothesis H1, H2.

Table 4: Mediation Mechanism Test.

	(1) ESG_cv	(2) Opaque	(3) ESG_cv
SC	0.000***	0.001***	0.000***
	(3.38)	(14.94)	(3.15)
Opaque			0.014*
			(1.66)
_cons	0.240***	0.122***	0.238***
	(9.96)	(5.06)	(9.89)
Controls	Yes	Yes	Yes
year fe	Yes	Yes	Yes
Industry fe	Yes	Yes	Yes
N	14650	14650	14650
r2_a	0.084	0.140	0.084

t statistics in parentheses
$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

6.2 Moderating Mechanism Analysis Based on Analyst Earnings Forecast Behavior

To examine the moderating effect of analyst earnings forecast behavior on the relationship between supply chain concentration and corporate ESG rating divergence, models (8), (9), and (10) are constructed.

$$ESG\_cv_{i,t} = \alpha_0 + \alpha_1 SC_{i,t} + \alpha_2 FERR_{i,t} + \alpha_3 (SC_{i,t} \times FERR_{i,t}) + \sum YEAR_{i,t} + \sum INDUS_{i,t} + \varepsilon_{i,t} \quad (8)$$

$$ESG\_cv_{i,t} = \beta_0 + \beta_1 SC_{i,t} + \beta_2 FDISP_{i,t} + \beta_3 (SC_{i,t} \times FDISP_{i,t}) + \sum YEAR_{i,t} + \sum INDUS_{i,t} + \varepsilon_{i,t} \quad (9)$$

$$ESG\_cv_{i,t} = \gamma_0 + \gamma_1 SC_{i,t} + \gamma_2 FOPT_{i,t} + \gamma_3 (SC_{i,t} \times FOPT_{i,t}) + \sum YEAR_{i,t} + \sum INDUS_{i,t} + \varepsilon_{i,t} \quad (10)$$

Table 5 presents the moderating mechanism test results, where these four columns correspond to the regression results for Models (1), (8), (9), and (10). Column (2) shows the results after including the moderator of analyst earnings forecast error, with its interaction term being significantly negative at the 1% level. Column (3) displays the results after including the moderator of analyst earnings forecast dispersion, with its interaction term significantly negative at the 5% level. The interaction term between supply chain concentration and analyst earnings forecast optimism bias is significantly positive at the 1%level. These findings collectively validate Hypothesis H3.

Table 5: Moderating Mechanism Test.

	(1) ESG_cv	(2) ESG_cv	(3) ESG_cv	(4) ESG_cv
SC	0.000***	0.000***	0.000***	0.000***
	(3.38)	(4.30)	(3.89)	(4.17)
FERR		0.004***		
		(3.23)		
SC×FERR		-0.000***		
		(-3.29)		
FDISP			0.003*	
			(1.91)	
SC×FDISP			-0.000**	
			(-2.08)	
FOPT				0.003***
				(2.95)
SC×FOPT				-0.000***
				(-3.23)
_cons	0.240***	0.236***	0.238***	0.237***
	(9.96)	(9.81)	(9.90)	(9.85)
Controls	Yes	Yes	Yes	Yes
Year fe	Yes	Yes	Yes	Yes
Industry fe	Yes	Yes	Yes	Yes
N	14650	14650	14650	14650
r2_a	0.084	0.084	0.084	0.084

t statistics in parentheses
$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

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6.3 Heterogeneity Analysis

As presented in Table 6, columns (1) and (2) display the regression results for state-owned enterprises and non-state-owned enterprises, respectively. In the state-owned enterprises sample, the effect of supply chain concentration on ESG rating divergence is significantly positive at the 1% level, whereas the result for non-state-owned enterprises shows an insignificant impact. This divergence arises because state-owned enterprises typically maintain well-established, long-term cooperative relationships with upstream and downstream supply chain partners; their relatively concentrated supply chain structures are designed to ensure supply chain stability and meet policy compliance requirements. Consequently, relevant supply chain information in state-owned enterprises is subject to policy-mandated confidentiality standards.

Table 6: Heterogeneity Test Based on Ownership Structure Regression.

	(1) ESG_cv	(2) ESG_cv
SC	0.000***	0.000
	(2.886)	(1.514)
_cons	0.220***	0.251***
	(6.156)	(7.337)
Controls	Yes	Yes
Year fe	Yes	Yes
Industry fe	Yes	Yes
N	6537	8113
r2_a	0.069	0.102

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

7. Conclusions and Implications

The main conclusions of this study are as follows: greater supply chain concentration increases information asymmetry within information transmission processes, which in turn elevates rating divergence; an increase in supply chain concentration exacerbates information asymmetry, thus leading to an expansion in ESG rating divergence; analyst earnings forecast behavior exerts a negative moderating effect between supply chain concentration and corporate ESG rating divergence; the positive impact of supply chain concentration on ESG rating divergence is particularly pronounced in state-owned enterprises.

Based on these findings, the following implications are proposed: While an increase in supply chain concentration can foster long-term, stable cooperative relationships for core enterprises, these enterprises must also fully consider the associated risks and the potential amplification of ESG rating divergence. To address these challenges, core enterprises should: First, enhance proactive information disclosure, comply with relevant requirements, cooperate actively, improve market information transmission efficiency, increase transparency, and collectively promote standardized information disclosure; Second, optimize operational management by aligning it with the company's own development plans in terms of corporate governance structure; Third, recognize the risks posed by increased ESG rating divergence and implement corresponding measures, such as introducing third-party ESG assurance reports to help reduce this divergence.

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