

Business Environment Optimization and Audit Quality in the STAR Market: Inverted U-Shaped Nonlinear Effect and ESG Risk Moderation Mechanism

Yixuan Li^{1,*}

¹School of Accounting (MPAcc Education Center), Shanxi University of Finance and Economics, Taiyuan 030006, China

Corresponding author: Yixuan Li (e-mail: pyramid1428572027@163.com).

ABSTRACT The business environment constitutes a fundamental institutional arrangement shaping the behavioral incentives of capital market participants. However, whether its relationship with audit quality follows a monotonic linear pattern or exhibits more complex nonlinear dynamics remains an open empirical question. Using a sample of 4,502 firm-year observations from the STAR Market and ChiNext Board during 2020–2024, this paper employs the modified Jones model to measure audit quality and constructs a comprehensive provincial business environment index encompassing four dimensions — government efficiency, legal environment, financial development, and market maturity — using the entropy-weight method. Through individual fixed-effects panel models, we systematically examine the impact of business environment on audit quality. The findings reveal three key insights. First, a significant inverted U-shaped nonlinear relationship exists between business environment and audit quality, with an inflection point at approximately 0.544. Second, ESG disclosure serves as a risk-moderating barrier rather than a mediating channel. Third, significant heterogeneity is observed across regions, industries, and firm life-cycle stages. This paper breaks the conventional assumption of a linear institutional-audit quality relationship and provides new empirical evidence and policy implications for audit regulation under the registration-based IPO system.

INDEX TERMS Business Environment; STAR Market; Audit Quality; Inverted U-shaped Effect; ESG; Risk Moderation

I. INTRODUCTION

Since 2003, the World Bank's Doing Business report has anchored institutional research in quantifying business environments and cross-national comparisons. China's parallel institutional evolution offers a natural experiment: the 2019 Regulations on Optimizing the Business Environment elevated institutional reforms to a national priority, while the 2020 launch of the STAR Market's registration-based IPO system marked a landmark capital market overhaul. This convergence enables a rigorous study of how business environments interact with capital market governance. Business environments—shaped by legal quality, market competition, and government efficiency—form the institutional substrate for firms, directly influencing resource allocation efficiency and fairness. STAR Market firms, characterized by high R&D intensity, growth uncertainty, and acute information asymmetry, heighten auditor challenges in evaluating quality and navigating complex business models. Audit quality, a critical gatekeeper for information integrity, is indispensable under the registration-based system, where relaxed administrative screening shifts investor protection burdens to auditors. Yet audit quality is not merely technical; it is embedded in institutional contexts that shape auditor incentives, market competition, and client governance. Theoretically, the busi-

ness environment–audit quality link is ambiguous. Stronger legal frameworks and reduced administrative interference may enhance auditor independence, yet over-permissiveness could weaken enforcement, encourage opinion shopping, and foster rent-seeking—suggesting a potential non-linear relationship overlooked in linear-assumption literature. Concurrently, mandatory ESG disclosure for STAR Market firms raises questions: does ESG act as a channel amplifying environmental effects, or a governance buffer mitigating institutional risks? This paper addresses these gaps via a tripartite framework linking business environment, ESG disclosure, and STAR Market audit quality. Analyzing 4,502 firm-year observations (2020–2024) from the STAR and ChiNext boards, we construct a provincial entropy-weighted business environment index, measure audit quality via a modified Jones model, and employ individual fixed-effects panel models. Contributions include:

- (1) identifying an inverted U-shaped relationship between business environment and audit quality, defining an optimal-ity threshold
- (2) revealing ESG as a risk-hedging moderator— not a transmission mediator—offering new theoretical insights
- (3) documenting regional, industry, and lifecycle heterogeneity to guide differentiated audit regulations.

The remainder proceeds: Section 2 reviews literature; Section 3 develops hypotheses; Section 4 outlines methodology; Section 5 presents results; Section 6 concludes.

II. LITERATURE REVIEW

A. BUSINESS ENVIRONMENT AND FIRM BEHAVIOR

North's (1990) institutional transition theory established the analytical framework for institutional economics, pointing out that institutional arrangements affect economic performance by shaping principals' incentive structures [1]. Formal institutions La Porta et al.'s (1998) legal origins hypothesis provided an influential strand of evidence showing that the quality of the legal environment is a critical determinant of investor protection and financial market development [2]. Countries with stronger legal origins tend to have better-developed capital markets, lower cost of capital, and more disciplined corporate governance. This line of research has inspired extensive empirical investigation of how specific institutional dimensions In the Chinese context, the business environment has attracted growing scholarly attention. Deng and Chen (2025) investigated how audit pricing deregulation influences audit efficiency and quality through three transmission mechanisms — increased audit resource commitment, intensified regulatory oversight via professional association interviews, and heightened market competition — while also noting that the efficacy of such liberalization is context-dependent, generating more pronounced positive effects in institutional environments with weaker marketization and rule of law, as well as among state-owned enterprises and low-fee audit firm [3]. Wang et al. (2021) investigated whether state audit can promote regional business environment optimization, finding significant bidirectional causal linkages between audit governance and institutional quality [4]. Yang and Wei (2021) empirically examined how business environment optimization affects urban innovation capability, documenting a significant direct promoting effect while further uncovering two distinct indirect transmission mechanisms — attracting foreign direct investment inflows and accelerating human capital accumulation [5]. Zhu et al. (2022) incorporated commercial system reform into a Melitz model, demonstrating that reducing market entry barriers promotes more firms to enter capital-intensive sectors and drives industrial structure upgrading [6]. The emerging consensus from this literature is that business environment effects are multidimensional and context-dependent, motivating the comprehensive measurement approach adopted in this paper. As illustrated in Figure 1, the keyword co-occurrence analysis further confirms these central research themes. The temporal evolution of Chinese business environment research has tracked the country's reform trajectory. Prior to 2014, research focused on traditional institutional factors such as marketization, legal framework development, and state ownership; during 2015–2019, internal control, institutional environment, and audit quality became research hotspots alongside the growing prominence of registration-based IPO reform discussions; from 2020 onward, the promulgation of the Business Environment Regulations, the launch of the STAR Market registration system, and the strengthening



FIGURE 1. Word Cloud of Research Keywords Based on 69 CNKI Core Journal Articles

of ESG disclosure oversight have driven research toward firm-level heterogeneity and multi-dimensional mechanism analysis.

B. DETERMINANTS OF AUDIT QUALITY

The extant literature analyzes audit quality along three dimensions: auditor characteristics, client attributes, and external institutional environment. DeAngelo (1981) pioneered the auditor size-audit quality hypothesis, arguing that larger accounting firms have stronger incentives to maintain reputation and resist client pressure, thereby providing higher quality audits [7]. Qiao and Du (2023) provided evidence that registration-based reform enhances audit quality, finding that auditors with IPO listing experience under the registration-based system deliver higher-quality audits due to strengthened professional competence and heightened litigation risk [8]. This relationship has been extensively replicated in subsequent research across different institutional contexts, though the magnitude varies with market development level. Beyond auditor size, research has verified the effects of industry specialization, audit tenure, and audit fees on audit quality. From the client perspective, corporate governance structure, internal control quality, and managerial incentives are identified as key micro-level determinants. The agency problem framework (Jensen and Meckling, 1976) suggests that managers have incentives to manipulate accounting information for personal gain, and high-quality audits serve as a mechanism to detect and deter such manipulation. Zhao (2012) systematically classified audit quality proxies into three categories — shareholder perspective, management perspective, and audited entity perspective — providing a comprehensive methodological framework for empirical measurement [9]. In the external institutional dimension, Han et al. (2023) found that higher legal environment scores significantly and positively affect audit quality, with legal services level, judicial efficiency, and intellectual property protection each making independent contributions [10]. Other scholars have documented the effects of digitalization, blockchain technology, and state audit on audit quality [11], reflecting the expanding scope of institutional factors considered relevant. The modified Jones model, adopted in this paper, has been validated as a reliable proxy in numerous studies covering both developed and emerging market contexts. The knowledge cluster map (Figure 2) visualizes eight major research clusters in this field.

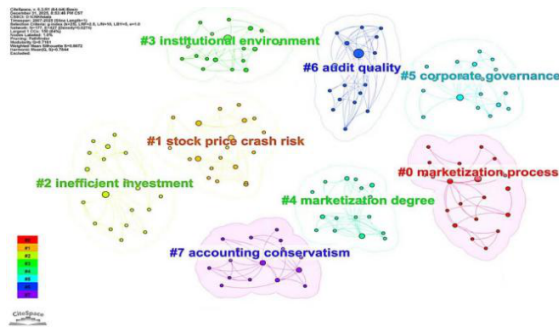


FIGURE 2. CiteSpace Knowledge Cluster Map of Audit Quality Research Field

C. ESG DISCLOSURE AND AUDIT QUALITY

Signal transmission theory (Spence, 1973) provides the theoretical foundation for understanding how ESG disclosure affects information quality and risk perception. High-quality ESG disclosure conveys positive signals about an enterprise's sustainable development capability, reducing information asymmetry between firms and external stakeholders including investors, creditors, and auditors. Li and Wei (2025) found that firms with better ESG performance exhibit higher information transparency, with the moderating effect of digital transformation amplifying the ESG-audit quality linkage [12]. This finding is consistent with the argument that ESG governance improvements reduce managerial opportunism by strengthening transparency and accountability mechanisms. Tang et al. (2023) investigated the ESG peer effect on audit fees, finding that industry-level ESG norms shape individual firm audit pricing decisions, reflecting auditors' sensitivity to non-financial risk signals [13]. Wang et al. (2022) further showed that firms with superior ESG performance are less likely to receive modified audit opinions, and this effect is primarily mediated through reduced operational risk and improved earnings quality [14]. Guo et al. (2023) provided evidence that superior ESG performance curtails financial restatement by constraining executives' accrual and real earnings management, with this effect being particularly pronounced in firms characterized by concentrated ownership and higher institutional shareholding [15]. ESG governance entails systematic risk management processes, stakeholder engagement protocols, and governance accountability structures that directly complement formal internal control systems. From the auditor dimension, these non-financial disclosure. However, prior research has not definitively established whether ESG plays a mediating or moderating role in the business environment-audit quality nexus. The mediating hypothesis posits that business environment $\rightarrow$ ESG performance $\rightarrow$ audit quality, suggesting that institutional improvements work through enhancing corporate ESG behavior. The moderating hypothesis posits that ESG governance creates an independent risk buffer that changes the sensitivity of audit quality to external institutional conditions. Distinguishing these two mechanisms has fundamental implications for understanding the complementarity between external institutional governance and internal corporate governance (Figure 3).

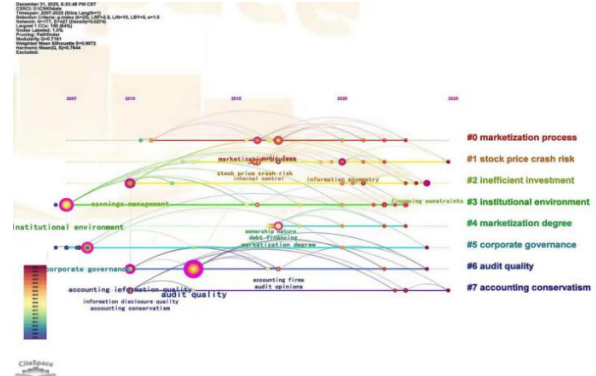


FIGURE 3. CiteSpace Timeline Visualization of Research Evolution (2007–2025)

D. RESEARCH GAPS AND CONTRIBUTION

Based on the above review, existing research exhibits four key limitations. First, most studies focus on single-dimensional traditional institutional factors such as market development or legal standard, lacking systematic consideration of the comprehensive business environment concept encompassing government efficiency, legal environment, financial development, and market maturity simultaneously. Second, the majority of studies implicitly assume a linear relationship between institutional environment and audit quality, ignoring potential nonlinear characteristics and the possibility that threshold effects generate non-monotonic dynamics. Third, the positioning of ESG disclosure within the institutional-audit quality framework remains contested. Tang et al. (2025) systematically examined ESG rating effects on audit report decisions from the dual perspectives of information generation and disclosure behavior, providing critical empirical evidence for understanding the ESG-audit nexus [16]. Fourth, existing studies have largely overlooked the non-monotonic dynamics in the institutional-audit quality relationship and the heterogeneous effects across regional and industry contexts. Figure 4 further highlights the most intensely studied topics using citation burst analysis. This paper addresses all four gaps by:

- (1) constructing a four-dimensional entropy-weight business environment index
- (2) explicitly testing for nonlinear effects with inflection point estimation
- (3) conducting both mediation and moderation tests for ESG
- (4) using a STAR Market-focused sample during the critical 2020–2024 registration-based reform period.

These design choices allow us to provide both theoretical and empirical contributions that advance the literature on institutional governance and capital market information quality.

III. THEORETICAL ANALYSIS AND HYPOTHESES

A. BUSINESS ENVIRONMENT AND STAR MARKET AUDIT QUALITY: THE INVERTED U-SHAPED HYPOTHESIS

Drawing on institutional economics, principal-agent theory, and existing literature, the business environment affects

Top 14 Keywords with the Strongest Citation Bursts

Keywords	Year	Strength	Begin	End	2007 - 2025
marketization degree	2017	1.93	2017	2018	
institutional environment	2007	1.93	2016	2020	
corporate governance	2008	1.7	2008	2010	
audit quality	2013	1.6	2017	2021	
corporate nature	2022	1.35	2022	2023	
fund occupation	2007	1.26	2007	2008	
listed companies	2008	1.1	2008	2013	
real earnings management	2020	1.09	2020	2021	
earnings management	2010	1.05	2010	2012	
internal control	2016	1.03	2016	2017	
information asymmetry	2020	1.02	2020	2022	
audit fees	2017	1.02	2021	2022	
stock price crash risk	2016	1.01	2019	2020	
accounting conservatism	2010	0.99	2010	2013	

FIGURE 4. Top 14 Keywords with the Strongest Citation Bursts (2007–2025)

STAR Market audit quality through three interrelated pathways, each generating upward pressure on audit quality up to a certain institutional threshold. The legal pathway operates through the formal rule-of-law framework. Improved legal system quality — encompassing enhanced judicial efficiency, stronger intellectual property protection, and expanded access to legal services — directly constrains opportunistic financial reporting behavior by STAR Market firms. Research and development manipulation, revenue fabrication, and other forms of earnings inflation become more legally costly as enforcement tightens. The deterrent effect raises the perceived probability and magnitude of penalties for audit failures, incentivizing auditors to exercise greater professional skepticism and expand audit procedures. This pathway is particularly salient for STAR Market firms, whose complex technology business models create abundant opportunities for subjective accounting estimates that could be exploited for earnings management. Wang and Xue (2022) demonstrated that legal system construction significantly promotes high-quality financial development in bond markets, highlighting the broader institutional-audit nexus [17]. The market competition pathway operates through the audit market structure. As the business environment improves and market mechanisms mature, competition in the audit market intensifies as local accounting firms are exposed to national and international competitive pressures. This competitive dynamic compels audit firms to invest more in professional training, quality control systems, and industry-specific expertise to differentiate their services. Additionally, improved market transparency makes audit quality failures more visible to prospective clients, strengthening reputation incentives. The agency cost dimension is also relevant: as information asymmetry between auditors and clients decreases with better institutional transparency, the likelihood of collusion and opinion shopping diminishes. The administrative efficiency pathway operates through the reduction of government intervention in enterprise operations and audit processes. Reduced administrative pre-approval requirements and regulatory burden decrease opportunities for politically-motivated interference in financial reporting. Simplified administrative procedures reduce the incentive for enterprises to maintain close relationships

with government officials through creative accounting that facilitates rent extraction. Furthermore, reduced government intervention in enterprise operations enhances auditor independence by making enterprises less dependent on political connections that could compromise audit relationship dynamics. However, the governance effects of business environment are subject to a critical threshold constraint. Excessive permissiveness — a business environment that has been ‘over-liberalized’ beyond the optimal institutional balance — generates countervailing negative effects. Local governments competing to attract innovative enterprises, particularly in the STAR Market context where technology firms are strategically valuable, may respond to excess competition by relaxing entry standards, weakening violation penalties, and tolerating or even facilitating regulatory arbitrage. Under such conditions, enterprises face reduced compliance costs and may shift from value-creating activities to rent-seeking and earnings manipulation strategies. The audit opinion shopping phenomenon — the practice of replacing auditors who issue qualified or modified opinions — becomes more prevalent when enforcement of auditor independence standards weakens. This deterioration of the institutional governance environment erodes the effectiveness of audit quality assurance mechanisms [18]. The theoretical logic is therefore one of diminishing and eventually negative marginal returns to business environment improvement: initial improvements generate strong positive governance effects through all three pathways, but beyond an optimal threshold, the cost of over-permissiveness outweighs the continued benefits of legal and market development. Based on the above theoretical analysis, we formally propose: H1: The marginal effect of business environment on STAR Market audit quality follows an inverted U-shaped nonlinear pattern — improving business environment initially enhances audit quality through legal, market, and administrative pathways, but exceeding the optimal institutional threshold generates negative effects through weakened enforcement and increased rent-seeking.

B. ESG DISCLOSURE: MEDIATING OR MODERATING ROLE

The relationship between ESG disclosure and audit quality can be theoretically framed through two competing hypotheses: the mediation hypothesis and the moderation hypothesis. Understanding which mechanism dominates has significant implications for both corporate governance design and audit regulatory policy. The mediation hypothesis, motivated by signal transmission theory, proposes the following causal chain: improved business environment → enhanced corporate ESG disclosure → higher audit quality. The logic is that stronger institutional oversight from a well-functioning business environment creates regulatory and stakeholder pressure for firms to invest in ESG infrastructure — environmental monitoring systems, social impact reporting, and governance transparency mechanisms. These ESG investments in turn reduce information asymmetry between the firm and its auditors, lower audit risk, strengthen internal control effectiveness, and ultimately improve audit quality. If this mediation pathway holds, it implies that

ESG functions as a transmission mechanism converting institutional quality improvements into audit governance outcomes [19]. However, the moderation hypothesis offers an alternative and arguably more compelling theoretical logic. ESG governance systems represent long-term strategic investments with high adjustment costs — they cannot easily be expanded or contracted in response to short-term external institutional fluctuations. As a result, ESG performance is unlikely to change significantly in response to business environment variations, breaking the first link of the mediation chain. Instead, ESG governance creates an endogenous risk-management infrastructure that operates independently of the external institutional context: high-quality ESG systems establish robust internal controls, enhance transparency, reduce earnings manipulation incentives through stakeholder accountability mechanisms, and signal sustainability commitments to auditors. This infrastructure functions as a 'shock absorber' that reduces the firm's exposure to external institutional risks — including the negative effects of excessive business environment permissiveness — thereby moderating the strength of the business environment–audit quality relationship. Under the moderation interpretation, firms with high ESG governance levels should exhibit relatively stable audit quality regardless of whether the business environment is at, below, or above the optimal institutional threshold. Conversely, firms with weak ESG governance remain more exposed to external institutional risks and would therefore exhibit stronger sensitivity to business environment variations, including the negative effects in the overly permissive zone. This gradient pattern — where the inverted U-shaped business environment effect on audit quality attenuates progressively as ESG governance improves — is the central prediction of the moderation hypothesis. Based on the above analysis, we propose: H2: ESG disclosure functions as a risk-moderating barrier rather than a mediating channel in the business environment–audit quality relationship. Specifically, the inverted U-shaped effect of business environment on audit quality will attenuate as firms' ESG governance levels improve, and will be statistically insignificant for firms in the high-ESG tercile.

IV. RESEARCH DESIGN

A. SAMPLE SELECTION AND DATA SOURCES

The research sample consists of firms registered and listed on the STAR Market (Science and Technology Innovation Board) of the Shanghai Stock Exchange during 2020–2024. We exclude: firms controlled by foreign entities, firms listed via Chinese Depositary Receipts (CDR), and firms with anomalous financial conditions (ST-designated firms). This yields 517 STAR Market firms with 1,690 firm-year observations. To enhance robustness, we further incorporate 565 ChiNext Board firms, resulting in a final sample of 4,502 firm-year observations. Financial data and the DIB internal control index are sourced from the CSMAR database's consolidated financial statements. ESG ratings come from the WIND Financial Terminal. Business environment evaluation indicator data are drawn from provincial statistical yearbooks, the National Development and Reform Commission, Ministry of Justice, State Intellectual Property

Office, People's Bank of China, and China Securities Regulatory Commission official websites.

B. VARIABLE DEFINITIONS

1) DEPENDENT VARIABLE: AUDIT QUALITY

Following the principal-agent framework (Zhao, 2024), this paper adopts the absolute value of discretionary accruals as the audit quality proxy. Higher absolute values indicate lower audit quality as shown in Table I.

2) CORE INDEPENDENT VARIABLE: BUSINESS ENVIRONMENT

This paper selects 12 secondary indicators across four primary dimensions. The index structure and weights are reported in Table II.

3) MEDIATOR VARIABLE AND CONTROL VARIABLES

The ESG mediator variable uses the WIND ESG annual rating, scored on a scale of 1 to 9 (C to AAA), with higher scores indicating better ESG performance. Control variables include firm size (size), leverage ratio (lev), return on assets (roa), auditor type (big4), firm age (age), largest shareholder ownership concentration (top1), and internal control quality (ic). Industry and year dummy variables are also included. All variable definitions are summarized in Table III.

C. MODEL SPECIFICATION

Given significant individual heterogeneity among STAR Market and ChiNext firms — firm size, industry characteristics, and governance structures may be correlated with business environment variables, potentially leading to omitted variable bias — and given that the Hausman test rejects the random effects model, this paper establishes an individual fixed-effects model. All regressions use firm-level clustered robust standard errors to address potential intra-firm serial correlation and heteroscedasticity. The baseline nonlinear regression model is specified as:

$$\text{auditqual}_{it} = \beta_0 + \beta_1 \cdot \text{env}_{it} + \beta_2 \cdot \text{env}_{it}^2 + \beta_3 \cdot \text{Controls}_{it} + \mu \quad (1)$$

For the mediation test, we follow the three-step approach of Baron and Kenny, combined with Bootstrap resampling to construct confidence intervals for indirect effects:

$$\text{esg}_{it} = \gamma_0 + \gamma_1 \cdot \text{env}_{it} + \gamma_2 \cdot \text{env}_{it}^2 + \gamma_3 \cdot \text{Controls}_{it} + \mu_i + \varepsilon_{it} \quad (2)$$

$$\text{auditqual}_{it} = \delta_0 + \delta_1 \cdot \text{env}_{it} + \delta_2 \cdot \text{env}_{it}^2 + \delta_3 \cdot \text{esg}_{it} + \delta_4 \cdot \text{Co} \quad (3)$$

V. EMPIRICAL ANALYSIS

A. DESCRIPTIVE STATISTICS

Table IV presents the descriptive statistics. The mean audit quality (auditqual) is 0.110 with a standard deviation of 0.106, suggesting that the overall audit quality of the STAR Market sample is relatively low and that there exists a certain degree of earnings management. The mean business

TABLE 1. Audit Quality Variable Definition

Variable	Symbol	Definition
Total accruals	TAC	Net income minus operating cash flow
Non-discretionary accruals	NDAC	Estimated by modified Jones model cross-sectional regression
Discretionary accruals	DA	TAC minus NDAC
Audit quality	auditqual	DA —absolute value of discretionary accruals; lower value indicates higher quality

Note: Total accruals = net income — operating cash flow; all variables scaled by lagged total assets.

TABLE 2. Business Environment Evaluation Index System

Primary Indicator	Secondary Indicator (Weight)	Symbol	Measurement	Weight
Government Efficiency (26.78%)	Fiscal intervention (8.45%)	FIS_INT	Local fiscal expenditure / regional GDP	0.039
	Government size (9.11%)	GOV_SIZE	Local civil servants / resident population	0.042
Legal Environment (23.26%)	Administrative efficiency (8.45%)	ADM_EFF	Days needed to register a business	0.042
	Legal services level (6.41%)	LAW_SERV	Practicing lawyers / resident population	0.029
	Judicial efficiency (7.83%)	JUD_EFF	Closed cases / received cases	0.036
	IPR protection (9.02%)	IP_PROT	Patent grants / patent applications	0.041
Financial Development (24.05%)	Financial depth (7.31%)	FIN_DEPTH	Bank loans / regional GDP	0.033
	Financial marketization (8.70%)	FIN_MKT	Non-state bank loans / total loans	0.040
	Direct financing (8.04%)	DIR_FIN	Stock market cap / regional GDP	0.036
Market Maturity (25.90%)	Non-state degree (8.83%)	NON_STATE	Non-state fixed asset investment / total	0.040
	Openness (8.44%)	OPENNESS	Import & export / regional GDP	0.039
	Market activity (8.63%)	MKT_ACT	New registered firms / resident population	0.039

Note: Weights computed via entropy-weight method; all weights sum to 1.00.

TABLE 3. Variable Definitions Summary

Type	Variable Name	Symbol	Definition
Dependent variable	Audit quality	auditqual	Absolute value of discretionary accruals (modified Jones model)
Core independent variable	Business environment composite score	env	Entropy-weight composite index (province-year)
Mediator variable	ESG performance	esg	WIND ESG annual rating, scored 1–9
Control variable	Firm size	size	ln(total assets at year-end)
	Leverage ratio	lev	Total liabilities / total assets
	Return on assets	roa	Net profit / average total assets
	Auditor type	big4	1 if Big-4 auditor, 0 otherwise
	Firm age	age	Observation year minus year of incorporation
	Ownership concentration	top1	Shareholding ratio of largest shareholder
	Internal control quality	ic	DIB internal control index score

Note: All continuous variables are winsorized at the 1st and 99th percentiles in robustness checks.

environment composite index (env) is 0.514 with a standard deviation of 0.070, indicating a relatively stable distribution with limited cross-regional institutional variation. The mean ESG score is 5.696, with a higher proportion of low-rated firms. Firm size has a mean of 2.548 and standard deviation of 0.563, covering large, medium, and small listed companies. The leverage ratio averages 0.350, indicating a relatively healthy capital structure; the return on assets averages 0.023, reflecting generally low profitability with some sustained loss-making firms. Big-4 auditor usage rate is 0.112, confirming that local accounting firms dominate the STAR Market audit landscape. The average listing age is 18.5 years, with mature firms predominating.

B. BASELINE REGRESSION RESULTS

Table V reports baseline regression results under four fixed-effects specifications. Model (1) is a linear individual fixed-effects model; the business environment coefficient is statistically insignificant at the 10% level, suggesting that the linear assumption may be misspecified. Model (2) introduces the quadratic term of business environment: the linear term coefficient is 0.309 (significant at 10%) and the squared term is -0.284 (significant at 10%), confirming an inverted U-shaped relationship. The inflection point is calculated at $env^* = 0.309/(2 \times 0.284) \approx 0.544$. Below this threshold, legal constraint enhancement, intensified market competition, and reduced administrative intervention synergistically

drive audit quality upward; once the threshold is crossed into an 'excessively permissive' zone, local governments' deregulatory incentives and the emergence of audit opinion shopping erode audit quality. Model (3) controls for industry fixed effects under random effects; the form shifts to a U-shape under industry controls, suggesting that industry heterogeneity moderates the effect direction. Model (4), a two-way fixed-effects model, is consistent with Model (2), confirming robustness of the nonlinear conclusion after controlling for macro annual shocks.

C. ROBUSTNESS CHECKS

To address potential bias from extreme outliers in enterprise financial data, we winsorize the dependent variable (auditqual) at the 1st and 99th percentiles and re-run the fixed-effects model. As shown in Table VI, the core business environment coefficient remains 0.300 (significant at 5%) and the squared term is -0.271 (significant at 5%). Winsorization results are reported in Table VI.

D. HETEROGENEITY ANALYSIS

1) REGIONAL HETEROGENEITY: CITY CLUSTER ANALYSIS

Following Li (2021), we divide the sample into six major city cluster groups — Beijing-Tianjin-Hebei (JJJ), Yangtze River Delta (CSJ), Guangdong-Hong Kong-Macao Greater Bay Area (GBA), Northeast China (NE), Non-Yangtze-Delta

TABLE 4. Descriptive Statistics

Variable	Mean	Std. Dev.	Min	Max	N
auditqual	0.110	0.106	0.000	1.335	4501
env	0.514	0.070	0.296	0.744	4501
esg	5.696	1.184	3.000	9.000	4501
size	2.548	0.563	0.815	5.266	4501
lev	0.350	0.197	0.019	1.501	4501
roa	0.023	0.093	-0.805	0.969	4501
big4	0.112	0.315	0.000	1.000	4501
age	18.503	5.343	4.000	43.000	4501
top1	0.281	0.116	0.040	0.819	4501
ic	626.192	99.845	0.000	842.960	4501

Note: N = 4,501 firm-year observations. Continuous variables are winsorized at the 1st and 99th percentiles in robustness checks.

TABLE 5. Baseline Regression Results

Variable	(1) FE-Linear	(2) FE-Nonlinear	(3) RE-Industry	(4) FE-Two-way
env	0.013 (0.017)	0.309* (0.163)	-0.300** (0.153)	0.287 (0.176)
env ²	—	-0.284* (-0.154)	0.270* (0.144)	-0.263 (-0.165)
size	0.003	0.003	0.014***	0.003
lev	0.125***	0.125***	0.092***	0.125***
roa	-0.493***	-0.493***	-0.463***	-0.492***
big4	0.002	0.002	0.005	0.002
age	-0.005***	-0.005***	0.001	-0.005***
top1	-0.001	-0.002	-0.013	-0.002
_cons	0.147***	0.075	0.157***	0.082
N	4501	4501	4412	4501
Inflection point	—	0.544	—	—

Note: Standard errors clustered at the firm level in parentheses. *p<0.10, **p<0.05, ***p<0.01. FE = fixed effects; RE = random effects.

TABLE 6. Robustness Check: Winsorization

Variable	(1) Baseline	(2) Winsorized (1%–99%)
env	0.309* (1.89)	0.300* (1.97)
env ²	-0.284* (-1.84)	-0.271* (-1.88)
size	0.003	0.003
lev	0.125***	0.095***
roa	-0.493***	-0.385***
big4	0.002	0.002
age	-0.005***	-0.003**
top1	-0.002	-0.005
_cons	0.075	0.045
N	4501	4501

Note: t-statistics in parentheses. *p<0.05, **p<0.01, ***p<0.001.

Yangtze Economic Belt (NCJ), and Yellow River Basin (HRB) [20]— and conduct separate comparative evaluations for each group. Table VII presents the results. The results identify three tiers:

(1) The Greater Bay Area achieves statistical significance at the 10% level, validating institutional governance effectiveness in China's most market-oriented and legally advanced region. As the business environment improves initially, the robust institutional system strengthens government oversight and standardizes information disclosure, raising audit quality; but as the environment becomes overly permissive, rent-seeking space expands and opinion shopping emerges, weakening audit quality.

(2) The Yangtze River Delta shows a marginally significant inverted U-shaped trend, partially diluted by the active private economy and frequent earnings management in the region.

(3) JJJ, Northeast China, Yellow River Basin, and NCJ show no significant effects, reflecting the relatively lagging market reform process and weaker regulatory binding force in traditional northern industrial bases and inland regions.

2) INDUSTRY HETEROGENEITY

We classify sample firms into five industry groups: traditional heavy industry, services and other, high-tech manufacturing, light industry and consumer goods, and equipment and metal manufacturing. Only the equipment and metal manufacturing sector exhibits a statistically significant inverted U-shaped effect (at 10%), while the other four industries show no significant response. The finding suggests that the audit governance effect of business environment is highly dependent on industry environmental sensitivity and compliance constraint intensity. Traditional heavy industry is subject to routine environmental regulation and shows weak marginal effects; services and light industry face weak environmental pressure; high-tech manufacturing's core competitiveness stems from research and development, making business environment a relatively less decisive audit quality factor.

3) FIRM LIFE-CYCLE HETEROGENEITY

Using the median listing age as the threshold, we divide the sample into mature firms and young firms. For ma-

TABLE 7. Regional Heterogeneity: City Cluster Regressions

Variable	(1) JJJ	(2) CSJ	(3) GBA	(4) NE	(5) NCJ	(6) HRB
env	0.124	1.467	0.688**	0.603	-0.227	-0.065
env ²	0.005	-1.307	-0.582*	-0.606	0.167	0.038
size	0.008**	0.004	0.010	0.003	-0.012	-0.008
lev	0.051	-0.138	0.213***	0.105*	0.075	0.128*
roa	-0.198**	-1.040***	-0.702***	-0.711***	-0.902***	-0.878***
_cons	0.063	-0.203	-0.087	0.033	0.333***	0.272***
N	2345	78	378	869	281	550

Note: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. JJJ = Beijing-Tianjin-Hebei; CSJ = Yangtze River Delta; GBA = Greater Bay Area; NE = Northeast; NCJ = Non-Yangtze-Delta Yangtze Belt; HRB = Yellow River Basin.

ture firms — with stable business models, well-established governance mechanisms, and sound information disclosure systems — the business environment coefficients fail to achieve 5% significance, consistent with the expectation that audit quality for mature firms is primarily determined by internal governance characteristics. For young firms, the business environment coefficients are significant at the 5% level in both the linear and quadratic terms, with a clear inverted U-shape. Young firms' short operating history, weak internal governance, and higher information asymmetry make them more sensitive to external institutional shocks: at the early stage of institutional improvement, external regulatory constraints standardize operations and improve accounting transparency; once the business environment becomes excessively interventionist, it may compromise auditor independence and inhibit audit oversight functions.

TABLE 8. ESG Mediation Test: Three-Step Analysis

Variable	(1) Total Effect	(2) Mediation Path	(3) Direct+Indirect
env	0.309 (1.89)	0.152 (0.14)	0.308 (1.89)
env ²	-0.284 (-1.84)	-0.179 (-0.18)	-0.283 (-1.84)
esg	—	—	0.003 (0.94)
size	0.003	-0.012	0.003
lev	0.125***	0.009	0.125***
roa	-0.493***	-0.010	-0.493***
big4	0.002	-0.159**	0.003
age	-0.005***	-0.004	-0.005***
top1	-0.002	-7.620***	0.019
_cons	0.075	7.921***	0.053
N	4501	4501	4501
Mediation conclusion	—	No significant mediation	—

Note: t-statistics in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Bootstrap with 500 replications confirms no significant indirect effect.

E. MECHANISM ANALYSIS

1) MEDIATION TEST: ESG TRANSMISSION PATH

We apply the three-step mediation approach (Baron-Kenny method combined with Bootstrap resampling) to test whether ESG performance mediates the business environment–audit quality relationship. Table VIII presents the results. In Step 1 (total effect), the inverted U-shaped main effect is confirmed. In Step 2 (mediation path), neither the linear nor the squared term of business environment significantly affects ESG performance, indicating that ESG governance has high strategic stability and inertia — short-term external institutional fluctuations cannot compel or drive enterprises to adjust their environmental responsibility, social responsibility, and governance behaviors. In Step 3 (joint test), after incorporating the ESG variable, the inverted U-shaped relationship remains robust, while ESG

itself has no significant direct effect on audit quality. The comprehensive three-step test results confirm that ESG does not serve as a mediating channel. From an audit professional perspective, this means that business environment's risk impact on audit quality is not transmitted through 'influencing corporate ESG governance and then changing auditors' risk perception' — ESG cannot function as an indirect transmission pathway for external environmental risk.

2) MODERATION TEST: ESG RISK BOUNDARY

To further investigate ESG's risk-moderating function, we divide the sample into low, medium, and high ESG terciles based on the 25th and 75th percentile scores of the WIND ESG annual rating, and conduct separate subsample regressions. Table IX presents the results. In the low-ESG subsample, the inverted U-shaped nonlinear relationship is marginally significant, with coefficient absolute values exceeding the full-sample baseline — the nonlinear shock effect is strongest. Low-ESG firms have weak environmental compliance, disclosure quality, and internal governance, so external institutional volatility further amplifies auditor professional risk perception, significantly increasing the effect magnitude. In the mid-ESG subsample, as non-financial governance improves, the buffering capacity against external environmental shocks increases, and the statistical significance and coefficient absolute values of the core variables decrease notably — the nonlinear effect is visibly attenuated. In the high-ESG subsample, the inverted U-shaped relationship completely disappears: robust ESG governance forms a stable risk-hedging barrier, effectively resisting operational risks from external uncertainties, and business environment volatility no longer affects audit quality. This gradient pattern fully validates ESG's 'institutional risk immunity' function: the higher the ESG governance level, the stronger the firm's ability to withstand external institutional risks. The moderation boundary effect of ESG governance receives complete empirical support.

TABLE 9. ESG Moderation Test: Tercile Subsample Regressions

Variable	(1) Low ESG	(2) Mid ESG	(3) High ESG
env	0.472 (1.52)	0.466 (1.21)	-0.115 (-0.37)
env ²	-0.425 (-1.43)	-0.444 (-1.21)	0.113 (0.39)
size	0.007	0.005	0.000
lev	0.145**	0.207***	0.038
roa	-0.203	-0.806***	-0.785***
big4	-0.001	-0.005	-0.009
age	-0.004	-0.006*	-0.003
top1	0.009	-0.026	0.023
_cons	-0.018	0.069	0.212*
N	2528	862	1111

Note: t-statistics in parentheses. *p<0.05, **p<0.01, ***p<0.001. Sample split by 25th/75th percentile of ESG score.

VI. CONCLUSIONS

Drawing upon a robust dataset of 4,502 firm-year observations from the technologically intensive STAR Market and growth-enterprise-oriented ChiNext Board spanning 2020 to 2024, this study establishes strong empirical feasibility through its alignment with a critical phase of China's capital market reforms and its deployment of rigorous two-way fixed-effects models that effectively isolate institutional impacts from confounding macroeconomic trends. Methodologically, the identification of the 0.544 inflection point and the validation of ESG's moderating role demonstrate the viability of applying threshold regression models to complex governance phenomena. However, the study is not without limitations: its generalizability is somewhat constrained by the unique regulatory ecosystems of these specific boards, potentially limiting extrapolation to traditional Main Board firms or private enterprises; furthermore, while fixed effects mitigate omitted variable bias, residual endogeneity arising from simultaneous causality—whereby higher audit quality might attract more favorable local business conditions—cannot be entirely dismissed. Looking forward, future research should pursue several expansive trajectories to deepen this inquiry: scholars should seek cross-national comparisons leveraging similar institutional indices to test whether the observed inverted U-shape is a universal trait of market maturation or culturally contingent; there is a pressing need to employ instrumental variable strategies or natural experiments based on exogenous policy shocks to definitively establish causality; additionally, future work must move beyond composite indices to deconstruct which specific levers of the business environment—be it judicial

efficiency, tax enforcement, or credit market accessibility—drive audit quality fluctuations. Finally, integrating emerging variables such as algorithmic auditing, climate-related financial disclosures, and supply chain resilience will be crucial for understanding how traditional institutional mechanisms adapt to the digital and green transitions, thereby providing a more granular roadmap for policymakers aiming to optimize institutional frameworks without triggering the "excessively permissive" pitfalls identified herein.

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