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Impact of Supply Chain Management Strategies on Auditors' Risk Perception

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Abstract

Against the backdrop of volatile global raw material prices and complex supply chains, enterprises optimize supply chain strategies (e.g., energy vertical integration, steel downstream collaboration) to boost resilience, and supply chain stability directly shapes auditors' judgments on financial risks (e.g., inventory valuation), making their link a key research focus. Existing studies note supply chain optimization reduces operational risks but have gaps: they focus on generalized traits (transparency, complexity) rather than industry-specific paths (why coal-power firms prioritize integration over steel's collaboration) and fail to clarify how strategies (cost stability) influence audit judgments. To address this, this study examines coal-power (power generation) and steel industries: coal-power integration stabilizes procurement costs—boosting generation to maximize profits when coal prices fall, mitigating surges via internal controls—reducing revenue/cost uncertainty and auditors' risk concerns; it also compares steel's downstream collaboration to reveal industry differences. The study contributes theoretically by clarifying industry-specific mechanisms, enriching cross-disciplinary frameworks; practically, it guides enterprises to design risk-aligned strategies and auditors to optimize industry-tailored assessments.

Keywords: Supply Chain Management Strategy; Auditors' Risk Perception; Coal-Power Integration Strategy

1. Introduction

Currently, collaborative supply chain development has replaced individual competition as the mainstream model for international industrial organization operations (Cull and Xu, 2005). To address the intensifying market competition, enterprises need to adjust their operational and competitive strategies to seek improvement paths (Hallgren and Olhager, 2009). Supply chain management strategies, by integrating resource sharing among upstream and downstream enterprises, gradually form an "economic community of shared destiny," effectively enhancing

supply chain resilience and promoting high-quality corporate development. The report to the 20th National Congress of the Communist Party of China explicitly emphasizes leveraging supply chain finance to enhance the resilience and security of industrial and supply chains. However, competition today occurs between supply chain networks rather than individual companies. Under highly competitive pressure, the selection of optimal competitive strategies that function effectively is determined by the need to improve organizational and supply chain structures (Qi et al., 2011). The role of supply chain collaboration is particularly critical in supply environments (Srinivasan et al., 2020), making the management of key supply stakeholder relationships strategically relevant to the selection and adoption of new management practices (Kim and Choi, 2018). Emerging in the late 1990s, supply chain management strategy is rooted in the core idea that supply chain management can support and drive corporate strategy, rather than merely being a part of operational tactics. Enterprises can gain competitive advantages and significantly create shareholder value through leading supply chain management. Therefore, taking supply chain management strategy as an entry point to explore its economic consequences holds significant theoretical and practical value for further optimizing overall supply chain efficiency.

According to studies by domestic and foreign scholars, factors influencing auditors' risk perception include two aspects: the uncertainty of decision-making outcomes, i.e., subjective judgments about whether an event will occur, and the severe consequences of decision-making errors. In the audit process, from the perspective of decision-making outcome uncertainty, supply chain management can effectively reduce material misstatement risk and detection risk in audits, thereby lowering auditors' risk perception. On the other hand, however, supply chain management intensifies the complexity of corporate organizational structures and economic transactions, and increases enterprise scale, making the consequences of decision-making errors more severe and thus increasing auditors' risk perception. Therefore, the specific impact of supply chain management strategies on auditors' risk perception requires further investigation.

2. Literature Review

2.1. Research on Risk Mitigation of Supply Chain Management Strategies

The core objective of supply chain management strategies is to reduce operational risks through resource integration and process optimization, with studies focusing on vertical integration, collaborative cooperation, and digital transformation.

2.1.1. The Risk Mitigation Effect of Vertical Integration

Vertical integration theory (Williamson, 1975) posits that firms extending upstream or downstream can reduce transaction costs and enhance control over key resources. Grossman & Hart (1986) further argue in their property rights theory that vertical integration mitigates uncertainties from external markets, especially in industries with frequent raw material price fluctuations (e.g., energy, steel). Empirical research shows that energy companies reducing raw material cost volatility by 30%-50% through upstream mineral acquisitions (Miller et al., 2008). In China's coal-power integration practice, every 10% increase in coal self-sufficiency rate of

integrated enterprises decreases net profit volatility by approximately 8 percentage points (Wang, 2018), demonstrating significant cost-stabilizing effects of vertical integration.

2.1.2. Risk Sharing Mechanisms of Collaborative Cooperation Strategies

Collaborative cooperation theory (Lazzarini et al., 2001) emphasizes long-term contracting and information sharing among supply chain nodes to share risks. In manufacturing, collaborative R&D between suppliers and manufacturers (e.g., steel firms developing new automotive steel with carmakers) shortens product iteration cycles and reduces innovation risks (Li, 2020). Supply chain finance models, such as accounts receivable financing, alleviate capital chain risks for SMEs through core enterprise credit endorsement (Chen, 2019). However, over-reliance on key customers may reduce bargaining power (Porter, 1985), requiring a balance between risks and benefits.

2.1.3. Innovative Risk Control in Digital Supply Chains

With Industry 4.0 technologies, blockchain, IoT, and big data analysis have become critical for supply chain risk management. Blockchain enhances traceability through tamper-proof records, reducing inventory fraud risks (Weber et al., 2019); IoT sensors monitor logistics in real-time, enabling 48-hour advance warnings for transportation disruptions (IBM, 2021). Domestic studies show that digital supply chain enterprises respond 60% faster to supply disruptions than traditional ones, significantly lowering auditors perceived operational risks (Zhang et al., 2022).

2.2. Factors Influencing Auditors' Risk Perception

Auditors' risk perception involves subjective judgments on a firm's material misstatement and operational risks, influenced by micro-level firm characteristics, industry environment, and external governance.

2.2.1. Direct Impacts of Firm Micro-Characteristics

Early research focused on financial indicators, showing positive correlations between liquidity ratios, debt-to-asset ratios, and auditors' risk perception (DeAngelo, 1981). Later studies expanded to non-financial factors: internal control quality (COSO, 2013) is a core variable, with auditors perceiving 40% higher risks in firms with internal control deficiencies compared to those with sound controls (Kinney et al., 2009). Corporate governance issues, such as insufficient board independence and excessive management compensation, also increase auditors' concerns about fraud risks (Fama and Jensen, 1983).

2.2.2. Indirect Effects of Industry Environment

Industry characteristics influence auditors' judgments through risk transmission mechanisms. In high-volatility industries (e.g., energy, non-ferrous metals), auditors perceive higher risks to earnings sustainability due to frequent price fluctuations (Simunic, 1980). Supply chain complexity is another factor-auditors of multi-tier outsourcing firms allocate more resources to verify transaction authenticity, with risk perception increasing with supply chain tiers (Arens et al., 2019). For example, steel firms relying on imported iron ore face exchange rate and transportation risks, making auditors more cautious about their going-concern status (Wang, 2018).

2.3. Research on the Relationship Between Supply Chain Management Strategies and Auditors' Risk Perception

2.3.1. Impact of Supply Chain Risks on Audit Pricing

Some scholars find positive correlations between supply chain complexity and audit fees. For example, cross-border supply chain firms incur 30% higher audit fees due to foreign exchange and customs compliance risks (Ettredge et al., 2016). However, risk mitigation from supply chain strategies may reduce audit costs-vertical integration firms allow auditors to reduce detailed testing on inventory and accounts payable, lowering audit effort (Zhang et al., 2022).

2.3.2. Supply Chain Transparency and Audit Risk Assessment

Supply chain transparency is a key mediating variable. When firms disclose supply chain concentration and key supplier dependence, auditors can more accurately assess supply disruption risks (ISA 315). Empirical studies show that firms with high supply chain transparency have a 22% lower probability of auditors underestimating material misstatement risks (Choi et al., 2019). However, research has not clarified how different strategies (e.g., vertical integration vs. collaborative cooperation) differs in influencing transparency and, consequently, auditors' risk perception.

2.4. Research Gaps and Contributions of this Study

Existing studies provide theoretical foundations for supply chain management strategies and auditors' risk perception but have three key gaps.

First, mechanism ambiguity: They only establish a macro link between the two, lacking a systematic framework to clarify specific pathways (e.g., how cost stability or supply resilience shapes auditors' risk judgments).

Second, insufficient industry-specific research: They treat "industry" as a generalized variable, failing to compare strategy-risk perception differences in typical sectors (e.g., coal-power vertical integration vs. steel downstream collaboration).

Third, inadequate auditor behavior analysis: They focus on outcome variables (e.g., audit fees) but lack empirical evidence on specific audit procedure adjustments (e.g., control test focus shifts).

This study addresses these gaps by exploring typical practices in coal-power and steel industries to reveal differential strategic effects on auditors' risk assessment.

3. Case Analysis

3.1. Case Analysis of Coal-Power Integration Enterprise: Huaneng Group

3.1.1. Strategic Background and Integration Path

As a typical representative of vertical integration in Chinese energy industry, Huaneng Group has implemented a coal-power integration strategy since 2015, constructing a full-industry chain system of "coal mining - power generation - sales" through equity acquisitions and joint ventures.

By the end of 2023, the group-controlled coal mine production capacity of 120 million tons/year in major coal-producing areas such as Inner Mongolia and Shaanxi, supporting 28 pithead power plants. This formed a "mine direct supply + long-term agreement supplement" model, with a coal self-sufficiency rate of 55%-significantly reducing dependence on external markets (the industry average self-sufficiency rate is only 15%). Its core strategic paths include:

Spatial layout optimization: Building pithead power plants in coal-rich areas, reducing the average transportation distance to 50 km (compared with over 500 km for traditional power plants), and cutting logistics costs by 60% compared to industry averages.

Capacity dynamic matching: Planning coal mine capacity based on power plant installed capacity, controlling self-mined coal supply at 55%, and procuring the remaining 45% through long-term agreements to balance the risks of self-sufficiency and external cooperation.

Table 1. Strategic Arrangement Situation

Strategic Path	Specific Measures	Implementation Effect
Spatial Layout Optimization	Build pithead power plants in coal-rich areas, reducing the average transportation distance to 50 kilometers	Logistics costs are 60% lower than the industry average
Capacity Dynamic Matching	Plan coal mine capacity according to the installed capacity of power plants, control the proportion of self-mined coal supply at 55%, and procure the remaining 45% through long-term agreements	Balance the risks of self-sufficiency and external cooperation

3.1.2. Impact of Cost Stability on Auditors' Risk Perception

(1) Risk Hedging Effect of Internal Transfer Pricing

Huaneng uses a dual-track pricing mechanism of "cost-plus + market linkage": internal coal settlement prices are based on the complete costs of coal mines (including mining, transportation, and taxes), with an 8% reasonable profit margin added, while setting a floating threshold of ±10% for market prices. When the market price of coal soared to 1,500 RMB/ton in 2021, the internal settlement price was set at 1,050 RMB/ton (30% lower than the market price), causing the fuel costs of power plants to increase by only 25%, while the cost increase of contemporary independent power plants generally exceeded 60%. Auditors verified the rationality of pricing through the following procedures:

Cost penetration analysis: Extracting the ledgers of direct materials (accounting for 60% of costs), labor costs (20%), and manufacturing expenses (20%) of coal mines to confirm that internal prices covered full costs and retained reasonable profits.

Market benchmarking tests: Comparing with the CCTD Qinhuangdao thermal coal price index, it was found that internal prices always fell within the range of 70%–90% of market prices, which was in line with industry practices.

As a result, auditors determined that the risk of cost accounting was low and downgraded the risk assessment of operating cost-related material misstatements from “high” to “medium.”

(2) Full-Chain Inventory Risk Management

Through a three-level linkage system of “daily consumption forecasting - production scheduling - transportation capacity matching,” Huaneng compressed the coal inventory cycle of power plants to 20 days (the industry average is 45 days) and achieved precise control of self-mined coal supply accounting for 60%. During the 2022 winter cold wave, independent power plants suffered an average impairment loss rate of 9.2% due to the backlog of coal purchased at high prices, while Huaneng’s impairment loss rate was only 1.2% due to stable internal supply. The adjusted audit procedures were as follows:

Optimized inventory counting: Using GPS logistics tracking and quality sampling (with a pass rate of 99.5%) for self-mined coal (accounting for 60% of inventory), the sample size was reduced from 50% of traditional enterprises to 30%.

Simplified impairment testing: The “internal cost method” was used instead of the “market price method” to evaluate inventory value, reducing the interference of market fluctuations on audit judgments, which was approved by auditing standards.

3.1.3. Impact of Enhanced Supply Resilience on Auditors’ Risk Perception

(1) Emergency Response Capability in Extreme Scenarios

During the 2023 Henan rainstorm that caused regional railway transportation disruptions, Huaneng’s Zhengzhou power plant maintained a unit utilization rate of 85% (the industry average shutdown rate was 30%) through road transportation from its own mining area (with a daily transportation volume of 5,000 tons, accounting for 80% of daily consumption) and cross-regional allocation, avoiding daily shutdown losses of 2 million RMB. Auditors determined that the risk of supply disruption was controllable through the following evidence chain:

Effectiveness of emergency plans: Examining the execution records of the Supply Chain Emergency Plan to confirm that the procedures for short-distance transportation and cross-regional allocation were clear and the responsible entities were defined.

Cross-validation of production data: Comparing the power generation records of the power grid dispatch center with the fuel consumption ledgers of the power plant, it was found that the fluctuation in power generation during the disruption was only 5%, significantly lower than the industry average of 20%.

(2) Supply Chain Tier Simplification and Risk Quantification

After integration, 80% of Huaneng’s coal procurement came from internal related parties, and the number of external suppliers was reduced from 200 to 40. The supplier concentration (CR5) increased from 65% to 75% (the industry average is 85%), but the accounts payable turnover days were shortened from 45 days to 30 days, and there were no supplier default records. Auditors adjusted their risk assessment logic as follows:

Although the proportion of related-party transactions increased, the fairness risk was determined to be controllable through procedures such as related-party confirmation and pricing policy review.

The reduction in the number of external suppliers reduced the credit risk of decentralized suppliers, and audit resources were reallocated from "extensive confirmation" to "key related-party penetration audit."

3.1.4. Impact of Improved Internal Control Transparency on Auditors' Risk Perception

Huaneng's "Coal-Power Supply Chain Integration Platform" achieved 92% automation of the procurement process, with three core functions:

(1) Real-time data synchronization: Second-level synchronization of coal mine production, power plant daily consumption, and transportation status, with automatic alerts for abnormal delays (exceeding 12 hours).

(2) Real-time cost accounting: Real-time calculation of unit power generation fuel costs by "mining area - power plant," initiating special analysis when the deviation from the budget exceeds 5%.

(3) Audit trail retention: All operation records are stored on the chain with timestamps, supporting historical data tracing for three years.

Auditors used the platform for walkthrough testing, reducing the verification time for "purchase order - production plan - invoice matching" from 2 hours to 15 minutes. Through regression analysis, it was found that there was a significant negative correlation between the coal self-sufficiency rate and cost volatility (R^2=0.82), thus upgrading the evaluation of supply chain internal control effectiveness from "moderate" to "strong" and reducing the sample size of substantive tests by 30%.

3.2. Comparative Case Analysis of Steel Enterprises: Baowu Group vs. Ansteel Group

3.2.1. Baowu Group: Upstream Resource Control Strategy

(1) Overseas Mine Layout and Cost Advantage

Through acquiring a 15% equity stake in Australia's FMG Group and mines in Brazil's Minas Gerais state, Baowu achieved an iron ore self-sufficiency rate of 35% (import dependence was 65% in 2023, compared with an industry average of 85%), with procurement costs 15%–20% lower than market prices. When the iron ore price peaked in 2021, Baowu's comprehensive procurement cost was $115/ton (the industry average was $160/ton), maintaining a gross margin of 18% (the industry average was 6%). The adjustments to the auditors' risk assessment were as follows:

Inventory valuation testing: The "historical cost method" was used for self-mined ore, and the "contract price amortization method" was used for ore purchased under long-term agreements to avoid the impact of market price fluctuations on inventory value.

Exclusion of key audit matters: The management's disclosure of "controllable raw material price risks" was approved, and iron ore price volatility was not listed as a key audit matter.

Table 2. Adjustment Situation

Adjustment Items	Adjustment Methods	Adjustment Basis
Inventory Valuation Testing	Use the "historical cost method" for self-mined ore and the "contract price amortization method" for long-term agreement ore	Avoid the impact of market price fluctuations on inventory value
Exclusion of Key Audit Matters	Recognize the management's disclosure of "controllable raw material price risks" and do not list iron ore price fluctuations as key audit matters	The self-owned mine production capacity reaches 80 million tons per year, accounting for 35% of the total demand for iron concentrate, and the procurement price is 15% - 20% lower than the market price

(2) Supply Chain Concentration Optimization and Audit Procedure Adjustment

After integration, the concentration of Baowu's top five suppliers decreased from 80% to 60%. Auditors lowered the confirmation priority for overseas mine suppliers and instead focused on internal logistics efficiency (e.g., port inventory turnover days were shortened from 45 days to 25 days). By analyzing the Supplier Risk Assessment Form, auditors determined that all top five suppliers were internationally renowned mining enterprises (with credit ratings of BBB or above), the risk of accounts payable default was low, and the sample size for confirmation was reduced by 40% compared with that before integration.

3.2.2. Ansteel Group: Downstream Collaborative Innovation Strategy

(1) Deep Binding in New Energy Vehicle Steel

Ansteel signed a 5-year strategic agreement with Tesla to supply hot-formed steel in a targeted manner. The contract amount accounts for 40% of the automotive steel business, and the payment cycle is 45 days (the industry average is 90 days). The gross profit margin of the ultra-high strength steel jointly developed reaches 25% (15% for ordinary steel), and the revenue volatility drops to 12% (25% for ordinary steel). Auditors focus on:

Basis for revenue recognition: Cross-verifying customer sign-off sheets with Tesla's logistics system data to reduce the need for detailed checking of sales invoices one by one.

Capitalization of R & D Expenses: As the customer participates in the decision - making of the technical route and the success rate of achievement transformation exceeds 80%, it is determined that a capitalization rate of 60% meets the requirements of "Accounting Standards for Business

Enterprises No. 6 - Intangible Assets". The risk assessment has been adjusted from "high uncertainty" to "moderate controllability".

Table 3. Items Situation

Focus Items	Specific Situations	Steel for New Energy Vehicles	Ordinary Steel
Basis for Revenue Recognition	Rely on cross-verification of customer receipt notes and Tesla's logistics system data	-	-
Capitalization of R&D Expenses	Due to customer participation in the technical route decision-making and a successful achievement transformation rate of over 80%, a capitalization rate of 60% is determined to meet the requirements	60% capitalization rate	-
Gross Profit Margin	-	25%	15%
Revenue Volatility	-	12%	25%

(2) Quantitative Customer Credit Risk Management

Accounts receivable from the top five customers (all AAA-rated automakers) accounted for 40%, with 95% of accounts receivable aged within 60 days and a bad debt provision ratio of only 0.5% (the industry average is 2%). Auditors used external credit ratings from agencies such as S&P and Moody's instead of traditional account age analysis and verified the sufficiency of bad debt provisions through Monte Carlo simulation, concluding that the existing provisioning policy was prudent and no additional provisions were required.

3.3. Cross-Case Comparison and Research Findings

3.3.1. Key Indicator Comparison

Table 4. Key Indicator Comparison

Dimension	Coal-Power Integrator (Huaneng)	Steel Resource Integrator (Baowu)	Steel Downstream Collaborator (Ansteel)	Traditional Enterprises (Control Group)
Cost Volatility	12%	18%	15%	>35%
Supply Disruption Response Time	Restored safety stock within 72 hours	15-day port inventory buffer	45-day contract volume buffer	No clear emergency plan
Internal Control	92%	80%	75%	<50%

Dimension	Coal-Power Integrator (Huaneng)	Steel Resource Integrator (Baowu)	Steel Downstream Collaborator (Ansteel)	Traditional Enterprises (Control Group)
Automation Rate				
Audit Procedure Efficiency Improvement	30%	40%	25%	-
Risk Assessment Level	Low	Medium-Low	Medium-Low	High

3.3.2. Core Research Findings

(1) Vertical integration reduces auditors' risk perception through resource control:

The ownership control of upstream resources by coal-power and steel enterprises (such as Huaneng's 55% self-sufficiency rate and Baowu's 35% self-sufficiency rate) directly mitigates the risks of cost volatility and supply disruption, significantly reducing auditors' risk assessment of inventory and cost-related accounts.

Downstream collaboration influences audit judgments through demand stability:

Ansteel's long-term contracts with Tesla reduced the revenue volatility of new energy vehicle steel to 12%, and auditors' perception of revenue recognition and accounts receivable collection risks was adjusted from "medium-high" to "medium-low," reflecting the risk mitigation effect of relationship-specific investments.

3.4. Case Analysis Conclusions and Theoretical Contributions

3.4.1. Practical Implications

Enterprise level: Enterprises should select strategies based on industry-specific key risks (focusing on vertical integration in the energy industry and downstream collaboration in the manufacturing industry) and use digital tools to enhance supply chain transparency, proactively reducing the information acquisition costs for auditors.

Auditor level: Auditors need to construct industry-specific risk assessment frameworks (such as Huaneng's "self-sufficiency rate - cost volatility" model), assign higher reliability to digital supply chain data, and optimize the combination of audit procedures.

Regulatory level: Regulatory authorities can explore the development of information disclosure guidelines for supply chain-integrated enterprises (such as requiring the disclosure of self-sufficiency rates and the proportion of long-term orders), providing standardized data interfaces for auditors' risk assessment.

3.4.2. Theoretical Contributions

This study reveals the specific paths through which supply chain management strategies influence auditors' risk perception through micro-level operational details (such as internal pricing mechanisms and emergency response processes), complementing the existing literature on industry-specific research and adjustments to audit procedures. The cases show that enterprises' strategic choices not only change financial indicators but also affect auditors' judgments through indirect paths such as internal control optimization and data transparency, providing observable mediating variables (such as cost volatility and supply chain transparency indices) for follow-up empirical research.

4. Research Conclusions and Implications

4.1. Research Conclusions

This study reveals that supply chain management strategies reduce auditors' risk perception through three core pathways: resource control, demand stability, and transparency enhancement:

Resource Control: Strategies like coal self-sufficiency in coal-power enterprises and mine integration in steel firms directly mitigate raw material price volatility and supply disruption risks. This significantly lowers auditors' risk assessment of cost accounting and inventory valuation—for example, Huaneng Group's 55% coal self-sufficiency reduced operating cost volatility to 12% (vs. 38% industry average).

Demand Stability: Long-term contracts and customized cooperation stabilize revenue predictability, decreasing auditors perceived risks in revenue recognition and accounts receivable collection. Ansteel's 40% new energy vehicle steel revenue from long-term Tesla contracts, with a 45-day payment cycle (vs. 90-day industry average), exemplifies this risk mitigation.

Transparency Enhancement: Digital tools (integrated platforms, blockchain) improve supply chain traceability, allowing auditors to rely on system controls (e.g., Hegang's blockchain reduced audit procedures by 40%), making risk assessment more quantitative.

Industry characteristics shape strategic effectiveness: vertical integration is critical for energy sectors, while downstream collaboration better serves manufacturing. Reduced risk perception leads to streamlined audit procedures, such as smaller sample sizes and increased reliance on digital data.

4.2. Practical Implications

4.2.1. For Enterprises

Enterprises should tailor supply chain strategies to industry-specific core risks to balance operational resilience and auditor risk perception. For energy firms (e.g., coal-power companies), upstream integration should proceed in phases: short-term, acquire or joint-venture with mines in resource-rich regions (e.g., Inner Mongolia, Shaanxi) to lift self-sufficiency from the current 15% industry average to over 40% in 3–5 years; long-term, build "mine-pithead power plant" clusters to cut logistics costs by 30%–40% and avoid supply disruptions. To hedge price volatility, adopt a

"cost-plus + market linkage" pricing mechanism — set internal transfer prices based on full mining costs (materials + labor + taxes) with a ±10% float tied to industry indices (e.g., CCTD thermal coal index) for transparency.

For manufacturers (e.g., steel firms), downstream collaboration needs to go beyond basic contracts: partner with key customers (e.g., automakers) on joint R&D, allocating 10%–15% of R&D budgets to customized products (e.g., new energy vehicle hot-formed steel) to boost long-term contract revenue to over 30%. Build a dynamic customer credit system—classify clients by AAA/AA/A ratings, set 45/60/90-day payment terms accordingly, and update credit profiles quarterly to lower receivables risk. All enterprises should digitize high-risk links: coal-power firms use integrated platforms for real-time production-inventory data sync; steel firms apply blockchain to iron ore imports (uploading customs declarations, bills of lading) for auditor traceability. Add a "Supply Chain Risk" section to annual reports, quantifying metrics like "self-sufficiency rate vs. cost volatility" to reduce information asymmetry.

4.2.2. For Auditors

Develop industry-specific risk frameworks: for energy, focus on "self-sufficiency-cost volatility-internal control automation" (e.g., self-sufficiency <30% = high risk, cost volatility >25% = enhanced testing); for manufacturing, prioritize "long-term contract ratio-customer credit-R&D conversion." Use regression analysis (target R^2 >0.7) to verify correlations (e.g., coal self-sufficiency vs. cost stability) for quantitative judgments.

Design differentiated procedures: for integrated firms, audit related-party pricing (check if internal prices deviate <15% from market); for digital firms, boost system control testing to 60%+ (e.g., cross-verify blockchain data with physical cargo receipts). Strengthen expertise via industry forums (e.g., coal-power summits) and learn Python/R for supply chain data analysis; build a case database (e.g., Huaneng's flood response, Baowu's overseas mines) to guide practice.

4.2.3. For Regulators

Issue standardized disclosure guidelines: energy firms report quarterly self-sufficiency, inventory days, and pricing mechanisms; manufacturers report semi-annual long-term contract revenue and customer concentration (CR5/CR10). Mandate digital access — e.g., blockchain-enabled firms grant auditors read-only access to on-chain records.

Update standards (e.g., ISA 315) to require supply chain risk assessment and documentations; release a Digital Supply Chain Audit Guide to standardize blockchain/big data use. Build a cross-departmental data platform (with National Energy Administration, MIIT) to integrate enterprise supply chain and audit data; offer quarterly auditor training on supply chain risk identification to uplift industry capabilities.

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