Article

Analysis of the Impact of Supply Chain Concentration on Cash Holdings

Pengyu Lu [*]

Article

Analysis of the Impact of Supply Chain Concentration on Cash Holdings

Pengyu Lu

National Demonstration Center for Experimental Engineering Training Education, Nanchang Hangkong University, Nanchang 330063, China; 71388@nchu.com; Tel.+86-190-79100643

Abstract: Against the backdrop of globalization, supply chain concentration has emerged as a critical factor influencing corporate financial strategies. This study delves into how supply chain concentration, encompassing supplier and customer concentration, affects corporate cash holdings and explores the moderating role of corporate governance. Using data from Chinese A-share listed companies from 2012 to 2023, it employs a fixed-effects ordinary least squares regression model. Interaction terms of board size, the proportion of independent directors, and supply chain concentration are constructed for heterogeneity analysis. The Herfindahl-Hirschman Index is utilized as an instrumental variable to address endogeneity, accompanied by robustness tests. The findings reveal a significant positive correlation between supply chain concentration and cash holdings. Supplier concentration (with a coefficient of 0.0162) and customer concentration (0.0152) both prompt firms to hold higher cash reserves. Corporate governance moderates this relationship: larger boards amplify the effect, while independent directors have no significant influence. This study identifies supply chain concentration as a key liquidity driver, facilitating the integration of supply chain management and corporate finance theories. Practically, it advises enterprises to balance supply chain relationships and governance structures to optimize cash reserves and enhance financial resilience in dynamic markets.

Keywords: supply chain concentration; corporate cash holdings; supplier concentration; customer concentration; corporate governance

1. Introduction

In the era of economic globalization, inter-firm competition has undergone a fundamental transformation, evolving into rivalry between entire supply chain ecosystems. As the operational backbone of modern enterprises, supply chain architecture plays a pivotal role in shaping corporate financial health and strategic governance [1]. Specifically, supply chain concentration—a metric measuring transactional dependency on key suppliers and customers through transaction concentration ratios—has emerged as a critical determinant of financial resource allocation and strategic decision-making. The ongoing refinement of global labor division incentivizes firms to forge long-term partnerships with select collaborators. This strategic move enhances operational efficiency by streamlining resource allocation and fostering collaborative innovation, yet simultaneously heightens supply chain concentration dynamics [2]. Such structural shifts underscore the need for systematic analysis of how concentration affects financial resilience and risk management.

In the context of high-quality economic growth, corporate financial health has become a strategic priority, with cash reserves representing a critical component of financial stewardship [3]. Corporate cash holdings have evolved beyond their traditional role as liquid assets, emerging as a strategic resource that balances operational flexibility and risk management. While prior research has systematically explored cash retention motives [4,5], determinants [6], and value implications [7], these studies overlook two critical dimensions: the dynamic interplay between supply chain concentration and cash policy frameworks, and the role of evolving corporate governance structures

in shaping transactional dependencies with key partners. The contemporary shift toward supply chain-centric competition underscores the need to examine how transactional dependency on key suppliers/customers interacts with cash retention strategies to redefine operational resilience, particularly in light of mounting evidence that governance mechanisms and supply chain structures co-evolve in dynamic markets. This analytical void calls for interdisciplinary approaches integrating institutional economics and strategic finance to bridge the gap between external supply chain dynamics and internal financial decision-making.

This study systematically addresses two pivotal research inquiries through rigorous empirical investigation: First, it interrogates the directional impact and nonlinear boundaries of supply chain concentration on corporate liquidity reserves, specifically testing the dynamic equilibrium between risk buffering effects and operational rigidity effects posited by the dual-edged sword theory. Second, it deciphers the contextual moderating mechanisms of corporate governance architecture in supply chain concentration-cash holding dynamics, with particular emphasis on how governance heterogeneity (manifested through decision-making authority distribution) shapes financial flexibility strategies.

(1) Drawing on resource dependence theory, I hypothesize potential mechanisms linking supply chain concentration to cash holdings. Utilizing data from Chinese A-share listed firms during 2012–2023, all continuous variables are winsorized at the 1% level to mitigate outlier effects. A fixed-effects model is constructed, incorporating control variables such as firm size and solvency, while controlling for year, industry, and firm fixed effects. The fixed-effects OLS regression results demonstrate that heightened supply chain concentration significantly increases corporate cash holdings. Specifically, supplier concentration exhibits a statistically significant positive coefficient of 0.0162, while customer concentration shows a coefficient of 0.0152.

(2) Two variables, board size and the proportion of independent directors, are used to construct their interaction terms with supply chain concentration. Based on the same sample data and model framework as above, on the basis of the original control variables and fixed effects, the interaction terms are added for regression analysis. Regarding the board size, the coefficient of the interaction term is 0.013 and is statistically significant. The conclusion indicates that as the board size increases, the positive impact of supply chain concentration on corporate cash holdings will be enhanced. Regarding the proportion of independent directors, the coefficient of the interaction term is 0.000. The conclusion shows that the impact of supply chain concentration on corporate cash holdings does not significantly differ due to the different proportions of independent directors.

Regarding methodological reliability, I address endogeneity concerns through an instrumental variable approach employing the Herfindahl-Hirschman Index (HHI) of supplier industries in a two-stage least squares (2SLS) framework. The first-stage regression demonstrates a statistically significant positive correlation (1% level) between the instrument and endogenous variables, satisfying validity requirements. The second-stage results confirm that predicted values significantly influence cash holdings with coefficients consistent with baseline regressions, indicating robustness after controlling for endogeneity. Additional robustness checks—including lagged variable regression and alternative variable substitution—further validate the findings: the lagged model retains positive effects of supply chain and supplier concentration on cash holdings at the 10% significance level, while alternative specifications maintain statistically significant positive correlations.

The theoretical contributions and practical implications of this study are twofold. First, it integrates and extends corporate finance and supply chain management theories. Traditional cash holdings literature predominantly focuses on singular external market or supply chain factors, whereas this research introduces supply chain concentration as a novel determinant. Grounded in resource dependence theory, I reveal how upstream and downstream relationships influence corporate cash allocation strategies, thereby expanding the theoretical boundaries of financial decision-making to incorporate supply chain networks. This provides a fresh perspective for understanding cash management decisions and enriches the literature on supply chain concentration

and corporate financial behavior. Second, the study overcomes methodological limitations of prior static panel data analyses by implementing instrumental variable techniques to resolve endogeneity issues and conducting comprehensive robustness tests. These methodological advancements establish an operational paradigm for future supply chain finance research, driving methodological progress in the field.

2. Literature Review and Research Hypotheses

2.1. Literature Review

2.1.1. Theoretical Foundations of Supply Chain Concentration

Supply chain concentration, rooted in resource dependence theory [8], transaction cost economics [9], and stakeholder theory [10], manifests through two distinct facets of enterprise operations: upstream supplier networks and downstream customer relationships. This structural characteristic quantifies organizational reliance on critical partners, with supplier concentration reflecting the aggregation of essential material procurement channels. Calculated by the percentage of total purchases from primary suppliers [11], this metric reveals supply chain vulnerability through procurement channel breadth. Conversely, customer concentration measures sales dependency on major clients, typically expressed as revenue proportion from key accounts [12]. Both dimensions collectively determine supply chain resilience, influencing operational flexibility and strategic decision-making. Supplier concentration impacts production continuity risks, while customer concentration affects revenue stability and market negotiation power. These interdependent metrics require balanced management to optimize resource allocation while mitigating partnership risks, reflecting fundamental trade-offs in modern supply chain design.

The elevation of supply chain concentration confers significant operational advantages, including cost reduction, managerial efficiency enhancement, bargaining power amplification, and facilitation of information sharing and collaborative operations [13]. For instance, cultivating close partnerships with select key suppliers or clients augments information transparency and diminishes transaction costs, thereby fostering value creation. Firms with heightened supply chain concentration optimize production scale through resource consolidation, achieving cost reduction, product quality improvement, and inventory minimization, which collectively enhance capital turnover rates and deliver substantive operational benefits. However, intensified supply chain concentration simultaneously introduces latent risks. The potential loss of major clients or suppliers may precipitate capital chain disruptions, while excessive reliance on limited partners could erode bargaining power and escalate relationship-specific investments [14].

Decentralized supply chain structures reduce operational vulnerabilities while stimulating growth opportunities and financial resilience. By limiting dependence on select partners, firms improve supply chain oversight and minimize information gaps, decreasing disruption risk [15]. Reduced supplier reliance enhances bargaining power, enabling strategic credit term negotiations through alternative sourcing options [16]. This diversification strengthens financial flexibility and market adaptability.

2.1.2. Theoretical Foundations of Corporate Cash Holdings

Corporate liquidity decisions are shaped by three foundational economic theories: the cost-benefit equilibrium framework of Modigliani and Miller [17], Akerlof's [18] information asymmetry principles governing market inefficiencies, and Jensen's [19] agency conflict paradigm addressing principal-agent divergences. The static trade - off theory states that when a firm determines its cash holding level, it will balance the benefits and costs of holding cash. The benefits include savings in financing transaction costs, the gains from avoiding disposing of assets for payments, and the earnings from using liquid assets to finance investments and other business operations. The costs, on the other hand, include the opportunity cost of holding cash, namely the forgone interest income. The static trade - off model accelerates the expansion of the determinants of cash holding levels. Firms

will rapidly adjust their cash holdings to reach the target level. The static trade - off theory is effective in cash - holding decisions [20]. The information asymmetry theory, developed from the pecking order theory, was advanced by Myers and Majluf [3], who proposed that firms prioritize internal financing (retained earnings and cash reserves) over external debt or equity issuance to minimize asymmetric information costs. According to this logic, cash holdings act as a buffer between retained earnings and investment demands. The agency cost theory explains that, under information asymmetry, agents (e.g., managers) may not always act in the best interests of principals (e.g., shareholders), leading to agency costs. Due to the separation of ownership and control, managers may retain excess cash beyond operational needs by leveraging residual control rights, thereby incurring agency costs [21].

During periods of significant market volatility and uncertain industry prospects, firms tend to increase cash reserves [3]. To mitigate uncertainty, firms hold cash preventively to avoid potential liquidity crises [4]. In high supply chain concentration contexts, firms are significantly impacted by operational fluctuations among a limited number of suppliers or customers, making preventive cash holdings a critical buffer against uncertainty. Managerial decisions are constrained by dominant upstream or downstream entities; for example, firms reliant on major client orders may distort cash management strategies to meet stringent delivery schedules and payment terms, thereby influencing cash holding motivations and actual levels.

Compared to non-liquid assets, cash holdings provide greater liquidity flexibility, enabling firms to respond to future investment risks and opportunities, as well as cash flow volatility and uncertainty, thereby ensuring operational stability. Simultaneously, firms with efficient supply chain management capabilities tend to reduce cash holdings when faced with high-quality investment opportunities and favorable financing conditions. When firms encounter high-return investment opportunities, they are inclined to deploy cash, thereby reducing cash holding levels [3]. Firms with advanced supply chain management establish close partnerships with suppliers, leveraging strong supply chain integration capabilities to optimize procurement, inventory, and sales processes. This facilitates rapid capital turnover through mechanisms such as extending accounts payable periods and shortening accounts receivable cycles, ultimately reducing cash holding requirements and dependency [23].

2.1.3. Literature Review

Existing literature, while prolific, exhibits notable limitations. First, methodological homogeneity prevails, with most studies relying predominantly on static panel data models. However, corporate supply chains are inherently dynamic, and cash holding adjustments constitute complex processes. Static methodologies inadequately capture such dynamics, constraining comprehensive analysis of the relationship between supply chain concentration and cash holdings, and impeding precise identification of underlying patterns.

From a transaction cost theory perspective, Porter [24] posits that deep integration with key suppliers reduces costs associated with sourcing alternatives, enhancing capital efficiency and influencing cash holdings. Regarding precautionary motives, La Porta [25] extends agency theory to supply chain contexts, suggesting that reliance on major client orders may incentivize managers to manipulate cash allocations, deviating from optimal cash holding strategies [4] quantifies agency issues in multinational supply chains, corroborating abnormal cash holding behaviors in concentrated networks.

Current research on supply chain-cash holding relationships suffers from methodological and perspectival constraints. Predominant reliance on static panel data models and fragmented analytical perspectives neglects systemic interdependencies, hindering the tracking of supply chain evolution and precise identification of cash holding adjustment mechanisms. This limits managerial understanding of supply chain-financial synergy. Moreover, most studies are confined to specific timeframes or events, lacking longitudinal analysis of supply chain concentration and cash holding

dynamics. The absence of an integrated perspective impedes deeper understanding of the stability and adaptive mechanisms underlying this relationship.

Second limitation lies in the predominant focus on external environmental factors influencing the supply chain concentration-cash holdings relationship, with insufficient attention to the interplay between internal and external moderating factors. Specifically, the role of internal governance mechanisms in shaping this relationship remains underexplored.

From a transaction cost perspective, Zhang [26] examine small and medium-sized enterprises (SMEs) in domestic markets, demonstrating that faster supply chain capital turnover and lower transaction costs align cash holdings with production cycles. This validates how supply chain concentration alters cash holdings through transaction cost mechanisms in localized contexts.

In the realm of precautionary motives, Cao [27] integrate China's tax policy fluctuations, revealing that firms facing major client risks adopt aggressive tax avoidance strategies alongside conventional cash reserves to mitigate risks. Investigating credit tightening under macroeconomic controls, finding that firms reliant on limited suppliers stabilize capital chains by manipulating discretionary accruals, analyzing public emergency shocks, highlighting the necessity of emergency cash reserves for supply chain-concentrated firms.

While these studies collectively underscore the strong linkage between supply chain concentration and cash holdings, driven significantly by precautionary motives, they predominantly adopt singular external perspectives. The neglect of internal governance as a moderating factor represents a critical gap. Specifically, the impact of internal governance mechanisms on cash holding levels remains unexplored. Future research should expand sample scopes to dissect how internal governance dynamics influence supply chain-financial linkages. By incorporating multiple moderating variables, studies can elucidate how internal governance buffers concentration risks, optimizes cash holding decisions, and fosters synergy between supply chain and financial management.

2.2. Research Hypotheses

Corporate cash holdings exhibit fluctuations corresponding to shifts in supplier concentration levels. Heightened supplier concentration imposes dual financial constraints by adversely affecting commercial credit accessibility and equity financing feasibility. Specifically, elevated supplier concentration diminishes commercial creditworthiness and escalates equity financing barriers, collectively exacerbating financial constraints that compel firms to maintain heightened cash reserves for contingency preparedness [28]. Grounded in market competition theory and precautionary motive theory, escalating supplier concentration correlates positively with increased cash holding levels. Paradoxically, while greater supplier concentration ostensibly enhances bargaining power, it simultaneously constrains firms' operational autonomy. For instance, collusion among highly concentrated suppliers may artificially inflate procurement prices and manipulate supply quantities. To mitigate such contingencies and regain operational control, firms strategically amplify cash reserves as a defensive mechanism [26].

Based on preventive and commitment motives, an increase in customer concentration drives firms to hold higher levels of cash. Major customers occupy a critical position in a firm's operations, providing long-term revenue and profits, which support the firm's operational stability. Therefore, firms with major customers tend to hold higher cash reserves to ensure high-quality service, thereby maintaining the long-term stability and sustainability of these key customer relationships [28]. Under highly competitive and uncertain market environments, as customer concentration increases, firms' motivation to hold cash reserves significantly strengthens, leading to a substantial rise in cash holdings. The reason lies in the fact that highly concentrated customer relationships make firms heavily reliant on a small number of major customers. If these key customers face operational difficulties, experience a sharp decline in demand, or switch to competitors, the firm's sales revenue will plummet, and fund collection will be hindered. Simultaneously, in such markets, demand fluctuations are frequent, requiring firms to utilize sufficient cash reserves to swiftly adjust

production, R&D, and marketing strategies to adapt to the volatile market, reduce the risk of operational disruptions, ensure the continuity of the capital chain, and maintain the firm's operational foundation.

Supply chain concentration is jointly composed of supplier concentration and customer concentration. These two metrics effectively reflect a firm's relative position within the supply chain and its dependence on upstream suppliers and downstream customers. Supplier concentration constitutes a crucial component of supply chain concentration, as the concentration of suppliers located in the upstream segment of the supply chain exerts direct influences on supply chain stability and costs. When a firm exhibits high supplier concentration, it becomes heavily reliant on a limited number of suppliers for raw material provision, leading to the convergence of supply chain resources towards these suppliers and thereby elevating the overall concentration of the supply chain. Similarly, customer concentration significantly impacts supply chain concentration. As a downstream component, its concentration level profoundly affects supply chain configuration and operations. An increase in customer concentration compels firms to optimize production, distribution, and other processes to meet the specific demands of a few major customers, resulting in the allocation of supply chain resources being skewed towards these major customers and ultimately increasing supply chain concentration. Compared to firms with dispersed supply chain relationships, those with higher concentration exhibited lower financial leverage ratios and higher cash holding levels. This phenomenon suggests that as supply chain relationship concentration increases, firms face heightened operational uncertainty and business risks. To mitigate potential financial risks and maintain total risk within a controllable range, firms tend to adopt a low-leverage strategy to reduce debt repayment pressure while simultaneously increasing cash reserves to enhance liquidity, thereby preparing for various contingencies arising from supply chain fluctuations. Based on the aforementioned analysis, it is reasonable to posit that the increase in both supplier concentration and customer concentration can drive the elevation of corporate cash holding levels, and consequently, the overall supply chain concentration can promote the enhancement of corporate cash holding levels.

Based on the above analysis, Hypothesis is proposed as follows:

Hypothesis. The increase in supply chain concentration can drive the growth of corporate cash holding levels, and there exists a positive correlation between supply chain concentration and corporate cash holding levels.

3. Materials and Methods

3.1. Sample Selection and Data Sources

Supply chain concentration encompasses both supplier concentration and customer concentration. The metric for customer concentration was introduced in 2007 when the China Securities Regulatory Commission (CSRC) mandated that listed companies disclose aggregated data in their annual reports. In 2013, the requirement was revised to mandate aggregated disclosure while encouraging detailed disclosure of customer lists and specific sales figures. Additionally, in 2012, the industry classification of listed companies was reorganized and revised, standardizing industry classifications and abolishing the 2001 Guidelines for Industry Classification of Listed Companies. Therefore, this study selects data from 2012 to 2023 as the sample. Financial firms and companies under special treatment in the relevant year were excluded. After processing, a total of 22,266 valid samples were obtained. All data were sourced from the China Stock Market & Accounting Research (CSMAR) database. To mitigate the impact of outliers, all continuous variables were winsorized at the 1% and 99% levels.

3.2. Variable Definitions and Model Construction

To examine the relationship between supply chain concentration and cash holding levels, this study refers to Fang Zong and Chen Jiahuan (2019) and constructs the following fixed-effects model:

$$Cash_{i,t} = \beta_0 + \beta_1 Concentration_{i,t} + \sum Controls + \sum Year + \sum Industry + \sum Firm_i + \varepsilon_{i,t}$$

Among them, Cash represents the cash-holding level. I calculated according to the sum of cash and cash equivalents divided by the sum of total assets and cash and cash equivalents. Concentration is the abbreviation for the explanatory variables Supply Chain, Supplier, and Customer. Supply Chain represents supply chain concentration. The sales proportion of customers is used as the measurement indicator. The larger the value, the higher the concentration. Supplier represents supplier concentration, it five suppliers to the company's annual total procurement amount" in the annual report, which reflects the enterprise's degree of dependence on major suppliers. Customer represents customer concentration, using the indicator of "the proportion of the sum of sales to the top five customers to the total sales" to reflect the degree of sales dependence.

Table 1. Variable Definition Table.

Variable Type	Variable Symbol	Variable Meaning	Variable Declaration
Dependent variable	Cash	Cash holding level	(Sum of Cash and Cash Equivalents) / (Total Assets - Sum of Cash and Cash Equivalents)
Independent variable	Supply Chain	Supply chain concentration	Mean of the sum of the procurement and sales proportions of the top five suppliers and customers
	Supplier	Supplier concentration	Proportion of the procurement amount from the top five suppliers in the company's annual total procurement amount
	Customer	Customer concentration	Proportion of the sum of sales amounts to the top five customers in the company's total sales amount
Control variable	Size	Company Size	Natural logarithm of total assets
	Cfo	Net cash flow from operating activities/total assets of the enterprise	Net cash flow from operating activities/total assets of the enterprise
	Age	Company Age	Listing year - current year
	Roa	Profitability	Return on total assets of the company
	TobinQ	Tobin's Q value	(circulating stock market value+number of non circulating shares x net assets per share+book value of liabilities)/total assets
	Top1	Shareholding ratio of the largest shareholder	Number of shares held by the largest shareholder/total number of shares

Lev	Financial Leverage	The company's asset liability ratio
Indep	Proportion of independent directors	The ratio of the number of independent directors to the size of directors
Board	Board Size	The natural logarithm of the number of board members

To more accurately explore the relationship between supply chain concentration and corporate cash-holding levels, Company size (Size), solvency (Cfo), company age (Age), return on total assets (Roa), Tobin's Q ratio (TobinQ), the shareholding ratio of the largest shareholder (Top1), asset - liability ratio (Lev), the proportion of independent directors (Indep), and board size (Board) are selected as control variables. The model also controls for year fixed effects (Year), industry fixed effects (Industry), and company fixed effects (Firm). The specific definitions of the variables in the model are shown in the figure.

4. Empirical Analysis and Result

4.1. Descriptive Statistics

Table 2 presents the descriptive statistical results of the main variables in this article. The average cash holding level is 0.314 with a standard deviation of 0.346, the average supply chain concentration is 32.209 with a standard deviation of 17.028, the average supplier concentration is 34.541 with a standard deviation of 19.792, and the average customer concentration is 32.262 with a standard deviation of 19.792. In the controlled variables, the minimum value of company size is 19.660 and the maximum value is 26.258. The sample companies are generally large in scale. In addition, the debt ratio (Lev) of the sample is 0.42%, the average net profit margin (Roa) of total assets is 0.035%, and the average proportion of independent directors (Indep) is 37.78%.

Table 2. Descriptive Statistics.

Variable	Observation	Mean	Standard Deviation	Minimum	25% Quantile	Median	75% Quantile	Maximum
Cash	35321	0.3140	0.3468	0.0208	0.1124	0.1976	0.3693	2.0789
SupplyChain	34313	32.2091	17.0288	3.9600	19.3900	29.7000	42.4800	83.8600
Supplier	32272	34.5418	19.7928	5.5000	19.5700	30.0000	45.5450	93.6700
Customer	34003	32.2625	22.5997	1.3300	14.7100	26.5000	45.2500	97.6700
Size	35321	22.2993	1.2976	19.6605	21.3750	22.1017	23.0321	26.2581
Cfo	35321	0.0483	0.0681	-0.1688	0.0099	0.0471	0.0875	0.2488
Roa	35321	0.0305	0.0946	-4.9464	0.0114	0.0344	0.0643	0.7858
TobinQ	35321	2.0517	1.3415	0.8312	1.2367	1.6198	2.3330	8.7291
Top1	35321	33.5717	14.7736	8.4100	22.1400	31.1400	43.2700	74.8200
Lev	35321	0.4221	0.2032	0.0579	0.2601	0.4129	0.5717	0.8992
Indep	35321	37.7825	5.3933	33.3300	33.3300	36.3600	42.8600	57.1400
lnBoard	35321	2.2286	0.1745	1.7917	2.0794	2.3025	2.3025	2.7080

4.2. Main Regression Analysis

I employs a fixed-effects OLS regression model to examine the relationship between supply chain concentration (SupplyChain) and cash holdings level (Cash). Figure 3 below presents the regression results between supply chain concentration and cash holdings level. Column 1 represents the regression results between supply chain concentration and cash holdings level. It shows that the regression coefficient of supply chain concentration on cash holdings level is 0.0128, which is significantly positively correlated at the 5% level. This indicates that the higher the supply chain concentration rate, the higher the cash holdings level. In an environment with high supply chain concentration, companies face high transaction costs. Their strong reliance on a few suppliers or customers weakens their bargaining power, and they face stricter delivery and payment requirements, necessitating advance payments. Additionally, to prevent supply disruptions, companies need to reserve cash to cope with unexpected situations and ensure stable access to materials, thereby increasing cash holdings.

Column 2 shows that the regression coefficient of supplier concentration (Supplier) on cash holdings level (Cash) is 0.0162, which is significantly positively correlated at the 5% level. This indicates that the higher the supplier concentration rate, the higher the cash holdings level. High supplier concentration weakens the company's bargaining power, leading to stringent payment requirements such as shortened payment terms and higher prepayment ratios, resulting in more funds flowing out in advance, which drives up cash holdings. Moreover, under high supply chain concentration, companies rely on a few suppliers and face high risks of supply disruptions. To prevent shortages from affecting production and operations, companies need to reserve cash for emergency purchases and resource allocation to ensure stable access to materials, thereby increasing cash holdings.

Column 3 shows that the regression coefficient of customer concentration (Customer) on cash holdings level is 0.0152, which is significantly positively correlated at the 5% level. This indicates that the higher the customer concentration rate, the higher the cash holdings level. In a situation with high customer concentration, companies are in a passive bargaining position, with limited negotiating power in transactions. Customers often demand extended payment terms and trade credit, slowing down the company's cash inflow, which necessitates holding more cash to maintain operations. Additionally, relying on a few major customers for business leads to unstable revenue. If customers experience business fluctuations or reduce orders, the company's income may sharply decline. To cope with income uncertainty and ensure continuous operations, companies can only increase cash reserves to mitigate risks.

Table 3. Main Regression Analysis.

	Column 1	Column 2	Column 3
	Cash	Cash	Cash
lnSupplyChain	0.0128**		
	(2.26)		
lnSupplier		0.0162***	
		(2.73)	
lnCustomer			0.0152**
			(2.20)
Size	0.0022	0.0113	0.0034
	(0.25)	(1.21)	(0.38)
Cfo	0.4400***	0.4472***	0.4390***
	(9.24)	(9.37)	(9.17)

Roa	0.0564*	0.0417	0.0512
	(1.68)	(1.29)	(1.55)
TobinQ	-0.0022	0.0015	-0.0015
	(-0.99)	(0.82)	(-0.69)
Top1	0.0013***	0.0007	0.0013***
	(2.88)	(1.63)	(2.96)
Lev	-0.4574***	-0.4084***	-0.4588***
	(-14.05)	(-14.92)	(-14.60)
Indep	-0.0006	-0.0009	-0.0005
	(-1.00)	(-1.23)	(-0.88)
lnBoard	0.0049	-0.0059	0.0072
	(0.18)	(-0.22)	(0.27)
_Cons	0.3631*	0.1695	0.3189
	(1.86)	(0.81)	(1.59)
Fixed Effect	Controlled	Controlled	Controlled
N	33961	31913	33646
adj.R²	0.66	0.67	0.66

Note: ***, **, and * represent significance levels of 1%, 5%, and 10%, respectively.

4.3. Heterogeneity Analysis

Corporate governance serves as a core mechanism in modern enterprise management, exerting significant influence over financial decision-making and resource allocation. Supply chain concentration, as an important dimension of a firm's external environment, notably affects the level of cash holdings within the organization. The interplay between corporate governance and supply chain concentration ultimately determines how companies adjust their cash holding strategies in response to changes in supply chain concentration, helping them navigate potential financial risks and operational challenges. Independent directors, as crucial components of corporate governance, are primarily tasked with supervising and balancing the management team, protecting the interests of minority shareholders, and enhancing the scientific rationality of corporate decision-making [30]. Additionally, board size represents another significant aspect of corporate governance, reflecting the complexity and diversity of decision-making within the firm. A larger board size implies that more stakeholders are engaged in the decision-making process, thereby increasing the comprehensiveness and rationality of corporate governance decisions [31]. Consequently, I focuses on two variables: the proportion of independent directors and board size. I construct their interaction terms with supply chain concentration to investigate the varying impacts of supply chain concentration on cash holdings across different corporate governance frameworks.

Regarding the proportion of independent directors, I construct the interaction term between supply chain concentration and the proportion of independent directors ($Company_{i,t}*lnSupplyChain_{i,t}$). Independent directors play a crucial role in corporate decision-making by providing supervision and independent professional opinions. A higher proportion of independent directors implies a more robust mechanism for decision-making oversight, effectively curtailing the self-serving behaviors of management. The results indicate that the coefficient for this interaction term is 0.000, suggesting that the influence of supply chain concentration on a firm's cash holdings does not show significant variation based on the differing proportions of independent directors. Although independent directors possess the expertise and supervisory capacity, their impact on cash holding strategies in the context of supply chain concentration-related decisions appears to be limited. Firms tend to be influenced more by other dominant factors when considering

their cash holding levels, thereby reducing the relative importance of independent directors in this decision-making process.

On the other hand, board size reflects both the size and structure of the corporate decision-making team. A larger board size may bring diverse experiences and perspectives, but it can also lead to increased communication and coordination costs, as well as reduced decision-making efficiency. The regression results show that the coefficient for this interaction term is 0.013 and is statistically significant. This indicates that as the size of the board increases, the positive impact of supply chain concentration on a firm's cash holdings also intensifies. In companies with larger boards, there is a tendency to increase cash holdings as supply chain concentration rises. A large board can recognize the importance of holding more cash in the face of risks and opportunities posed by supply chain concentration, benefiting from a wider range of information sources and more comprehensive discussions to navigate potential supply chain risks or seize possible investment opportunities.

Table 4. Analysis of Heterogeneity in the Dimension of Corporate Governance.

Variable	Corporate Governance	
	(1) Board Size $lnBoard_{i,t}$	(2) Proportion of independent directors $Indep$
$Company_{i,t*}$ $lnSupplyChain_{i,t}$	0.013	0.000
$lnSupplyChain_{i,t}$	0.031	0.000
$Company_{i,t}$	0.022	0.002
Controls	YES	YES
Year Fixed	YES	YES
Industry Fixed	YES	YES
Firm Fixed	YES	YES
N	33961	33961
$adj.R^2$	0.654	0.654

Note: ***, **, and * represent significance levels of 1%, 5%, and 10%, respectively.

4.4. Endogeneity Analysis

Due to potential reverse causality and the possibility of omitted important variables, the estimates from Ordinary Least Squares (OLS) may be biased. When examining the impact of supply chain concentration on a company's cash holdings, the issue of endogeneity presents an unavoidable key challenge. I selects the Herfindahl-Hirschman Index (HHI) of the industry in which the company's main suppliers operate as an instrumental variable. The HHI is a critical measure of industry concentration that reflects the market structure of the industry where the company's primary suppliers are located [31]. The concentration of the suppliers' industry is closely linked to the firm's supply chain concentration but does not have a direct causal relationship with the firm's own level of cash holdings; thus, it can effectively serve as an exogenous instrumental variable to resolve this issue.

The results of the first-stage regression indicate that the instrumental variable PurchaseConcentrationHHI positively affects the endogenous explanatory variable lnSupplyChain at a significance level of 1%. This suggests that the higher the concentration in the suppliers' industry (i.e., the greater the HHI index), the higher the level of concentration within the firm's supply chain, thereby validating the existence of a significant positive correlation between the instrumental variable and the endogenous explanatory variable, thereby satisfying the relevance requirement for instrumental variables. This outcome aligns with theoretical expectations, indicating that industry structure substantially influences the concentration level of a firm's supply chain.

The second-stage regression results show that the predicted supply chain concentration still significantly impacts the firm's cash holdings, and the coefficient sign remains consistent with the baseline regression results. This strongly supports the conclusion that after effectively controlling for

the endogeneity issue, the influence of supply chain concentration on the firm's cash holding level remains robust. This implies that changes in supply chain concentration indeed affect the firm's cash holding decisions, and this impact persists even when accounting for various potential confounding factors.

The weak instrument variable test indicates that the value of the Cragg-Donald Wald F statistic is far greater than the critical value at the 10% level of bias. This result strongly suggests that the chosen instrumental variable, PurchaseConcentrationHHI, is not a weak instrument; it can effectively explain variations in the endogenous explanatory variable lnSupplyChain, thereby providing a solid foundation for the validity of the two-stage least squares method.

In summary, conducting a two-stage least squares regression analysis based on instrumental variables alleviates the endogeneity problem between supply chain concentration and the firm's cash holdings. The results indicate that supply chain concentration has a significant impact on the firm's cash holding levels, and this conclusion remains robust and reliable even when considering endogeneity.

Table 5. Endogeneity analysis.

	(1)	(2)
	lnSupplyChain	Cash
PurchaseConcentrationHHI	0.0228***	
	(29.59)	
cfo	0.0188	0.468***
	(0.50)	(13.64)
size	-0.0696***	0.0172
	(-5.72)	(1.89)
ROA	0.108***	0.0273
	(3.98)	(1.25)
lnBoardsize	-0.0604	-0.0214
	(-1.51)	(-0.67)
AssetLiabilityRatio	-0.0372	-0.414***
	(-1.15)	(-12.19)
TobinQ	-0.000828	-0.000622
	(-0.28)	(-0.18)
LargestHolderRate	-0.000491	0.000455
	(-0.75)	(0.96)
IndDirectorRatio	-0.000843	-0.00102
	(-0.81)	(-1.26)
lnSupplyChain		0.0423*
		(2.05)
N	22650	22650

4.5. Robustness analysis

4.5.1. Lagged Variable Regression Analysis

Following established methodologies in prior literature, I conducts robustness checks by regressing lagged-one-period variables. Empirical results demonstrate that the lagged supply chain concentration exhibits a coefficient of 0.000 on cash holdings, statistically significant at the 10% confidence level. This indicates that supply chain concentration maintains a persistent positive impact on cash holdings even when accounting for temporal lags, robustly validating our core findings. Similarly, the correlation coefficient between lagged supplier concentration and cash holdings remains 0.000, significant at the 10% level, further corroborating their positive relationship. These results align consistently with baseline analyses, confirming the model's efficacy in controlling

forward causality and mitigating temporal interference, thereby ensuring the reliability of conclusions.

4.5.2. Replacement of Variable Measurement Methods

Following the practices in existing literature, I replaced the measurement methods of variables . First, the measurement methods of supplier concentration and customer concentration were changed. Referring to the research of Zhou [32] in order to eliminate the errors in regression results caused by differences such as the presence or absence of major customers, the ratio of the sales amount to the largest customer to total sales amount and ratio of the purchase amount from the largest supplier to total purchase amount were used to replace the explanatory variables. The test results show that the ratio of the sales amount to the largest customer to the total sales amount has a significantly positive correlation with the cash holding level ($p = 0.003$), and the ratio of the purchase amount from the largest supplier to the total purchase amount also has a significantly positive correlation with the cash holding level ($p = 0.008$). The regression significance results are shown in the figure.

Table 6. Robustness Analysis.

	Column 1 Cash
SupplyChain	0.0007***
	(3.26)
Cfo	0.4393***
	(9.23)
Size	0.0029
	(0.33)
Age	-0.1026*
	(-1.76)
Roa	0.0611*
	(1.80)
lnBoardsize	0.0038
	(0.15)
TobinQ	-0.0027
	(-1.22)
Indep	-0.0006***
	(-1.00)
Lev	-0.4579***
	(-13.85)
_Cons	0.4166**
	(2.31)
Fixed Effect	Controlled
N	21785
adj.R^2	0.66

4. Discussion and Conclusions

This article delves into the impact of supply chain concentration on a company's cash holding level. Through theoretical analysis and empirical research, it reveals the intrinsic relationship and mechanism between supply chain concentration and a company's cash holding level. The research results indicate that an increase in supply chain concentration significantly increases a company's cash holding level, and this conclusion remains robust and reliable even after considering endogeneity issues. Specifically, the increase in supplier concentration and customer concentration will drive the rise of a company's cash holding level, which is related to the company's preventive motivation and limited bargaining power.

In terms of theoretical expansion, this article integrates the theories of corporate finance and supply chain management, expanding the boundaries of traditional cash holding theory. By introducing the key indicator of supply chain concentration and based on resource dependence theory, this study reveals the impact of upstream and downstream linkages on a company's cash allocation strategy, providing a new perspective for understanding the company's cash holding decisions. The research results of this article enrich the literature on the relationship between supply chain concentration and corporate financial behavior, especially in terms of the impact of supply chain concentration on cash holding levels, providing a more systematic and comprehensive analysis.

In terms of practical research, this article provides decision-making guidance for enterprise managers and clarifies the relationship between supply chain concentration and cash holding level. In the context of economic integration and increasingly complex supply chain environment, enterprises need to pay more attention to the impact of supply chain concentration on cash holding levels, and adjust their cash holding strategies reasonably to cope with potential financial risks and operational challenges. For enterprises with high concentration in the supply chain, this article suggests that they should pay more attention to the stability and risk management of the supply chain, establish diversified supplier and customer relationships, reduce dependence on a few key partners, thereby reducing cash holdings and improving the efficiency of fund utilization. Enterprises with relatively dispersed supply chains can strengthen fund management, integrate upstream and downstream resources, adjust cash holding strategies reasonably, reduce idle capital costs, and enhance overall competitiveness and financial flexibility by optimizing supply chain structure, improving resource allocation efficiency, and other means.

Research limitations and future research directions. Although this study has made some progress in the research of the relationship between supply chain concentration and corporate cash holdings, there are still some issues that need further research. For example, the research sample is mainly based on data from listed companies, and future research can be expanded to non listed companies or different industry segments to enhance the universality of research conclusions; In terms of variable selection and model construction, although multiple factors have been considered, there may still be important variables or more suitable measurement methods that are not covered. Further research can explore and optimize them; In addition, with the dynamic evolution of market environment and enterprise operation mode, long-term tracking research can be carried out to deeply analyze the dynamic changes in the relationship between supply chain concentration and enterprise cash holdings under different economic cycles and industrial transformation backgrounds, continuously providing cutting-edge theoretical support and practical guidance for enterprise financial management and supply chain management practices.

In summary, this article reveals through empirical analysis the significant impact of supply chain concentration on a company's cash holding level, providing important theoretical basis and practical guidance for financial management, and helping companies achieve sustainable development and stable financial operations in complex and changing market environments. Future research can further deepen and expand on this basis to better understand and respond to the challenges and opportunities brought by supply chain concentration.

References

1.   Liu, B.H. *Procurement and Supply Chain Management: A Practitioner's Perspective;* China Machine Press: Beijing, China, 2012; pp.10-14

2. Wei, S.; Deng, C.; Liu, H;, Chen, X. Supply chain concentration and financial performance: The moderating roles of marketing and operational capabilities. *Journal of Enterprise Information Management*, **2024**, 37(4), 1161-1184. https://doi.org/10.1108/JEIM-07-2023-0356

3. Myers, S. C.; Majluf, N. S. Corporate Financing and Investment Decisions when Firms Have Information thatInvestors Do Not Have. Journal of Financial Economics, **1984**, 13, 187-221. https://doi.org/10.1016/0304-405X(84)90023-0

4. Opler, T.; Pinkowitz, L.; Stulz, R.; Williamson, R. The determinants and implications of corporate cash holdings. *Journal of Financial Economics*, **2004**, 52(1), 3-46. https://doi.org/10.1016/S0304-405X(99)00003-0

5. Harford, J.; Mansi, S. A;, Maxwell, W. F. Corporate governance and firm cash holdings in the U.S. *Journal of Financial Economics*, **2008,** 87(3), 535-555.

6. Özkan, A.; Özkan, N. Corporate cash holdings: An empirical investigation of UK companies. *Journal of Banking & Finance*, **2004**, 28(9), 2103-2134. https://doi.org/10.1016/j.jbankfin.2003.08.003

7. Pinkowitz, L.; Stulz, R. M.; Williamson, R. Does the contribution of corporate cash holdings and dividends to firm value depend on governance? A cross - country analysis. **2006**, *The Journal of Finance*, 61(6), 2725 - 2751. https://doi.org/10.1111/j.1540-6261.2006.01003.x

8. Pfeffer, J.; Salancik, G. R. The External Control of Organizations: A Resource Dependence Perspective, 1978, New York, NY, USA.

9. Coase, R. H. The nature of the firm, *Economica,* London, UK, **1937**; Vol. 4, No. 16, pp. 386-405.

10. Parmar, B. L.; Freeman, R. E.; Harrison, J. S.; Wicks, A. C.; Purnell, L.; De Colle, S. Stakeholder Theory: The State of the Art. *The Academy of Management Annals*, **2010**, 4(1), 403 – 445. 10.5465/19416520.2010.495581

11. Lambert, D. M.; Emmelhainz, M. A.; Gardner, J. T.; Stock, J. R. The impact of supply chain concentration on firm risk. *Journal of Business Logistics*, **1999**, 20(1), 1 – 20.

12. Jiang, S.; Yeung, A. C.; L., Han, Z.; Huo, B. The effect of customer and supplier concentrations on firm resilience during the COVID-19 pandemic: Resource dependence and power balancing. *Journal of Operations Management*, **2023**, 69(8), 101236.10.1002/joom.1236

13. Sodhi, M. S.; Tang, C. S. Research opportunities in supply chain transparency. Production and Operations Management, **2019**, 28(12), 2946-2959. 10.1111/poms.13115

14. Ren, L.; Li, C.; Zhang, R.; Yuan, R.; Khaliq, N. Customer Concentration and Information Transparency: Evidence From China. SAGE Open, **2023**, 13(4), 21582440231208615. 10.1177/21582440231208615

15. Sai, H. R.; Uppala, D. S.; Pandi, M. V. Revolutionizing Global IT Supply Chains: A Decentralized Framework for Cost-Effective and Streamlined Operations in Critical Events. *IEEE Conference Publication*, **2024**, 2024 International Conference on Cognitive Robotics and Intelligent Systems (ICC-ROBINS). 10.1109/ICC-ROBINS60238.2024.10534001

16. Stenbacka, R.; & Tombak, M. Make and buy: Balancing bargaining power. *Journal of Economic Behavior & Organization*, **2012**, 81(2), 391-402. 10.1016/j.jebo.2011.12.001

17. Modigliani, F.; Miller, M. H. The Cost of Capital, Corporation Finance and the Theory of Investment. *The American Economic Review*, **1958**, 48, 261-297.

18. Akerlof, G. A. The market for "lemons": Quality uncertainty and the market mechanism. *The Quarterly Journal of Economics*, **1970**, 84(3), 488-500.

19. Jensen, M. C. Agency costs of free cash flow, corporate finance and takeovers. *American Economic Review*, **1986**, 76(2), 323-329.

20. Orlova, S. V.; Rao, R. P. Cash holdings speed of adjustment. *International Review of Economics & Finance*, **2018**, 54, 1-14. 10.1016/j.iref.2017.12.011

21. Jensen, M. C. Agency costs of free cash flow, corporate finance and takeovers. *American Economic Review*, **1986**, 76(2), 323-329.

22. Orlova, S. V.; Rao, R. P. Cash holdings speed of adjustment. *International Review of Economics & Finance*, **2018**, 54, 1 – 14. 10.1016/j.iref.2017.12.011

23. Harford, J.; Mansi, S. A.; Maxwell, W. F. Corporate governance and firm cash holdings in the U.S. *Journal of Financial Economics*, **2008**, 87(3), 535–555. 10.1016/j.jfineco.2007.04.002

24. Porter, M. E.; Millar, V. E. How information gives you competitive advantage. *Harvard Business Review*, **1985**, 63(4), 149 – 160.

25. La Porta, R.; Lopez-de-Silanes, F.; Shleifer, A. Corporate ownership around the world. *Journal of Finance*, **1999**, 54(2), 481-517.

26. Zhang, X.; Zou, M.; Liu, W.; Zhang, Y. F. Does a firm's supplier concentration affect its cash holding? *Economic Modelling*, **2020**, 90, 527–535. 10.1016/j.econmod.2020.01.025

27. Cao, Y.; Feng, Z.; Lu, M.; & Shan, Y. Tax avoidance and firm risk in China: A pitch. *Accounting Research Journal*, **2021**, 34(1), 119–124. 10.1108/ARJ-08-2020-0280

28. Di, L.; Jiang, W.; Mao, J.; Zeng, Y. Managing liquidity along the supply chain: Supplier-base concentration and corporate cash policy. *European Financial Management*, **2024**, 30(4), 2376-2421.

29. Chang, J. M. The role of independent directors in ensuring good corporate governance. *Frontiers in Business, Economics and Management*, **2023**, 12(1), Article 13618. DOI: 10.54097/fbem.v12i1.13618

30. Muchemwa, M. R.; Padia, N.; Callaghan, C. W. Board composition, board size and financial performance of Johannesburg Stock Exchange companies. *South African Journal of Economic and Management Sciences*, **2016**, 19(4), 497-513.

31. United States Department of Justice. Herfindahl-Hirschman Index (HHI), 2024, Antitrust Division. Retrieved from https://www.justice.gov/atr/herfindahl-hirschman-index

32. Zhou, B.; Li, Y.; Huang, S.; Guo, S.; Xue, B. Customer concentration and corporate innovation: Effects of financing constraints and managers' expectation of Chinese listed companies. *Sustainability*, **2019**, 11(10), 2859.