

Internal Control Quality, Supply Chain Concentration and the Risk of Stock Price Collapse: The Empirical Evidence from Shanghai and Shenzhen A-share Listed Companies

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Abstract. Based on the sample of A-share listed companies in Shanghai and Shenzhen from 2008 to 2018, this paper examines the influence of supply chain concentration on the risk of the stock price collapse, and the possible moderating effect of internal control quality on the relationship between supply chain concentration and stock price collapse risk. The results show that the higher the concentration of the supply chain, the higher the risk of stock price collapse. Internal quality control alleviates the promoting effect of supply chain concentration on the risk of stock price collapse. Furthermore, it is found that the positive correlation between the concentration of the supply chain and the risk of the stock price collapse is more significant in enterprises with excessive debt and a high concentration of executive power.

Keywords: Supply chain concentration; Internal control quality; Risk of stock price collapse.

1. Introduction

As an important channel for the input and output of modern enterprises' resources, the supply chain plays a crucial role in promoting the development of the real economy and the structural reform of the supply side. With the promulgation of Guiding Opinions on Actively Promoting Supply Chain Innovation and Application and Notice on Piloting Supply Chain Innovation and Application, the supply chain management system of enterprises has attracted the wide attention of domestic scholars. At present, China's enterprise supply chain has gradually changed from a decentralized relationship between suppliers and customers to a strategic alliance based on specific investments. By keeping a close cooperative relationship with several suppliers and customers, enterprises can reduce transaction costs in purchase and sale activities and give full play to the advantages of supply chain integration [1][2][3]. On the other hand, relying too much on suppliers or customers will make enterprises situated at a disadvantage in negotiations, which will shorten the financing period and reduce the financing scale of commercial credit [4][5][6]. At the same time, in order to avoid increasing the business risks of enterprises due to the loss of suppliers or customers, enterprises reduce research and development (R&D, henceforth) investment out of pandering motivation and promising opportunities, thus inhibiting the innovation of enterprises [7][8][9]. The relationship between customers and suppliers based on specific investment determines that major suppliers and customers have high economic importance, and they can get the required financial information through non-public channels. Based on the principle of cost-effectiveness and the trade-off theory of information disclosure, enterprises will reduce the disclosure of information to the outside world, thus infringing on the rights and interests of other stakeholders [10].

In 2008 and 2012, China's Ministry of Finance, together with China Securities Regulatory Commission, National Audit Office, and China Banking and Insurance Regulatory Commission, promulgated the Basic Standards of Enterprise Internal Control and the Supporting Guidelines of Enterprise Internal Control, which put forward constructive requirements for the internal control system of listed companies.

In recent years, the financial fraud of Kangmei Pharmaceutical and the improper risk management of Shuanghui Group's supply chain have made people re-examine the effectiveness of internal control of the listed companies. At the micro level, internal control is the motivation for the sustainable development of enterprises and the foundation for improving operating efficiency. At the macro level, an effective internal control system is the realistic need to promote the stable development of financial markets. As far as the enterprise itself is concerned, effective internal control can prompt the

management to carry out appropriate resource allocation and cost management strategies, improve the enterprise's defense ability against capital market fluctuations, and significantly reduce the idiosyncratic risks and systemic risks faced by enterprises [11]. From the stakeholder's perspective, reasonable internal control can effectively supervise managers' behavior, prevent managers from obtaining excessive salaries or seeking benefits from third parties in improper ways, and thus reduce agency costs [12]. Scientific internal control can solve the problem of information asymmetry in debt contracts, effectively restrain creditors from facing greater losses when enterprises suffer from financial difficulties, and protect creditors' interests.[13].

The financial anomaly of China's stock price crash in 2015 seriously affected the normal production, operation, and financing activities of the listed companies in China, causing huge losses to investors. The stock price crash is influenced by many potential factors. On the one hand, investors cannot grasp the corporate governance news in time, and only using the existing information may not make a reasonable decision on whether to continue holding or withdrawing the investment, which makes the company's stock price deviate from the real investment value of the enterprise [14]. On the other hand, when the transparency of information disclosure is low, managers tend to reduce the disclosure of unfavorable news, which aggravates the risk of stock price collapse [15]. At the micro level, the stock price crash will have a huge impact on the real economy and investors. At the macro level, a large number of stocks' decline limit will seriously affect the stability of the financial market, which will make the listed companies fall into financial difficulties, and it is difficult to take measures to stop this risk [16]. General Secretary Xi Jinping once asked the stock market to prevent and resolve financial risks, and to lay a solid foundation system and financing function. It can be seen that a safe and stable financial market is a prerequisite for the existence and development of the listed companies in China. At present, China is in a period of economic transformation, and it needs a healthy, stable, and prosperous financial market to create a favorable external environment for the development of the real economy. Therefore, it is necessary to analyze the stability of the financial market from the perspective of stock price collapse risk.

The existing literature mainly analyzes the influencing factors of stock price collapse risk from two perspectives. The first one is at the non-idiosyncratic level, such as institutional environment[17], investor sentiment[18], and behavior of institutional investors[19]. The second is at the company's idiosyncratic level, such as management characteristics[20][21], and corporate governance [22][23]. However, a limited number of papers analyzed the cause of stock price collapse based on the whole supply chain. The internal mechanism of the stock price collapse is mainly reflected in the information asymmetry and agency conflict in modern enterprises. For one thing, stakeholders' external supervision of enterprises can effectively prevent the bursting of the stock market bubble. For another, the close relationship in the supply chain makes it impossible for enterprises to be independent when major customers and suppliers are facing financial difficulties. Excessive supply chain concentration will inevitably increase the business risks of enterprises and lead to the possibility of stock price collapse [24]. From the perspective of the whole supply chain, suppliers and customers are closely related to the input and output of enterprise resources, which may have a certain impact on major decisions such as product pricing and financing strategies of enterprises, and further aggravate or inhibit the possibility of stock price collapse of enterprises. At the same time, internal control can effectively adjust the improper behavior of managers, and prevent and resolve the risk of stock price collapse by improving the transparency of information disclosure [25]. This paper conducts theoretical analysis and empirical research, trying to solve the following questions:

(1) Under the background of the significant increase in vertical integration of modern enterprise supply chain, will it affect the risk of stock price collapse?

(2) As an important internal adjustment mechanism of enterprises, can internal control effectively inhibit the promotion of supply chain concentration to the stock price crash of enterprises?

Based on the above research questions, this paper uses the panel data fixed effect model to test the data of Shanghai and Shenzhen A share of the listed companies from 2008 to 2018. The results show that the higher the concentration of the supply chain, the greater the risk of the stock price collapse,

and the relationship still holds after considering the errors caused by variable measurement methods. The positive impact of supply chain concentration on the risk of the stock price collapse is only significant in enterprises with poor financial situations and a high concentration of executive power. The improvement of internal control can significantly reduce the possibility of the stock price collapse, and simultaneously, high-quality internal control can effectively alleviate the promotion effect of supply chain concentration on the risk of stock price collapse.

2. Literature Review

2.1 Supply Chain Concentration and Related Research

Although the enterprises in the supply chain have a complicated relationship of cooperation and game in the highly competitive capital market, the number of theoretical analysis and empirical research on the influence of supply chain concentration on enterprises is limited at home and abroad. Generally speaking, academia mainly studies the influence of supply chain concentration on enterprises from the aspects of accounting information quality, R&D innovation, cash holding policy, profitability, and financing ability.

Through empirical analysis, Crawford et al. found that keeping close contact with suppliers would reduce the willingness of enterprises to disclose accounting information voluntarily [26]. Gu Xiaolan et al. learned from previous methods to measure earnings transparency and find that the increase in supply chain concentration significantly increased the possibility of inflated earnings, which showed a certain adverse impact on earnings transparency [27]. Economy found that when enterprises rely on a few upstream suppliers for purchasing activities, suppliers tend to provide less commercial credit, and long-term cooperation is beneficial for enterprises to raise funds through suppliers [4]. Yu Bo indicated that the excessive concentration of customers makes the main customers use the bargaining advantage in negotiations to force enterprises to provide them with credit financing [6]. Based on the bargaining power of suppliers in the five forces model, Ma Lijun [5] concluded that a higher concentration of suppliers may limit the scale and duration of commercial credit financing. Zou Meifeng proposed that the ratio of new income to intangible assets at the end of the period should be used as the measure of innovation income. Through data analysis, it was found that the concentration of suppliers would significantly reduce the innovation level of enterprises, which further supported Ren Lili's conclusion [8]. Based on resource dependence theory and supply chain management theory, Guo Tongmei, et al. verified that enterprises would reduce R&D innovation in order to ensure sufficient resource supply and supply chain flexibility [9]. Itzkowitz found that enterprises hold a lot of cash to offset the operational risks caused by establishing strategic relationships with major customers [28]. Jiang Yihan found that corporate cash manipulation was directly affected by the concentration of the supply chain [29]. Patatoukas creatively formulated the measurement standard of customer concentration. By analyzing the enterprises in the supply chain, it was found that there was a positive correlation between customer concentration and the return on assets of enterprises [1]. Cheng Mingyong showed that when an enterprise relies too much on major suppliers, it will significantly reduce its profitability [30].

2.2 Internal Control Quality and Related Research

Since SOX Act was promulgated in the United States in 2002, internal control has become an important mechanism for the internal integration of enterprises. The research on internal control abroad mainly focuses on the financial or non-financial consequences caused by internal control defects. For example, Bauer, AM found that the duration of the supply chain decreased with the decline of internal quality, indicating that suppliers and customers tend to cooperate with companies with higher internal control quality [31].

Compared with foreign countries, domestic scholars pay more attention to the current situation and influencing factors of internal control quality [32], including board heterogeneity [33], executive characteristics [34], equity incentive [35][36], and so on. In addition, some evidence about external

constraints is provided, including market characteristics [37][38], and media supervision [39]. There is much literature on corporate governance, and Guo Jun et al. have demonstrated that the supervisory role of independent directors can effectively improve the internal control quality of enterprises [33]. Shen Lie found that the ability of senior management improved the quality of internal control by ameliorating the internal control environment of the company [34]. Zhang Ping found that the implementation of incentive plans in enterprises can promote the improvement of internal control quality to a certain extent [35]. An in-depth analysis by Yu Yaping found that external environments such as the market and industry could significantly affect the relationship between employee motivation and internal control [36]. Meanwhile, financial marketization enables all parties to pursue the lowest transaction cost and urges enterprises to strengthen internal control construction [37]. Yang Jing demonstrated that enterprises with fierce competition in the product market have stricter standards for identifying internal control defects, thus improving the quality of internal control [38]. Lu Dong et al. analyzed the influence of different kinds of media supervision on the internal control of the listed companies, and expanded the research direction on the internal control of companies [40]. Both Xu Yu and Chen Zhijun found that media attention can enhance the effectiveness of internal control of enterprises to a certain extent [41][39].

2.3 The Risk of Stock Price Collapse and Related Research

In 2020, the COVID-19 pandemic situation continued to lead to the collapse of U.S. stocks, resulting in a four-week meltdown. In order to effectively avoid the huge losses caused by the stock price collapse to the capital market and the listed companies, the academic research in this field is abundant, but most of the research focuses on the overall level of the market, and the research on the listed companies is scarce [23].

Based on information asymmetry and principal-agent theory, the reasons for the risk of stock price collapse are discussed through internal factors such as management characteristics, corporate governance, and external factors such as investor sentiment, institutional environment, and institutional investor behavior. Yang Mianzhi found that corporate governance could significantly reduce agency costs and play a negative role in regulating the relationship between earnings persistence and the risk of stock price collapse [22]. It is found that the higher the cash flow right of Su Kun's ultimate shareholder, the lower the degree of separation between the two rights, and the lower the possibility of the stock price crash [23]. Zou Yan found that managers' power increased the market risk of enterprises [20]. Ding Yi found that overconfident executives are more likely to hoard adverse news for enterprises, and this conclusion is more obvious in enterprises with a poor financial situation such as excessive debt [21], which supports Mamun et al.[42]. The analysis of external factors in China mainly focuses on institutional investors. Xu Nianxing found that institutional investors can influence the overall decision-making of the company through consultation and cooperation, cover up the information content of the stock price, and aggravate the risk of stock price collapse [43]. From the perspective of competition, Kong Dongmin found that information competition among institutional investors is also an important cause of stock price collapse [19].

When studying the risk of the stock price collapse, the perspective of the research abroad is more flexible. For example, Callen subdivided institutional investors and found that only institutional shares of public pension funds are negatively correlated with the future stock price collapse of enterprises [44]. Mamunm examined whether the risk of stock price collapse will be affected by management power from the perspective of option incentive, and enriches the research in related fields [42]. In addition, foreign literature has also studied personal cultural values, legal environment, and other fields. Based on the cultural dimension of individualism, Dand found that the risk of the stock price collapse is more significant in the context of individualization [45]. Starting from the cultural norm of marriage, Kim found that the risk of the stock price collapse in companies managed by married CEO was lower [46]. Defond found that using IFRS for information disclosure can increase the transparency of financial reports and reduce the risk of stock price collapse in non-financial enterprises [47]. Bauer indicated that compared with tax evasion and accrued profit

manipulation, regulatory channels have a more significant impact on the risk of stock price collapse [31].

2.4 Research on the Relationship between Supply Chain Concentration and the Risk of Stock Price Collapse

China is in a period of economic transformation, and there is still a large gap between the developed degree of capital market and that of western countries, so research on the relationship between them is still scarce.

Chu Jian found that the supply chain can realize the optimal allocation of enterprise resources, improve the company's operating efficiency, and alleviate the possibility of stock price collapse [48]. Yu Bo found that there is an inverted U-shaped relationship between customer concentration and the risk of stock price collapse. When the customer concentration exceeds the critical point, the high customer concentration will have an encroachment effect. Major customers use the bargaining advantage in negotiations to force enterprises to provide commercial credit, crowding out the profitability of enterprises, and promoting the possibility of stock price collapse [6].

Based on the analysis of the listed companies in the United States, Ma found that the promotion effect of customer concentration on the risk of stock price collapse was more significant in the enterprises with high proprietary investment, poor information environment, and low customer switching cost [49].

Generally speaking, the research content related to the risk of the stock price collapse is too fragmented, and there are many controversies about the specific role of a specific influencing factor in the risk of stock price collapse. The research on the risk of the stock price collapse in foreign countries started earlier than that in China and covered more diverse contents. When examining the supply chain concentration and the risk of the stock price collapse in China, we only pay attention to the direct relationship between them, and especially lack relevant theoretical support and research on the regulatory mechanism. At present, there is a lack of research on the concentration of suppliers. Suppliers provide raw materials necessary for the production and operation of enterprises, which play an important source role in the upstream of the supply chain, and have a certain influence on the strategic choice of enterprises. However, there is no literature on the influencing factors of stock price collapse risk based on the overall perspective of the supply chain through the dual roles of suppliers and customers. The enterprises in the supply chain consolidate the strategic alliance relationship through special investment. Once the core suppliers or major customers get into financial difficulties, the enterprises will face huge losses. Good internal control can alleviate the information asymmetry and adverse selection, and reduce the risks brought by a high concentration of the supply chain. However, the existing literature has not yet investigated the moderating effect of internal control quality on supply chain concentration and stock price collapse risk.

Therefore, the marginal contributions of this paper are as follows:

This paper reveals the driving factors of the risk of stock price collapse from the perspective of the interaction between supply chain concentration and internal control quality for the first time and makes up for the deficiency of previous related literature.

It enriches the economic consequences of supply chain concentration and has certain practical guiding significance for enterprise supply chain management.

It opens the black box of the role of internal control and explains its bridge role between the concentration of the supply chain and the risk of stock price collapse. It also expands the impact of internal control and its research margin and provides an innovative economic basis for enterprises to strengthen risk management.

3. Hypothesis Test

3.1 Supply Chain Concentration and the Risk of Stock Price Collapse

A high concentration of supply chain will bring business risks to enterprises to a great extent [50]. First of all, based on the theory of rational economic man, when suppliers or customers find themselves in a dominant position in trading activities, they will use this advantage to grab the profits of enterprises, which will make the business performance of enterprises decline [51]. Secondly, according to the five forces model, when an enterprise relies on a few suppliers and customers, its bargaining and negotiating power in transactions will be significantly improved, which will affect the company's business decisions. Major suppliers and customers can force the enterprise to provide commercial credit, thus worsening the financing constraint level of the enterprise [6].

Thirdly, there is a non-zero-sum game relationship among enterprises in the supply chain. The higher the concentration of the supply chain, the more initiative the main suppliers and customers can take in the transaction process. And they can get information about the business operation through non-public channels. Out of the trade-off theory between cost-benefit and information disclosure, public information disclosure will be reduced [26]. Finally, according to the resource dependence theory, any enterprise needs external resources to meet its own survival needs. The higher the concentration of the supply chain, the more the enterprise depends on this special resource or special investment, which increases the business risk of the enterprise [30]. Therefore, the high concentration of the supply chain will worsen the business performance and financing constraint level of enterprises. In order to prevent credit constraints and reduce friction with stakeholders, enterprises are more inclined to hoard the unfavorable news generated in the operation, which makes the risk of stock price collapse surge. Accordingly, hypothesis 1 is put forward:

Hypothesis 1: Controlling other conditions, the higher the concentration of the supply chain, the greater the risk of stock price collapse.

3.2 Supply Chain Concentration and the Risk of Stock Price Collapse

The Internal Control Integration Framework issued by COSO Committee shows that control activities are the important link of enterprise internal control, and supply chain risk management, as an indispensable part of control activities, plays an important role in enterprise management. The requirement of supply chain risk management is to moderately reduce the vertical integration degree of enterprises and ensure the stability and flexibility of the whole industrial chain. However, nowadays, most of the customer-supplier relationships in the capital market form a lock-in effect through specific investment, so rashly reducing the concentration of the supply chain may increase the transaction costs and switching costs of enterprises [50].

Therefore, enterprises need to carry out external integration and internal adjustment of the supply chain through internal control, so as to replace the cost-reduction benefits brought by the concentration of the supply chain. Reasonable internal adjustment can transform the advantages of external integration into the profit effect of the enterprise itself and improve the business performance of the enterprise [51]. In addition, internal control can prevent management from profiting for themselves and third parties out of opportunism, and reduce agency costs [12]. Furthermore, according to the management's cover-up hypothesis, internal control can restrain managers' behavior in three-time dimensions: before, during, and after the event, reducing the motivation of executives to hide negative news, and improving the quality of information disclosure [25]. To sum up, high-quality internal control can alleviate the negative impact of supplier concentration by reducing risks, and improve the quality of information disclosure, and reducing agency costs. Accordingly, hypothesis 2 is put forward:

Hypothesis 2: Controlling other conditions, the improvement of internal control quality can effectively alleviate the positive effect of supply chain concentration on the risk of stock price collapse.

4. Research Design

4.1 Sample Selection and Data Source

This paper selects the listed companies in Shanghai and Shenzhen A shares from 2008 to 2018 as the initial research sample and excludes the following companies: (1) financial and insurance companies and real estate companies; (2) ST and ST* companies; (3) insolvent companies; (4) companies with less than 30 weeks of stock trading; (5) companies missing data of key variables. Finally, 19,619 observations were obtained.

The internal control index comes from Shenzhen DIB's internal control and risk management database, and other data come from CSMAR database. In order to reduce the influence of extreme values, all continuous variables in the research process are treated by Winsorize with a 1%-99% percentile.

4.2 Definition and Measurement of Variables

4.2.1 Measurement of Supply Chain Concentration (SCC)

This study is based on the existing measurement methods of supplier concentration and customer concentration [10]. In this paper, based on the customer concentration calculated by the sum of the top five customers' sales to total sales and the supplier concentration calculated by the sum of the top five suppliers' purchases to total purchases, the index of supply chain concentration is constructed, and the definition of supply chain concentration (SCC) is the average of the sum of the top five suppliers' and customers' purchases to sales, namely

$$SCC = (Customer + Supplier) / 2 \quad (1)$$

SCC is a comprehensive index, which can reasonably reflect the vertical concentration degree of an enterprise's supply chain. The larger the index, the higher the concentration of the supply chain.

4.2.2 Measurement of Stock Price Collapse Risk (NCSKEW, DUVOL)

According to the existing literature [46], in this paper, two indicators, NCSKEW and DUVOL are constructed to measure the risk of stock price collapse. The specific calculation process is as follows:

First of all, according to model (1), the weekly return rate of each year is regressed:

$$r_{i,t} = \alpha + \beta_{1,t} r_{t-2} + \beta_{2,t} r_{t-1} + \beta_{3,t} r_{m,t} + \beta_{4,t} r_{m,t+1} + \beta_{5,t} r_{m,t+2} + \varepsilon_{i,t} \quad (2)$$

Among them, $r_{i,t}$ represents the return of stock i in the t week of each year, and $r_{m,t}$ represents the average return rate of the capital market weighted by the circulating market value in the t week. Model (1) adjusts the influence of asynchronous stock trading by introducing the leading term and the lagging term. The market-adjusted return rate of stock i in week t is $W_{i,t}$, where $\varepsilon_{i,t}$ represents the part of the model (1) where the market volatility cannot explain the return rate of a stock.

$$W_{i,t} = \ln(1 + \varepsilon_{i,t}) \quad (3)$$

Secondly, we construct the following two indexes to measure the risk of stock price collapse. The first index is the NCSKEW of the weekly yield of stock i after market adjustment, where n is the number of trading weeks of stock i in the t year. The calculation process is as follows:

$$NCSKEW_{i,t} = -[n(n-1)^{3/2} \sum W_{i,t}^3] / [(n-1)(n-2)(\sum W_{i,t}^2)^{3/2}] \quad (4)$$

The second indicator is the difference in volatility between rising and falling stock prices (DUVOL). According to whether the weekly return rate ($W_{i,t}$) of stock i after market adjustment is greater than the average annual return, the stock return data is divided into two sub-samples of rising stage and falling stage, and the standard deviation (R_u , R_d) of stock return in the two sub-samples is calculated, respectively. $DUVOL_{i,t}$ is calculated by using the model, where n_u and n_d are the number of rising and falling weeks, respectively.

$$DUVOL_{i,t} = \ln\left\{ \frac{[(n_u - 1) \sum_{down} R_d^2]}{[(n_d - 1) \sum_{up} R_u^2]} \right\} \quad (5)$$

The larger the numerical value of NCSKEW, the more serious the skewness coefficient is, and the greater the risk of collapse. The larger the value of DUVOL, the more the yield distribution tends to the left, and the greater the risk of collapse.

4.2.3 Internal Control Quality (ICQ)

Using the practice of Cao Yue et al. (2018), the internal control index is divided by 100.

4.2.4 Control Variable

In order to better investigate the relationship between supply chain concentration and stock price collapse risk, relevant control variables are introduced (see Table 1). At the same time, the dummy variables of Year and Industry are added to control the annual effect and industry effect, and the standard error is adjusted by Cluster at the industry level.

Table 1. The Definitions of the Variables and Calculation Method

Variable name	Symbol	Definition of variable
Negative income skewness coefficient	<i>NCSKEW</i>	Negative deviation degree of weekly stock return rate of a company
Income fluctuation ratio	<i>DUVOL</i>	The fluctuation ratio of the company's weekly stock yield
Concentration ratio of supply chain	<i>SCC</i>	(supplier concentration + customer concentration) / 2
Internal control quality	<i>ICQ</i>	Internal control index /100
Average weekly market yield	<i>RET</i>	Average weekly stock market return rate of the company
Standard deviation of weekly market return rate	<i>SIGMA</i>	Standard deviation of weekly stock market return rate
Asset-liability ratio	<i>LEV</i>	Total liabilities/total assets
Return on assets	<i>ROA</i>	Net profit/total assets
Board size	<i>BOARD</i>	Ln (number of board members)
CEO holds both positions	<i>BOTH</i>	If the CEO is also the chairman of the board, it will be recorded as 1, otherwise it will be recorded as 0.
Executive Shareholding ratio	<i>SR</i>	Number of shares held by executives/total number of common shares issued.
Nature of the property right	<i>STATE</i>	If it is a state-owned enterprise, it is recorded as 1, otherwise it is recorded as 0.
Industry	<i>Industry</i>	The industry classification of CSRC, 2012 edition, is used to control the fixed effect of the industry.
Year	<i>Year</i>	Control year fixed effect

4.3 Model Design

4.3.1 Supply Chain Concentration and the Risk of Stock Price Collapse

$$NCSKEW, DUVOL = \gamma_0 + \gamma_1 SCC + \gamma_2 RET + \gamma_3 SIGMA + \gamma_4 LEV + \gamma_5 ROA + \gamma_6 BOARD + \gamma_7 BOTH + \gamma_8 SR + \gamma_9 STATE + \sum Year + \sum Industry + \varepsilon_2 \quad (6)$$

4.3.2 Internal Quality Control, Supply Chain Concentration, and the Risk of Stock Price

$$NCSKEW, DUVOL = \lambda_0 + \lambda_1 SCC + \lambda_2 ICQ + \lambda_3 SCC_ICQ + \lambda_4 RET + \lambda_5 SIGMA + \lambda_6 LEV + \lambda_7 ROA + \lambda_8 BOARD + \lambda_9 BOTH + \lambda_{10} SR + \lambda_{11} STATE + \sum Year + \sum Industry + \varepsilon_3 \quad (7)$$

In this paper, the main explanatory variables (SCC) and regulatory variables (ICQ) are standardized, so as to suppress the influence of multicollinearity on regression results.

5. Empirical Analysis

5.1 Descriptive Statistical Analysis

It can be seen from Table 2 that the mean values of NSCKEW and DUVOL are -0.245 and -0.158, respectively, and the standard deviations are 0.696 and 0.477, which are close to the results of the existing literature [43][52].

Overall, the concentration of the supply chain of Chinese enterprises is on the right side. The minimum value of SCC is 0.03, the maximum value is 0.764, and the standard deviation is 0.171, which indicates that the vertical integration degree of the enterprise supply chain is quite different among the samples.

The average value of internal control quality is 6.495, the maximum value is 8.619, and the minimum value is 0, which shows that there are significant differences in internal control quality of non-financial listed companies in Shanghai and Shenzhen.

Table 2. Descriptive Statistics

VarName	Obs	Mean	SD	Min	Median	Max
<i>NCSKEW</i>	19619	-0.245	0.696	-2.707	-0.209	2.139
<i>DUVOL</i>	19619	-0.158	0.477	-1.588	-0.159	1.272
<i>SCC</i>	19619	0.282	0.171	0.030	0.255	0.764
<i>ICQ</i>	19619	6.495	1.264	0.000	6.729	8.619
<i>RET</i>	19619	0.002	0.011	-0.018	0.000	0.031
<i>SIGMA</i>	19619	0.065	0.024	0.029	0.060	0.139
<i>LEV</i>	19619	0.424	0.203	0.060	0.417	0.860
<i>ROA</i>	19619	0.039	0.053	-0.153	0.036	0.176
<i>BOARD</i>	19619	2.145	0.196	1.609	2.197	2.639
<i>BOTH</i>	19619	0.256	0.437	0.000	0.000	1.000
<i>SR</i>	19619	0.127	0.198	0.000	0.001	0.670
<i>STATE</i>	19619	0.399	0.490	0.000	0.000	1.000

5.2 Correlation Analysis

Table 3 shows the results of the correlation analysis. Generally speaking, there is a significant correlation between the control variables and the risk of stock price collapse (NCSKEW, DUVOL) at the level of 10%, indicating that the selection of control variables in this paper is representative. In addition, the correlation coefficient between most variables is less than 0.5, which indicates that there is no serious multicollinearity problem among variables. There is a positive correlation between SCC skewness coefficient and the fluctuation ratio of earnings, but it is not significant. Considering that correlation analysis does not control the influence of other variables on the explained variables, the result of regression analysis shall prevail.

Table 3. Correlation Coefficient Matrix

	<i>NCSKEW</i>	<i>DUVOL</i>	<i>SCC</i>	<i>ICQ</i>	<i>RET</i>	<i>SIGMA</i>	<i>LEV</i>	<i>ROA</i>	<i>BOARD</i>	<i>BOTH</i>	<i>SR</i>	<i>STATE</i>
<i>NCSKEW</i>	1											
<i>DUVOL</i>	0.880***	1										
<i>SCC</i>	0.001	0.009	1									
<i>ICQ</i>	-0.023***	-0.028***	-0.145***	1								
<i>RET</i>	-0.170***	-0.181***	-0.035***	0.056***	1							
<i>SIGMA</i>	-0.109***	-0.107***	0.081***	-0.081***	0.379***	1						
<i>LEV</i>	-0.074***	-0.087***	-0.104***	-0.085***	-0.013*	-0.027***	1					
<i>ROA</i>	0.038***	0.032***	-0.083***	0.414***	0.098***	-0.106***	-0.386***	1				
<i>BOARD</i>	-0.037***	-0.044***	-0.090***	0.061***	-0.024***	-0.092***	0.168***	0.007	1			
<i>BOTH</i>	0.045***	0.052***	0.053***	-0.012*	0.01	0.053***	-0.146***	0.044***	-0.188***	1		
<i>SR</i>	0.086***	0.100***	0.059***	0.030***	0.025***	0.103***	-0.328***	0.156***	-0.208***	0.253***	1	
<i>STATE</i>	-0.096***	-0.104***	-0.079***	0.033***	-0.028***	-0.094***	0.314***	-0.119***	0.286***	-0.298***	-0.502***	1

Note: The lower triangle is Pearson correlation coefficient, and ***, **, and * are at 1%, 5%, and 10% significance levels, respectively.

5.3 Regression Analysis

5.3.1 Supply Chain Concentration and the Risk of Stock Price Collapse

Table 4 reports the test results of model (6). The test results of columns (1)-(4) show that supply chain concentration (SCC) is positively correlated with the risk of stock price collapse before and after the introduction of other control variables. This shows that the highly concentrated supply chain will produce an embezzlement effect, which will reduce the profitability of enterprises. According to the resource dependence theory, in order to prevent suppliers and major customers from withdrawing their exclusive investment, the management will hoard the unfavorable news of enterprises by the position of power, which may lead to the possibility of a stock price crash. Hypothesis 1 is verified.

Table 4. Supply Chain Concentration and Risk of Stock Price Collapse

	(1)	(2)	(3)	(4)
VARIABLES	<i>NCSKEW</i>	<i>NCSKEW</i>	<i>DUVOL</i>	<i>DUVOL</i>
<i>SCC</i>	0.111*** (2.93)	0.072** (2.30)	0.079*** (4.21)	0.048*** (3.58)
<i>RET</i>	-12.812*** (-30.00)	-13.020*** (-37.16)	-10.732*** (-32.61)	-10.830*** (-37.21)
<i>SIGMA</i>	-6.175*** (-22.41)	-6.995*** (-23.08)	-3.012*** (-14.52)	-3.614*** (-17.95)
<i>LEV</i>		-0.114*** (-3.14)		-0.104*** (-3.89)
<i>ROA</i>		0.130 (1.63)		0.065 (1.16)
<i>BOARD</i>		-0.072*** (-3.83)		-0.051*** (-4.97)
<i>BOTH</i>		0.024*** (3.53)		0.020*** (3.18)
<i>SR</i>		0.212*** (7.79)		0.160*** (10.86)
<i>STATE</i>		-0.095*** (-9.35)		-0.061*** (-8.63)
Constant	0.147*** (7.35)	0.414*** (7.85)	0.034** (2.70)	0.231*** (7.88)
Year & Industry fixed	YES	YES	YES	YES
Cluster at Industries	YES	YES	YES	YES
Observations	19, 619	19, 619	19, 619	19, 619
Adj_R ²	0.091	0.107	0.090	0.108
F value	423.84	630.17	358.38	900.08

Robust t-statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

5.3.2 Internal Quality Control, Supply Chain Concentration, and the Risk of Stock Price Collapse

Table 5 reports the regression results of model (7). Before the introduction of other control variables, NCSKEW's interaction items (ICQ_SCC) with supply chain concentration (SCC) and internal control (ICQ) were significantly negatively correlated at the level of 5%, and DUVOL's interaction items were significantly negatively correlated at the level of 10%. After controlling other factors that affect the stock price collapse, the cross-product of supply chain concentration and internal control is negatively correlated with the risk of stock price collapse at 1%, that is, the quality of internal control will significantly weaken the positive relationship between supply chain concentration and the risk of stock price collapse. This is because the efficiency goal of internal control can encourage enterprise management to allocate resources reasonably, improve the profitability and liquidity of enterprises, meet the needs of investors and reduce the principal-agent problem. At the same time, the compliance goal requires managers to report the assets and operating results of enterprises according to the current system and standards, so as to avoid information asymmetry caused by management's manipulation of accrued profits and increase the risk of stock price collapse. Thus, by establishing an effective internal control system, the enterprise can achieve good internal integration and restraint, so as to reduce the possibility of executives hiding negative

news about the enterprise out of speculative motives or catering motives, that is, the effective operation of internal control has alleviated the information asymmetry and principal-agent problem to some extent, and weakened the positive effect of supply chain concentration on the future stock price collapse of the enterprise. Hypothesis 2 is verified.

Table 5. Quality of Internal Control, Concentration of Supply Chain, and Risk of Stock Price Collapse

VARIABLES	(1) <i>NCSKEW</i>	(2) <i>NCSKEW</i>	(3) <i>DUVOL</i>	(4) <i>DUVOL</i>
<i>SCC</i>	0.110** (2.85)	0.071** (2.28)	0.077*** (4.37)	0.047*** (3.61)
<i>ICQ</i>	-0.013*** (-3.47)	-0.024*** (-4.78)	-0.008*** (-4.02)	-0.016*** (-5.28)
<i>ICQ SCC</i>	-0.017** (-2.36)	-0.023*** (-3.54)	-0.009* (-2.08)	-0.014*** (-3.43)
<i>ConVars</i>		YES		YES
Constant	0.236*** (7.32)	0.555*** (10.91)	0.091*** (4.53)	0.326*** (9.17)
Year & Industry fixed	YES	YES	YES	YES
Cluster at Industries	YES	YES	YES	YES
Observations	19, 619	19, 619	19, 619	19, 619
Adj_R²	0.091	0.109	0.090	0.110
F value	255.99	688.85	249.15	832.35

Robust t-statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1

5.4 Further Analysis

Modern academia mainly holds that the principal-agent problem under the background of asymmetric information and the risk situation of enterprises are the important reasons for the future stock price collapse of enterprises (Zeng, et al., 2020). The information asymmetry and principal-agent problems faced by enterprises with different financial statuses and management power are quite different. This determines that there are significant differences in the possibility of future stock price collapse among enterprises with different debt ratios and power concentrations. Therefore, this paper further examines the influence of supply chain concentration on the stock price collapse in groups of debt level and power concentration, and the moderating effect of internal control on supply chain concentration and stock price collapse risk under different conditions.

5.4.1 Financial Situation

In this paper, the total debt at the end of the year is divided by the total assets at the end of the year to represent the debt level of the enterprise, and the median debt ratio (*med_LEV*) is calculated by industry and year. The value of *med_LEV* greater than or equal to the median is 1, which indicates the over-debt group, and the value of *med_LEV* less than the median is 0, which indicates the under-debt group. The regression results from (1) to (8) in Table 6 show that: in the over-indebted group, *ICQ_SCC* is significantly positively correlated with *NCSKEW* and *DUVOL* at the level of 5%, but this relationship is not significant in the under-indebted group, which verifies the conclusion of Lin Kunhai [55]. According to the five forces model, with the increase in supply chain concentration, the bargaining power of suppliers and major customers will also be improved, and the business risks will increase. The information disclosure risks interact with the business risks to a certain extent. When enterprises are faced with business difficulties, the possibility of management hoarding bad news increases, which increases the possibility of stock price collapse [48]. However, companies with insufficient debt may have some risk tolerance space, and the concentration of the supply chain has less impact on the stock price crash. The coefficients of *ICQ_SCC* in both over-indebted and under-indebted groups are significantly negative, which indicates that the quality of internal control will significantly weaken the role of supply chain concentration in promoting the risk of stock price collapse.

Table 6. Grouping Regression Results under Different Financial Conditions

	med_LE V=1	med_LE V=1	med_LE V=1	med_LE V=1	med_LE V=0	med_LE V=0	med_LE V=0	med_LE V=0
	<i>NCSKEW</i>	<i>NCSKEW</i>	<i>DUVOL</i>	<i>DUVOL</i>	<i>NCSKEW</i>	<i>NCSKEW</i>	<i>DUVOL</i>	<i>DUVOL</i>
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>SCC</i>	0.108**	0.100**	0.077**	0.071**	0.049	0.060	0.029	0.037
	(2.42)	(2.23)	(2.55)	(2.34)	(1.18)	(1.45)	(1.04)	(1.30)
<i>ICQ</i>		- 0.028***		- 0.020***		-0.012*		-0.007
		(-5.15)		(-5.33)		(-1.73)		(-1.47)
<i>ICQ_SCC</i>		-0.021*		-0.012*		-0.032**		-0.020**
		(-1.95)		(-1.68)		(-2.53)		(-2.35)
<i>ConVars</i>	YES	YES	YES	YES	YES	YES	YES	YES
<i>Constant</i>	0.362***	0.546***	0.169***	0.299***	0.369***	0.429***	0.211***	0.246***
	(4.05)	(5.67)	(2.79)	(4.57)	(4.33)	(4.46)	(3.59)	(3.70)
<i>Year&Industr y fixed</i>	YES	YES	YES	YES	YES	YES	YES	YES
<i>Cluster at Industries</i>	YES	YES	YES	YES	YES	YES	YES	YES
<i>Observations</i>	9, 765	9, 765	9, 765	9, 765	9, 854	9, 854	9, 854	9, 854
<i>Adj_R²</i>	0.104	0.107	0.104	0.107	0.108	0.109	0.108	0.108
<i>F value</i>	78.14	65.79	75.75	63.96	92.80	75.50	82.83	67.28

Robust t-statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1

5.4.2 Concentration of Management Power

Table 7. Grouping Regression Results under Different Power Concentration

	BOTH=1	BOTH=1	BOTH=1	BOTH=1	BOTH=0	BOTH=0	BOTH=0	BOTH=0
	<i>NCSKEW</i>	<i>NCSKEW</i>	<i>DUVOL</i>	<i>DUVOL</i>	<i>NCSKEW</i>	<i>NCSKEW</i>	<i>DUVOL</i>	<i>DUVOL</i>
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>SCC</i>	0.109**	0.107**	0.065***	0.063***	-0.035	-0.037	-0.002	-0.003
	(2.81)	(2.78)	(3.95)	(4.02)	(-0.69)	(-0.72)	(-0.07)	(-0.11)
<i>ICQ</i>		-0.024***		-0.016***		-0.025***		-0.015***
		(-3.87)		(-4.66)		(-7.75)		(-6.37)
<i>ICQ_SCC</i>		-0.023***		-0.014***		-0.020		-0.012
		(-3.64)		(-3.63)		(-1.57)		(-1.23)
<i>ConVars</i>	YES	YES	YES	YES	YES	YES	YES	YES
<i>Constant</i>	0.339***	0.478***	0.185***	0.282***	0.657***	0.806***	0.378***	0.469***
	(4.90)	(7.18)	(4.71)	(5.91)	(11.46)	(14.93)	(8.09)	(11.51)
<i>Year&Industry fixed</i>	YES	YES	YES	YES	YES	YES	YES	YES
<i>Cluster at Industries</i>	YES	YES	YES	YES	YES	YES	YES	YES
<i>Observations</i>	14, 587	14, 587	14, 587	14, 587	5, 032	5, 032	5, 032	5, 032
<i>Adj_R²</i>	0.110	0.112	0.111	0.113	0.095	0.097	0.096	0.097
<i>F value</i>	480.68	408.12	912.33	795.68	470.78	446.32	1007.35	5010.44

Robust t-statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

If the CEO holds two positions concurrently, it is defined that the power concentration of the management of the company is high (BOTH=1). By contrast, the company's management power concentration is low (BOTH=0). The lines from (1) to (8) in Table 7 report the results of grouping regression. When the concentration of management power is high, the concentration of the supply chain is significantly positively correlated with the risk of the stock price collapse, while for enterprises with a low concentration of management power, the relationship between them is not significant. This shows that when the CEO holds two positions concurrently, his decision-making power will be increased. For self-interest motives, the management is more inclined to cover up the bad news of the enterprise. When the negative news hoarded by the manager exceeds the acceptable threshold of the enterprise, the bad news will be released to the capital market in a concentrated way, prompting investors to withdraw their funds quickly, and resulting in a short-term plunge in the stock price of the enterprise. When BOTH=1, ICQ_SCC is negatively correlated with NCSKEW and

DUVOL, which indicates that the positive effect of internal control quality on enterprises is more significant in enterprises with high power concentration.

5.5 Robustness Test

In order to avoid the influence of variable measurement methods on the research results, the measurement methods of supply chain concentration are changed for the robustness test, and the original model is used for regression.

This study refers to Fang Hongxing [10] to select the lower of the two indicators the proportion of total sales of top five customers to total sales and the proportion of total purchases of top five suppliers to total purchases as the explanatory variable *Custsupp_min* of supply chain concentration.

Table 8. Robustness Test Results

VARIABLES	(1)	(2)	(3)	(4)
<i>Custsupp_min</i>	<i>NCSKEW</i> 0.097*** (4.19)	<i>NCSKEW</i> 0.386*** (3.10)	<i>DUVOL</i> 0.066*** (3.19)	<i>DUVOL</i> 0.246*** (3.05)
<i>ICQ</i>		-0.015** (-2.15)		-0.011** (-2.44)
<i>ICQ_SCCI</i>		-0.049** (-2.38)		-0.030** (-2.44)
<i>ConVars</i>	YES	YES	YES	YES
Constant	0.420*** (8.59)	0.512*** (7.83)	0.235*** (8.00)	0.299*** (7.01)
Year&Industry fixed	YES	YES	YES	YES
Cluster at Industries	YES	YES	YES	YES
Observations	19, 619	19, 619	19, 619	19, 619
Adj. R ²	0.107	0.109	0.108	0.110
F value	638.83	896.17	951.99	1254.44
Robust t-statistics in parentheses				
*** p<0.01, ** p<0.05, * p<0.1				

6. Conclusion and Future Suggestions

This paper analyzes the impact of supply chain concentration on the future stock price crash by taking the A-share listed companies in Shanghai and Shenzhen from 2008 to 2018 as research samples. The results show that: (1) The higher the concentration of the supply chain, the higher the possibility of future stock price crashes; (2) As an important internal adjustment mechanism of enterprises, high-quality internal control can significantly alleviate the positive effect of supply chain concentration on the future stock price crash of enterprises; (3) The positive correlation between the concentration of supply chain and the risk of the stock price collapse is more significant in enterprises with excessive debt and high management power.

According to the above conclusion, the following three suggestions are put forward:

(1) The enterprise shall establish an effective internal control system to prevent managers from covering up. Enterprises should constantly update supply chain risk management measures, and reduce risks faced by enterprises by changing suppliers or customers when necessary.

(2) Government regulatory authorities should establish and improve corresponding laws and regulations, promote the internal control construction of the listed companies, encourage enterprises to carry out supply chain risk management, and provide scientific internal guarantees for the stable development of financial markets.

(3) Investors should keep a cautious attitude, fully consider the expected returns and investment risks brought by investment decisions, use known information to avoid huge losses, and safeguard their legitimate rights and interests.

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