



Supply Chain Shareholding and Audit Risks

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Abstract. This study uses A-share listed companies on the Shanghai and Shenzhen stock exchanges from 2013 to 2023 as its research sample to systematically examine the impact of supply chain equity holdings on audit risk. The findings reveal that supply chain equity holdings significantly increase a firm's audit risk. Further analysis indicates that the positive impact of supply chain equity holdings on audit risk is more pronounced in firms with higher supply chain concentration and greater external scrutiny. From the perspective of supply chain equity linkages, this study enriches the research on factors influencing audit risk, providing empirical evidence and decision-making references for firms to optimize supply chain governance and for auditors to refine risk assessments.

Keywords: Supply chain equity holdings; Audit risk; Operational risk

1 Introduction

Against the backdrop of digital transformation and industrial restructuring, supply chains have evolved from transactional chains into networks for co-creating value. An increasing number of enterprises recognize that traditional market transactions alone cannot guarantee stable supply and sustainable costs; only through aligning interests and establishing equity ties can upstream and downstream entities achieve shared risk-bearing and value-sharing. In 2016, relevant national authorities promoted vertical equity holdings between upstream and downstream entities through the “Ten Reform Pilot Programs” to facilitate mergers and reorganizations of state-owned enterprises and the development of mixed-ownership. Vertical equity holdings have become a key pathway for enterprises to deepen supply chain cooperation and enhance competitiveness^[1]. Supply chain equity holdings refer to equity linkages formed between listed companies and their core suppliers or customers for the purpose of vertical integration, such as strengthening supply chain synergy, stabilizing transactional relationships, and improving industrial chain efficiency^[2].

However, as a unique equity arrangement, supply chain equity participation may have dual effects. On the one hand, this model helps strengthen information-sharing mechanisms between enterprises, improve decision-making efficiency, and establish a cross-enterprise risk-sharing system. On the other hand, upstream and downstream enterprises are essentially in a competitive-cooperative relationship, and their interests are not entirely aligned; supply chain equity participation may also provide opportu-

nities for exploitative or predatory behavior. At the same time, this equity arrangement increases the complexity of corporate business structures, lowers the cost of collusion, heightens the incentive for collusion, and threatens the orderliness of capital markets. While supply chain equity participation is a common form of supply chain relationship in actual business operations, academic research on its economic consequences is still in its infancy. Based on this, this paper empirically examines the impact of supply chain equity participation on audit risk using Chinese A-share listed companies on the Shanghai and Shenzhen stock exchanges from 2013 to 2023 as the research sample.

2 Literature Review

2.1 Research on the Economic Consequences of Supply Chain Equity Participation

From the perspective of corporate governance, supply chain shareholding helps strengthen a sense of shared responsibility, curb contract breach, improve capital allocation efficiency, and promote the convergence of investment decisions with the overall optimization of the supply chain. Suppliers or customers acting as shareholders can constrain management's opportunistic behavior and reduce irrational and inefficient investments^[3]. Supply chain equity ownership can also broaden financing channels, improve the information environment, generate synergistic governance effects, curb collusive fraud, lower debt financing costs and bankruptcy risks, alleviate financing constraints, and increase financing cash flows^[2].

From the perspective of supply chain collaboration, on the one hand, suppliers or customers with shareholder status can access more non-public information, mitigate external uncertainties through deeper collaboration, improve capital allocation efficiency^[4], and alleviate pricing distortions of intermediate goods caused by information asymmetry, thereby promoting a return of prices to marginal cost^[5]. On the other hand, supply chain equity can strengthen mutual trust among enterprises, reduce the risk of supply chain disruptions, and improve capacity utilization. At the same time, it lowers transaction costs, promotes specialized division of labor, and enhances the overall resilience and exploratory innovation capabilities of the supply chain^[6]. Additionally, Hu Haifeng et al. found that supply chain equity participation can facilitate high-quality development of enterprises^[7].

2.2 Research on Factors Influencing Audit Risk

Audit risk refers to the probability that a certified public accountant will issue an inappropriate audit opinion when material misstatements exist in financial statements. From the firm's perspective, mandatory disclosure of industry-specific operational information reduces the auditor's assessment of material misstatement risk by alleviating information asymmetry between the auditor and the firm, thereby lowering audit risk^[8]. Corporate earnings management behaviors increase the risk of material misstatement, operational risk, and regulatory risk, and lead to audit delays, thereby prompting auditors to charge higher risk premiums^[9]. From the auditor's perspective,

high-quality auditors can enhance the risk awareness and risk-response capabilities of team members, thereby reducing audit risk^[10]. The resilience of accounting firms can significantly reduce audit risk by lowering assessment risk, examination risk, and pre-audit risk^[11].

Existing literature on the impact of supply chain equity holdings primarily focuses on a company's internal management, financial performance, and market behavior, while rarely addressing the effects on other stakeholders, such as external auditors. Although some studies have discussed the relationship between supply chain equity holdings and auditing, most research is limited to audit pricing and audit quality. Few studies have explored the impact of supply chain equity holdings on audit risk and its underlying mechanisms.

3 Theoretical Analysis and Research Hypotheses

From the perspective of operational risk: On the one hand, as a form of deeply integrated supply chain relationship, supply chain equity participation strengthens the interdependence between upstream and downstream firms. When external risks occur, this relationship can generate synergies, stabilize corporate expectations, and help firms weather the storm together^[7]. Regarding supply chain stability and resilience, supply chain equity participation creates a "lock-in of interests" through equity ties, enhancing mutual trust among enterprises, safeguarding supply chain stability and resilience, and reducing the risk of "supply chain disruption" caused by external shocks^[6]. Furthermore, supply chain equity participation helps improve corporate governance, enhances the willingness and ability of enterprises along the chain to supervise the management of the invested firm, and curbs self-serving behavior by management, thereby reducing operational management risks and, consequently, inherent audit risk. On the other hand, while supply chain equity participation strengthens upstream-downstream cooperation, its deep interdependence and locked-in interests may conversely lead to increased business risks. Once enterprises in the supply chain form deep strategic partnerships through equity participation, the dependency arising from equity relationships tightly locks in their contractual ties, limiting the strategic decision-making flexibility of weaker enterprises^[7]. At the same time, excessive interdependence can also affect the bargaining power of weaker firms vis-à-vis other suppliers or customers, making them vulnerable to control by core firms within the chain and reducing their market competitiveness^[1]. Furthermore, upstream and downstream enterprises essentially maintain a competitive-cooperative relationship. Shareholding enterprises may engage in covert exploitative practices due to conflicts of interest, sacrificing the overall interests of the enterprise to secure their own gains, thereby increasing operational risks^[12] and, consequently, exacerbating the audit risks faced by auditors.

From the perspective of information effects, on the one hand, supply chain equity participation can have a positive impact on a company's information environment. Due to deepened cooperation, enterprises within the supply chain have developed stronger capabilities for information gathering and multi-channel cross-verification,

making it easier to identify earnings management activities and thereby enhancing the accuracy of information disclosure^[3]. At the same time, equity-holding enterprises assume a dual role, with significantly heightened monitoring incentives and information needs; this encourages them to increase the volume and improve the quality of information disclosure, effectively alleviating information asymmetry^[13]. Furthermore, supply chain equity participation enables enterprises to obtain supply chain risk information more quickly, accelerate risk response, and promote the establishment of collaborative trust mechanisms among enterprises in the chain. This reduces the likelihood of intentionally concealing or fabricating accounting information due to internal supply chain competition^[4], thereby improving the quality of information disclosure and reducing auditors' risk assessments. On the other hand, supply chain equity participation may reduce enterprises' willingness and quality of information disclosure. Regarding disclosure willingness, suppliers or customers holding equity can communicate with the enterprise through internal channels and directly participate in management decisions by appointing executives or directors, no longer relying solely on public information. Moreover, public disclosure itself entails certain compliance costs; therefore, when demand weakens, enterprises tend to reduce relevant disclosures^[14]. Regarding disclosure quality, when upstream and downstream firms deeply engage with the investee through equity holdings, they may seek to maintain their informational advantage to preserve the supply chain's overall competitive edge or secure excess returns. To this end, equity-holding firms may collude to erect information barriers via their equity relationships, thereby lowering the quality of the core firm's disclosures^[13], which in turn increases the audit risks faced by auditors. Based on the above analysis, this paper proposes the following competitive hypothesis:

H1a: Supply chain equity holdings reduce audit risk.

H1b: Supply chain equity ownership increases audit risk.

4 Research Design

4.1 Sample Selection and Data Sources

This study selected data from A-share listed companies on the Shanghai and Shenzhen stock exchanges from 2013 to 2023 as the research sample. The raw data underwent the following processing: (1) companies in ST or PT status were excluded; (2) all listed companies in the financial sector were excluded; (3) companies with missing data for key variables were excluded. Ultimately, 37,273 sample data points were obtained, and all continuous variables were trimmed at the top and bottom 1%. The research data in this paper are primarily sourced from the Guotai-An Database (CSMAR) and the China Research Data Service Platform (CNRDS).

4.2 Variable Selection

Dependent Variable. The dependent variable in this study is audit risk (Arisk). Following the approach of Li Yuedong and Tian Bo'ao (2025), we use abnormal related-party transactions to reflect audit risk. The specific calculation method is as fol-

lows: drawing on Jian et al. (2010), we perform a regression on the total related-party transactions (RPT) using Model (1). The resulting residuals represent abnormal related-party transactions, which serve as the dependent variable Arisk in this study. As shown in the formula, where Lev is the debt-to-equity ratio, Size is firm size, and MTB is the market-to-book ratio. A larger residual value indicates higher audit risk for the firm, consistent with the logic of existing research.

$$RPT_{i,t} = \beta_0 + \beta_1 Lev_{i,t} + \beta_2 Size_{i,t} + \beta_3 MTB_{i,t} + \sum Year + \sum Industry + \varepsilon \quad (1)$$

Explanatory Variable. The core dependent variable in this study is supply chain ownership (Scs). Following the approach of Hu Haifeng et al. (2024), we measure this by the ownership ratio of the top five suppliers or customers among a listed company's top ten shareholders; if no supply chain holdings appear among the top ten shareholders, the value is set to 0.

Control Variables. Following existing research, the control variables include: debt-to-equity ratio (Lev), institutional investor ownership (Ins), audit opinion (Opinion), return on assets (ROA), board size (Board), firm size (Big4), company size (Size), loss status (Loss), proportion of independent directors (Indep), change in audit firm (Change), firm age (Age), equity concentration (Top1), dual-role arrangement (Dual), and management shareholding (Mshare).

4.3 Model Specification

To examine the impact of supply chain ownership on audit risk, we construct the following model (2) to test the hypotheses of this paper:

$$Arisk_{i,t} = \alpha_0 + \alpha_1 Scs_{i,t} + \alpha_1 Control_{i,t} + \sum Year_{i,t} + \sum Industry_{i,t} + \varepsilon_{i,t} \quad (2)$$

where i represents the firm, t represents the year, $Arisk_{i,t}$ denotes audit risk, $Scs_{i,t}$ denotes the level of supply chain shareholding, $Control_{i,t}$ denotes all control variables mentioned above, $Year_{i,t}$ is the year fixed effect, $Industry_{i,t}$ is the industry fixed effect, and $\varepsilon_{i,t}$ is the error term.

5 Empirical Results and Analysis

5.1 Descriptive Statistics and Correlation Analysis

Tables 1 and 2 present the descriptive statistics and correlation analysis for the main variables, respectively. As shown in Table 2, there is no serious multicollinearity among the variables, and the correlation coefficient between Scs and Arisk is significantly positive at the 1% level, providing preliminary support for Hypothesis H1b.

Table 1. Descriptive Statistics.

Variable	N	mean	SD	min	P50	max
risk	37,273	0.009	3.998	-15.020	0.361	10.530
scs	37,273	0.370	3.110	0.000	0.000	29.100
opinion	37,273	0.968	0.175	0.000	1.000	1.000
ROA	37,273	0.039	0.068	-0.239	0.039	0.222
Big 4	37,273	0.060	0.238	0.000	0.000	1.000
size	37,273	22.230	1.307	19.89	22.040	26.330
change	37,273	0.096	0.295	0.000	0.000	1.000
top1	37,273	0.335	0.147	0.083	0.311	0.738

Table 2. Correlation Analysis.

Variable	arisk	scs	Opinion	ROA	Big 4	size	change	Top 1
risk	1.000							
scs	0.028***	1.000						
opinion	-0.011**	0.004	1.000					
ROA	-0.043***	-0.011**	0.282***	1.000				
Big 4	-0.017***	0.019***	0.026***	0.025***	1.000			
size	-0.024***	0.085***	0.041***	0.012**	0.329***	1.000		
change	0.019***	0.010*	-0.056***	-0.060***	0.027***	0.025***	1.000	
top1	-0.020***	0.118***	0.090***	0.150***	0.133***	0.182***	-0.002	1.000

Note: *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively; the same applies below.

5.2 Baseline Regression Results

Table 3. Baseline Regression Results.

	(1)	(2)	(3)
	Arisk	Arisk	Arisk
Scs	0.0390*** (5.8762)	0.0265*** (3.6320)	0.0254*** (3.5655)
Control	YES	YES	YES
Constant	-0.0057 (-0.2766)	0.0230*** (8.4986)	6.5312*** (3.9757)
Firm/Year	YES	YES	YES
N	37,273	37273	37273
Adj. R2	0.001	0.172	0.175

Table 1 reports the results of the baseline regression between supply chain shareholding and audit risk. Column (1) presents the regression results with only the independent and dependent variables included; the results show that the coefficient for supply chain shareholding (Scs) is 0.0390, which is significantly positive at the 1% level. Column (2) further controls for firm- and year-specific fixed effects based on Column (1). Here, the coefficient for supply chain ownership (Scs) is 0.0265, which remains significantly positive at the 1% level. Column (3) adds all control variables to the

model in Column (2). The results indicate that the estimated coefficient for supply chain equity holdings (Scs) is 0.0254, and it remains significantly positive at the 1% level. These regression results validate Hypothesis H1b of this paper, namely that supply chain equity holdings increase audit risk.

5.3 Endogeneity Tests

Instrumental Variables (IV) Method. To mitigate endogeneity issues such as reverse causality, this study uses the average supply chain equity holdings within the same industry and city in the same year as an instrumental variable (IV). Companies in the same industry and city face similar external environments and supply chain networks; moreover, industry- and city-level averages are macro-level variables that are unlikely to directly influence the audit risk of individual companies, thereby satisfying the requirements of relevance and exogeneity. As shown in columns (1) and (2) of Table 4, the estimated coefficient of IV on Scs in the first-stage regression is 0.9606, which is significantly positive at the 1% level; the second-stage results indicate that the estimated coefficient of Scs on Arisk is significant at the 1% level, supporting the baseline regression results.

Differ-in-differences Model. To better mitigate endogeneity issues such as reverse causality and identify the causal effect of supply chain shareholding on audit risk, this study constructs a nested differ-in-differences model for testing. The specific model is as follows:

$$\text{Arisk}_{i,t} = \beta_0 + \beta_1 \text{Treat} \times \text{Post}_{i,t} + \beta_n \text{Controls}_{i,t} + \sum \text{Year}_{i,t} + \sum \text{Industry}_{i,t} + \epsilon_{i,t} \quad (3)$$

Here, the subscripts *i* and *t* denote the year and the firm, respectively. Specifically, if a firm has supplier or customer shareholdings for the first time, the variable is assigned a value of 1 for the year of the shareholding and subsequent years; otherwise, it is assigned a value of 0. As shown in column (3) of Table 4, the coefficient of the overlapping difference-in-differences estimator (*Treat* × *Post*) is 0.5865, which is significantly positive at the 1% level, indicating that supply chain shareholding significantly increases a firm's audit risk. This result is consistent with the conclusions of the baseline regression and validates the robustness of the study's research hypothesis.

Heckman Two-Stage. To mitigate endogeneity issues caused by sample selection bias, this study employs the Heckman two-stage method for testing. In the first stage, whether a firm discloses information on major suppliers or customers is used as the dependent variable, and the inverse Mills ratio (IMR) is calculated via Probit regression; in the second stage, the IMR is included as a control variable in the baseline regression model. As shown in columns (4) and (5) of Table 4, the estimated coefficient for supply chain shareholding (Scs) remains significantly positive at the 5% level, while the IMR coefficient is not significant. This indicates that the model does not suffer from severe sample selection bias, and the results of the baseline regression are reliable.

5.4 Robustness Tests

Indicator sensitivity tests. To eliminate the potential impact of firm size and industry differences on the measurement of audit risk, this study conducts robustness tests using audit risk standardized by firm size (*Arisk_st*) and audit risk adjusted by industry mean (*Arisk_adj*), respectively. As shown in columns (6) and (7) of Table 4, the estimated coefficients for supply chain equity holdings on audit risk are both significantly positive, consistent with the baseline regression results, indicating good robustness.

Interaction Fixed Effects. To minimize the interference of unobserved omitted factors on the research conclusions, this study further incorporates city-year interaction fixed effects and industry-year interaction fixed effects into the baseline regression model for robustness testing. As shown in column (8) of Table 4, the estimated coefficient of supply chain equity holdings on audit risk remains significantly positive, consistent with the baseline regression results. This indicates that the conclusions of this study are largely unaffected by omitted factors and demonstrate good robustness.

Table 4. Endogeneity and Robustness Tests.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Scs	Arisk	Arisk	Arisk	Arisk	Arisk st	Arisk adj	Arisk
Scs		0.0300*** (2.6310)			0.0404** (2.5271)	0.0075*** (3.4069)	0.0238*** (3.2770)	0.0288*** (3.5012)
IV	0.9606*** (30.2538)							
Treatment × Post			0.5865*** (3.1439)					
IMR					-0.1771 (-1.0043)			
Control	YES	YES	YES	YES	YES	YES	YES	YES
Firm/Year	YES	YES	YES	YES	YES	YES	YES	YES
Industry / Year	NO	NO	NO	NO	NO	NO	NO	YES
City / Year	NO	NO	NO	NO	NO	NO	NO	YES
Constant	0.8127 (0.9820)	6.5458*** (3.9849)	6.5703*** (4.0003)	-2.6257*** (-6.3725)	6.2421*** (3.7648)	2.0466*** (4.5105)	6.1856*** (3.8011)	5.6160*** (3.2346)
N	37,273	37,273	37,272	37,273	37082	37273	37273	35770
Adj_R(2)	0.700	0.175	0.175	0.1408	0.175	-0.114	0.173	0.183
/Pseudo R2								

5.5 Further Analysis

Supply Chain Bargaining Power. When a company has relatively little bargaining power within its supply chain, it may be forced to accept certain unfair terms, which

may lead auditors to raise their assessment of audit risk. This study measures supply chain concentration using the mean of the sum of the top five suppliers' and customers' procurement and sales ratios, and divides the sample into high- and low-concentration groups based on the median across industry-year combinations for group regression analysis. As shown in Table 3, columns (1) and (2), the estimated coefficient is significantly positive in the high-concentration group but not significant in the low-concentration group. This indicates that the positive impact of supply chain concentration on audit risk is more pronounced when supply chain concentration is high.

External attention. Media and analyst scrutiny places auditors' work under broader public scrutiny; in such circumstances, auditors tend to allocate more resources to address potential risks in order to protect their firm's reputation. Therefore, this study measures a firm's external attention from two dimensions—media attention and analyst attention—and divides the sample into high and low groups based on the median of industry-specific annual data for a group-by-group analysis. As shown in columns (3), (4), (5), and (6) of Table 5, in the groups with high media and analyst attention, the estimated coefficients for the relationship between supply chain ownership and audit risk are positive and more significant. This suggests that the positive impact of supply chain ownership on audit risk is more pronounced when external attention is high.

Table 5. Heterogeneity Analysis.

	(1)	(2)	(3)	(4)	(5)	(6)
	Arisk	Arisk	Arisk	Arisk	Arisk	Arisk
	High supply chain concentration	Low supply chain concentration	High media attention	Low media attention	High analyst attention	Low analyst attention
Scs	0.0249** (2.1683)	0.0169 (1.6378)	0.0261*** (2.6802)	0.0160 (1.4796)	0.0371*** (3.3091)	0.0173* (1.8200)
Control	YES	YES	YES	YES	YES	YES
Firm/Year	YES	YES	YES	YES	YES	YES
Sample size	17,597	17,413	17,844	17,667	14,953	21,077
Adj R ²	0.175	0.179	0.200	0.200	0.189	0.184

6 Conclusions and Implications

This study uses Chinese A-share listed companies on the Shanghai and Shenzhen stock exchanges from 2013 to 2023 as its sample. Adopting a dual perspective of supply chain coordination and equity ties, it systematically examines the impact of supply chain shareholding on audit risk. The findings reveal that supply chain shareholding significantly increases a firm's audit risk. This conclusion holds true even after conducting a series of robustness tests. Further analysis indicates that this effect is more pronounced when a firm's supply chain concentration is high and external attention is high.

Based on the above conclusions, this paper offers the following recommendations: First, companies should guard against the operational and information risks associated with supply chain equity holdings. They should focus on monitoring cash flows with companies holding equity in the supply chain and ensuring the fairness of pricing; they should also improve internal governance by establishing independent review procedures for unusual related-party transactions. Second, auditors should include supply chain equity holdings in their risk assessments, cross-referencing disclosures in annual reports with information from corporate registration platforms to identify a company's supply chain equity relationships as comprehensively as possible. For companies with supply chain equity holdings, auditors should expand the scope of related-party transaction testing, focusing on verifying the fairness of pricing and whether there are abnormal fluctuations in transaction frequency. They should also perform confirmation procedures with the equity-holding parties to verify the authenticity of transaction amounts and terms and identify hidden agreements or commitments. Furthermore, auditors should consider the risk of management override by taking into account the proportion of supply chain equity holdings and the degree of reliance on the supply chain, thereby keeping audit risk at an acceptably low level. Third, regulatory authorities should improve disclosure requirements by mandating that companies disclose complete details of supply chain equity holdings. They should strengthen oversight of companies with excessively high supply chain concentration or abnormal changes in performance to ensure the healthy and orderly development of capital markets.

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