Supplier Association Relationship and Cost Stickiness

—Analysis of Cooperation Effect Based on Environmental Uncertainty

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Abstract

From different perspectives with supplier relationships as the entry point, this paper explores the impact of external enterprises on the cost stickiness of listed companies based on the data of listed manufacturing companies in Shanghai and Shenzhen from 2016 to 2019. The results show that when the main suppliers are the associated companies of the listed company, the suppliers' correlation degree and the influence of the associated suppliers will significantly reduce the cost stickiness, while the suppliers' volatility degree will significantly increase the cost stickiness. Further researches show that in the samples with high environmental uncertainty, associated suppliers can exert more cooperative effects. State-owned enterprises can better deal with the cooperative relationship with associated suppliers, thus reducing cost stickiness. This study enriches the related research on the correlation relationship of supply chain to cost stickiness. Under the current background of economic transformation and upgrading, choosing the right supplier relationship can effectively deal with the negative impact of environmental uncertainty, reflecting the "alliance effect".

Keywords

Cost Stickiness, Associated Suppliers, Supplier Volatility, Environmental Uncertainty, Cooperative Effects

1. Introduction

Cost management is an important part of management accounting. Cost control is a necessary condition for enterprises to improve profitability and sustainable development. Today, China's economic development has entered the stage of structural reform, cost control is also one of the important tasks of "Three go,

one drop, one supplement". At the same time, the report of the 19th National Congress clearly proposed to optimize the allocation of stock resources and achieve a dynamic balance between supply and demand. With the development of the new economy, the market competition is becoming more and more fierce. In addition, the sudden COVID-19 epidemic has caused a huge impact on all enterprises. They are facing greater uncertainty in the form of macroeconomic and external environment, cost management has become the key link of enterprises' operation and management.

For the research of cost, the traditional cost model believes that cost can be divided into fixed cost and variable cost, and there is a corresponding linear relationship between cost and business volume. However, previous studies have found that enterprises have "cost stickiness". Cost stickiness refers to the fact that when business volume decreases, the amount of cost reduction is less than that when business volume increases. In other words, the relationship between business volume and cost is not the traditional linear. The in-depth study of cost stickiness is helpful for listed companies to correctly understand cost habits, effectively carry out cost management, improve management efficiency and resource allocation efficiency, and thus improve sustainable development ability.

With the deepening of economic reform, enterprises are facing increasingly high degree of market competition, and gradually from the original competition between enterprises into the competition between supply chains. In recent years, the CPC Central Committee and the State Council of China have attached great importance to the development of modern supply chain, which has become an important field for fostering new drivers of economic growth. As an important part of the supply chain, suppliers are also one of the important external stakeholders of the company. Therefore, enterprise management must pay attention to the management of supplier relationship. Concentrated suppliers help to improve information transparency and reduce transaction costs and agency costs (Chen et al., 2019; Yu et al., 2017; Wei et al., 2018). But they may also have higher bargaining power and higher investment in relations-specific assets, thus posing a threat to enterprises (Zhu & Hu, 2018; Chen et al., 2019). Previous studies on the relationship between supplier concentration and cost stickiness have not reached a unified conclusion. In order to alleviate the negative impact of concentration on enterprises, enterprises are more and more inclined to establish a close relationship with suppliers to achieve long-term and stable development. More and more enterprises begin to establish associated relationship with suppliers, such as investing in supplier enterprises or letting supplier enterprises hold shares. The establishment of ownership relationship changes the competitive game relationship between suppliers and enterprises, and strengthens the strength and durability of supply chain relationship to a certain extent (Jia & Yan, 2020). What impact will the suppliers have on the enterprise's cost stick-

iness after the establishment of the association relationship? In addition, China has now entered a new era of economic development, and enterprises are faced with high demand uncertainty and large performance fluctuations. In addition, the COVID-19 outbreak in 2020 will bring greater uncertainty to the business environment. Under the impact of such a business environment, will establish partnership with suppliers help reduce cost stickiness? This paper will study it and provide management advice for the management to cope with the impact of the uncertain external environment.

This paper uses the data of listed manufacturing companies in Shanghai and Shenzhen from 2016 to 2019 to empirically analyze the impact of supplier association relationship on cost stickiness. This study may have the following contributions: 1) To expand the research perspective on the influencing factors of cost stickiness, enrich the related research on the correlation relationship of supply chain to cost stickiness, and help to enrich the theory of enterprise cost management; 2) The empirical test of the cooperation effect of associated suppliers on enterprises is helpful for managers to correctly deal with supplier relationship and provide new ideas for enterprises in supplier relationship management; 3) Under the background of new environmental uncertainties caused by the current economic transformation, it provides new strategic decisions for enterprises to better cope with the uncertainty of external environment; 4) To provide theoretical basis and data support for China's state-owned enterprises in further improving cost management.

2. Literature Review and Research Hypothesis

2.1. Research on Cost Stickiness

Cost stickiness was first discovered by foreign scholars. Anderson, Banker, Janakiraman (2003) (ABJ for short) found through large sample data that the increase rate of sales and management cost is greater than the reduction one when the income decreases, and proved the existence of sales and management cost stickness in an empirical study for the first time.

As for the motivation of cost stickiness, the three motivations widely recognized by scholars are the adjustment cost view, managers' expectation view and managers' opportunism view (Banker et al., 2013; Tu, 2014). According to the adjustment cost theory, when the business volume decreases, if the resource adjustment cost is greater than idle cost, the manager will choose to hold the remaining resources and will not make the decision of resource adjustment immediately, thus generating cost stickiness (Holzhacker et al., 2015). However, according to the managers' expectation theory, if the manager is optimistic about the future, he will think that the decline of business volume is only temporary, and it may not be wise to cut costs immediately. Once the operating conditions are improved, the reconstruction of these resources may have to pay a high price (Chen et al., 2012). The view of managers' opportunism holds that the separa-

tion of ownership and management rights leads to agency problems. "The construction of empire" motivation could prompt managers to continually expand the scale of the company. Managers may no longer allocate resources for the purpose of maximizing enterprise value but for the purpose of maximizing their own interests, which results in the low efficiency of enterprise resource allocation and cost stickiness (Kim & Wemmerlöv, 2015).

The influencing factors of cost stickiness include corporate financial characteristics and industry characteristics, macroeconomic and managers subjective factors, corporate strategy, corporate governance, legal factors, earnings management and so on. For example, in asset-intensive and labor-intensive industries, enterprises' cost stickiness is high because they are faced with high adjustment costs (Kong et al., 2007). Innovation input and financial flexibility will increase the stickiness of enterprise cost (Song et al., 2017; Liu, Sun et al., 2020); When macroeconomic growth or environmental uncertainty is high, managers have a higher expectation for the future, believing that income may increase in the future period, and they continue to hold surplus resources in the short term, the cost stickiness is higher (Anderson et al., 2003; Banker & Byzalov, 2014; Liang, 2020; Yu et al., 2018); the cost stickiness of differentiation strategy firms is higher than that of low cost strategy firms (Zhou et al., 2016); the better the corporate governance, the lower the cost stickiness (Chen et al., 2012; Wan & Wang, 2011; Xie & Hui, 2016); the implementation of labor protection law will improve the stickiness of cost (Liu & Liu, 2014); it is worth noting that scholars should take full account of the impact of earnings management when conducting related studies on cost stickiness, because it also affect the cost stickiness of enterprises (Jiang et al., 2015; Chen, 2020).

2.2. Research on Supplier Relationship and Cost Stickiness

In the studies on the relationship between suppliers and cost stickiness, some studies have found that higher supplier concentration can reduce cost stickiness, while higher supplier volatility can significantly increase cost stickiness. Higher internal control quality can alleviate the negative impact of volatility on enterprises (Yu et al., 2017). The more concentrated suppliers are, the stronger the stickiness of cost is, among which specific assets are the mediating factor (Zhu & Hu, 2018). Other studies have found an inverted U-shaped relationship between supplier concentration and cost stickiness. The farther the supply chain is, the greater the cost stickiness will be. Supply chain partnership can significantly reduce the cost stickiness of enterprises (Chen et al., 2019).

By combing the relevant literature, it can be found that the literature on the impact of supply chain relationship on cost stickiness is not rich, and no consistent conclusion has been reached, which is also related to the "duality" of supply chain. More empirical tests are needed in the research on supplier relationship. The measurement of supply chain relationship by scholars is relatively simple, and the concentration of suppliers is considered more. Multidi-

mensional measurement can be considered, such as the length of cooperation, whether the supplier holds shares, or whether the supplier is an affiliate of a listed company, etc. Few studies have examined the moderating effect of external macro environment on supplier relationships and cost stickiness. But in the process of economic system reform and economic globalization, frequent changes in policies, fierce market competition and the outbreak of COVID-19 all contribute to increased uncertainty in the external environment. Thus it is of practical significance to study the moderating effect of external macro environment.

2.3. Theoretical Analysis and Research Hypothesis

1) Supplier association and cost stickiness

The so-called association relationship refers to the relationship that has direct or indirect control relationship or significant influence with the listed company, including joint ventures and subsidiaries. According to the theory of relational capital, relational capital refers to the relationship of mutual trust and respect between an enterprise and its partners (Wei et al., 2018). Correlation can suppress the "trap" effect to a certain extent. The harmonious relationship between listed companies and suppliers form relatively flexible coping mechanisms, for flexibility of supply chain is higher. When manufacturing enterprise business volume decline, they will be based on the common interests of both sides to make appropriate adjustments on special assets. It is easy to cut unnecessary resources and reduce the adjustment cost. When a firm has close strategic partnerships with suppliers, it costs less to negotiate for reductions in resources and is more likely to continue to enjoy the same benefits in terms of price or quality. Adjustment costs will also be reduced in future attempts to restore the size of the resource (Yu et al., 2017).

The establishment of association relationship is helpful to unify the interest demands of enterprises and suppliers, and to improve the strength and durability of supply chain relationship (Jia & Yan, 2020). The supplier is one of the external stakeholders of the company, and the production and operation conditions of the downstream manufacturing industry will also have a certain impact on the upstream suppliers, so the suppliers will supervise and restrict the production and operation of the company (Yu, 2019). Related relationship means that the supplier has a long-term cooperative relationship with the enterprise, rather than a short-term cooperative relationship, so both sides are more focused on long-term mutual interests. As suppliers of related enterprises, they will also strengthen supervision and restraint on the production and operation activities of enterprises, and restrain the opportunistic behaviors of managers. In this way, enterprise resources can be adjusted in time to improve capacity utilization and reduce cost stickiness. Therefore, this paper holds that supplier association relationship can reduce cost stickiness by improving supply chain flexibility, reducing adjustment costs and increasing supervision of managers.

H1: Supplier correlation can reduce cost stickiness. The higher the degree of correlation, the lower the cost stickiness

2) Influence of associated suppliers and cost stickiness

When the procurement proportion of the associated suppliers is high, that is, the influence of the associated suppliers is large. At this time, the number of suppliers supplying the enterprise is small, and the trading volume between the listed company and the main associated suppliers will increase. At this time, communication is more convenient, and both parties can reduce information asymmetry through good information communication. When the company's business volume drops, the centralized associated suppliers can obtain such information in time and adjust the supply plan. The centralized suppliers are conducive to identify better supply chain coordination plan to reduce the adjustment cost. At the same time, managers may have deviations in their expectations. When business volume drops, managers tend to be overconfident and believe that the decline in business volume is only temporary, so they will not cut resources in time. Excessive purchase of raw materials may lead to lower capacity utilization and inventory backlog. Information sharing between enterprises and suppliers increases the enterprises' understanding of market information. Together, they can identify the key reasons for the decline in business, thus reducing managers' optimistic expectations (Chen et al., 2019) and improving the operational efficiency of enterprise assets. When the associated suppliers have a high influence, they are more eager to supervise the downstream enterprises, so as to avoid the influence of the management's "empire building" motive on their own interests. Therefore, this paper holds that centralized related suppliers can reduce cost stickiness by reducing information asymmetry, reducing managers' overconfidence and their opportunistic behaviors.

H2a: Increased influence of associated suppliers will reduce cost stickiness

However, previous studies have shown that supplier concentration is a "double-edged sword". The study of Wang and Gao (2017) found that customer concentration may play a "cooperation effect" or a "rip-off effect". Wang et al. (2017) found that the positive impact of the increase in supplier concentration is difficult to offset the negative impact. The high degree of association between suppliers and enterprises may also have adverse effects on enterprises. There are also cases that can be proved, such as the first largest supplier of Coli sensor became their competitors. According to the "rights-dependency" theory, dependency affects the power level (Jia & Yan, 2020). The higher influence of associated suppliers may enhance the power of discourse of suppliers and increase their dependence. At this time, the associated suppliers are more capable of seizing the interests of enterprises to maximize their own interests, and the "rip-off" effect of supplier relationship will appear. At the same time, close supplier relationships for special assets investment level in general is higher, because they will through the relationship-specific assets investment to strengthen the long-term

strategic partner relationship. Zhu and Hu (2018) proposed that the complementarity and integration of resources would bring "relationship rent" to enterprises, suppliers and customers, so the investment of specific assets would in turn enhance the willingness of both parties to cooperate in the long term (Zhu & Hu, 2018). Therefore, the closer the relationship between the two parties, the more specific assets will be invested. And the more specific investment will stimulate the intention of developing long-term cooperation between the two parties, while such commitment investment is difficult to be withdrawn or recovered. Therefore, this paper holds that centralized related suppliers may increase cost stickiness by enhancing suppliers' discourse power, enhancing their opportunistic behaviors and increasing investment in special assets.

H2b: Increased influence of associated suppliers will increase cost stickiness

3) Supplier volatility and cost stickiness

When the business volume of the company recovers or increases from the previous decline, it is very necessary for manufacturing enterprises to promptly restore the purchase of raw materials. When the degree of supplier volatility is high, the relationship between the enterprise and the supplier is unstable, and it may not be able to find the corresponding supplier timely and accurately, and the re-selection of the supplier will face high negotiation costs. In addition, the investment in special assets formed between the company and the original suppliers will also lose its original value with the termination of cooperation, which will bring higher adjustment costs and thus increase cost stickiness.

The high degree of supplier volatility means that the cooperation between suppliers and manufacturing enterprises may only be short-term. Unstable supply chain relationship will increase the cost for each supplier to obtain relevant company information (Yu, 2019). As a result, suppliers may pay less attention to the production and operation of the company and reduce their supervision of the management. Their main purpose is to obtain immediate short-term benefits, which will increase the agency cost of the enterprise. Managers have the motivation to build "personal empire", and the reduction of resources is contrary to this motivation. Such self-interested behavior of managers is easy to produce cost stickiness. Therefore, this paper holds that fluctuating supplier relationship will increase cost stickiness by increasing negotiation cost, increasing adjustment cost and reducing supervision of management.

H3: Supplier volatility will increase the cost stickiness. The higher the degree of volatility, the lower the cost stickiness.

3. Research Design

3.1. Model Design and Variable Description

1) Basic model

In this paper, the ABJ model proposed by Anderson et al. (2003) is used as the basic model. The specific model is as follows:

$$\ln \text{Cost} = \alpha_0 + \alpha_1 \ln \text{Rev} + \alpha_2 \ln \text{Rev} * D + \mu \qquad (1)$$

Wherein, lnCost represents cost change, equal to the natural logarithm of the ratio of the current year's operating cost to the previous year's operating cost; LnRev represents revenue change, which is used to replace business volume change, and is equal to the natural logarithm of the ratio of the current year's operating income to the previous year's operating income. D is the dummy variable, 0 when $\text{Rev}_{i,t} > \text{Rev}_{i,t-1}$, otherwise 1; α_1 is the increase rate of cost when revenue increases by 1%, and $\alpha_1 + \alpha_2$ is the reduction rate of cost when revenue decreases by 1%. If cost stickiness exists, $\alpha_1 + \alpha_2 < \alpha_1$, that is, $\alpha_2 < 0$. The smaller the value of α_2, the stronger the degree of cost stickiness.

2) The influence model of supplier relationship on cost stickiness

Based on the basic model and with reference to the research of Wang Xiongyuan and Gao Kaijuan (Wang & Gao, 2017), the following model is built to verify Hypothesis 1-3:

$$\begin{aligned}
\ln\text{Cost} = {} & \alpha_0 + \alpha_1 \ln\text{Rev} + \alpha_2 D + \alpha_3 \ln\text{Rev} * D + \alpha_4 \text{Supply} * \ln\text{Rev} * D \\
& + \alpha_5 \text{Supply} + \alpha_6 \text{Supply} * \ln\text{Rev} + \alpha_7 \text{Supply} * D + \\
& \alpha_8 \text{Controls} * \left(1 + \alpha_9 \ln\text{Rev} + \alpha_{10} D + \alpha_{11} \ln\text{Rev} * D\right) + \text{year} + \mu
\end{aligned} \qquad (2)$$

Among them, Supplier relationship (Supply) is specifically divided into supplier association degree (SP), influence of associated suppliers (SP * SC) and supplier fluctuation degree (SS). Controls in the model represent a set of control variables.

The specific form of variables in the above model is shown in Table 1.

Table 1. Variable description.

variable		Variable definitions
Revenue and Costs	Rev	Operating revenue for the current year
	Cost	Total operating costs: Current operating costs + Taxes and Surcharges + Selling and administrative expenses
	lnRev	Ln (Current year's revenue/last year's revenue)
	lnCost	Ln (Current year's total operating costs/last year's total operating costs)
	D	Dummy variable, if the operating income of the current year is lower than that of the previous year, it will be 1, otherwise it will be 0
Supplier relationship (Supply)	SP	Supplier association degree: Total purchase amount of the top five suppliers from associated suppliers/total annual purchase amount (association includes associates, joint ventures and subsidiaries)
	SPSC	Influence of associated suppliers: association degree * concentration degree
	SC	Supplier concentration degree: Total purchase amount from the top five suppliers/total purchase amount
	SS	Supplier volatility degree: Standard deviation/mean of supplier concentration degree in previous three years
Control variables	AI	Total assets/revenue
	EI	Total number of employees/operating revenue (unit is ten thousand)
	Dec	Dummy variable, if the operating income declines for two consecutive years, the value is 1; otherwise, it is 0
	Inde	Number of independent directors/number of all directors
	Year	Annual dummy variable

3.2. Data Collection

As manufacturing enterprises are asset-intensive and labor-intensive industries, with typical characteristics of cost stickiness. In addition, suppliers have a greater impact on their cost, quality and efficiency. In recent years, the uncertainty of the operating environment is also increasing. Therefore, manufacturing enterprises are selected as the research objects. As listed companies did not fully disclose the related transactions of suppliers until 2016, so this paper selects manufacturing enterprises listed on Shanghai and Shenzhen A-shares from 2016 to 2019 as the research samples. Since some variables require lag data, this paper covers the period from 2014 to 2019. Screening of data samples: 1) Eliminating companies with missing supplier data; 2) Excluding ST, *ST enterprises; 3) Eliminate enterprises with incomplete financial data, 3772 samples of 943 companies were finally obtained. To avoid the influence of extreme values, Winsorize is used to indent the continuous variables at the upper and lower 1% level. All financial data are from CSMAR. CSMAR is an economic and financial database based on China's actual conditions.

3.3. Descriptive Statistics

Table 2 presents the descriptive statistical results of the main variables in the model.

As can be seen from the descriptive statistical results of lnCost and lnRev, the distribution of the two is relatively similar, because when the operating revenue occurs, the operating cost should be recognized according to the matching principle, which complies with the provisions of the accounting standards for enterprises. The mean value of D is 0.233, indicating that only 23.3% of the samples experienced a decline in operating income. There are certain differences in the

Table 2. Descriptive statistical results

Variable		Count	Mean	Standard Deviation	Minimum	Maximum
Revenue and Costs	lnCost	3772	0.122	0.233	−0.545	0.966
	lnRev	3772	0.131	0.256	−0.712	1.040
	D	3772	0.233	0.422	0.000	1.000
Supplier relationships (Supply)	SP	3772	0.004	0.026	0.000	0.575
	SPSC	3772	0.001	0.014	0.000	0.388
	SC	3772	0.330	0.179	0.067	0.869
	SS	3772	0.151	0.110	0.012	0.549
Control variables	AI	3772	2.264	1.509	0.475	10.32
	EI	3772	0.013	0.008	0.002	0.043
	Dec	3772	0.092	0.289	0.000	1.000
	Inde	3772	0.376	0.054	0.333	0.571

association degree and influence of associated suppliers. The mean value of supplier concentration is 0.33, indicating that the purchase amount of the top five suppliers of listed manufacturing companies accounts for about one-third of the total purchase amount on average, which is also similar to the previous research results of scholars. The mean value of supplier volatility is 15.1%, and the standard deviation is 11%, indicating that the overall relationship between suppliers is relatively stable. The mean value of asset intensity is 226.4%, indicating that the total assets of manufacturing enterprises are relatively large. The mean value of employee intensity is 1.3%, indicating that the proportion of employee cost in operating revenue is relatively low on the whole. The mean value of DEC is 0.092, indicating that only 9.2% of the samples experienced a decline in business income for two consecutive years. Among the 23.3% of the samples with a decline in business income in the same year, the sample with a decline in business income for two consecutive years accounted for 39.5%. The mean and standard deviation of the proportion of independent directors in the board of directors is 37.6% and 5.4%, indicating that the proportion of independent directors in the board of directors of each company is basically stable.

4. Empirical Results and Analysis

4.1. Empirical Analysis of the Impact of Supplier Relationships on Cost Stickiness

Table 3 and Table 4 report the results of the empirical analysis. The supplier relationship is not controlled in the column (1) of Table 3, and the coefficient of lnRev * D is significantly negative at the 1% level, which proves that the cost stickiness phenomenon exists in listed manufacturing companies in China. Column (2) controls the supplier association relationship. The coefficient of SP * lnRev * D is 0.023 and is significantly positive at the 1% level, indicating that the supplier association relationship can significantly reduce the cost stickiness, and the higher the supplier association degree, the lower the cost stickiness. This may be because when the main suppliers are listed company associates, joint ventures or subsidiaries, the flexibility of supply chain can be improved to reduce the adjustment cost, and the supervision of managers can be enhanced to reduce opportunistic behavior, thus reducing the stickiness of cost. This empirical result verifies H1. Collider (3) controls the influence of associated suppliers, in which the coefficient of SPSC * lnRev * D is significantly positive at the 1% level, indicating that the greater the influence of associated suppliers, the more conducive it is to exert the "cooperation" effect to reduce cost stickiness. This empirical result supports H2a.

Column (2) of Table 4 presents the results of the impact of supplier volatility on cost stickiness. The coefficient of SS * LnRev * D is significantly negative, indicating that the greater the degree of supplier volatility, the higher the adjustment cost faced by the enterprise, and the higher the negotiation cost faced when it re-selects the supplier. External suppliers have less supervision over managers,

Table 3. Analysis of the impact of supplier association relationship and associated supplier influence on cost stickiness.

variable	(1) Do not control the supplier	(2) lnCost	(3) lnCost
Constant	0.019***	0.019***	0.019***
	(3.55)	(3.54)	(3.52)
lnRev	0.941***	0.942***	0.942***
	(66.38)	(66.34)	(66.43)
D	−0.033***	−0.035***	−0.034***
	(−3.70)	(−3.85)	(−3.83)
lnRev * D	−0.195**	−0.235***	−0.230***
	(−2.54)	(−2.98)	(−2.93)
SP * lnRev * D		0.023***	
		(2.86)	
SP * lnRev		0.002	
		(0.96)	
SP * D		−0.006*	
		(−1.77)	
SPSC * lnRev * D			0.001***
			(2.84)
SPSC * lnRev			0.000
			(0.68)
SPSC * D			−0.000**
			(−2.38)
AI	−0.002	−0.002	−0.002
	(−1.16)	(−1.16)	(−1.16)
AI * lnRev * D	0.007	0.007	0.007
	(0.85)	(0.87)	(0.84)
AI * lnRev	−0.023***	−0.023***	−0.023***
	(−4.16)	(−4.14)	(−4.10)
AI * D	0.010***	0.009***	0.009***
	(3.32)	(3.27)	(3.28)
EI	−0.742***	−0.749***	−0.748***
	(−2.68)	(−2.71)	(−2.70)
EI * lnRev * D	−5.445***	−5.421***	−5.388***
	(−3.19)	(−3.18)	(−3.16)
EI * lnRev	0.888	0.893	0.866
	(0.96)	(0.97)	(0.94)

Continued

EI * D	0.948*	0.987*	0.988*
	(1.82)	(1.9)	(1.9)
Dec * lnRev * D	0.068***	0.074***	0.074***
	(3.31)	(3.58)	(3.56)
Inde * lnRev * D	0.386**	0.451**	0.443**
	(2.17)	(2.5)	(2.46)
Year	control	control	control
Obs	3772	3772	3772
R-squared	0.9	0.9	0.901

Note: The values in parentheses are T values. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table 4. Analysis of the impact of supplier volatility on cost stickiness.

Variable	(1) Do not control the supplier	(2) lnCost
Constant	0.019***	0.023***
	(3.55)	(3.86)
lnRev	0.941***	0.911***
	(66.38)	(54.5)
D	−0.033***	−0.033***
	(−3.70)	(−3.36)
LnRev * D	−0.195**	−0.161**
	(−2.54)	(−2.08)
SS		−0.023
		(−1.18)
SS * LnRev * D		−0.231*
		(−1.79)
SS * LnRev		−0.01
		(−0.27)
SS * D		0.165***
		(3.07)
AI	−0.002	−0.002
	(−1.16)	(−1.04)
AI * LnRev * D	0.007	0.009
	(0.85)	(1.08)
AI * LnRev	−0.023***	−0.024***
	(−4.16)	(−4.33)
AI * D	0.010***	0.010***
	(3.32)	(3.35)

Continued

EI	−0.742***	−0.720***
	(−2.68)	(−2.60)
EI * LnRev * D	−5.445***	−5.243***
	(−3.19)	(−3.05)
EI * LnRev	0.888	0.65
	(0.96)	(0.7)
EI * D	0.948*	0.911*
	(1.82)	(1.75)
Eec * LnRev * D	0.068***	0.068***
	(3.31)	(3.29)
Inde * LnRev * D	0.386**	0.391**
	(2.17)	(2.18)
Year	control	control
Obs	3,772	3,772
R-squared	0.9	0.901

Note: The values in parentheses are T values. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

so the stickiness of the enterprise's cost will be significantly enhanced. This result verifies H3.

Among the control variables, labor intensity can significantly enhance cost stickiness, because enterprises are faced with higher adjustment costs. Two consecutive years of decline in operating revenue will reduce managers' expectations, thus significantly reducing cost stickiness; A high proportion of independent directors can improve the level of corporate governance, strengthen the supervision of managers, reduce their opportunistic behaviors, and significantly reduce cost stickiness.

4.2. Robustness Test

In order to verify the reliability of the above conclusions, the following robustness tests were conducted in this paper by referring to relevant literature:

Using operating cost (Operating costs + Taxes and Surcharges) and selling and administrative expenses (Selling + administrative expenses) to replace the above total operating cost for regression, the robustness results are basically consistent with the above.

Studies have shown that earnings management behavior of listed companies can significantly affect cost stickiness (Jiang, Hu, & Lv, 2015). Therefore, in order to avoid the upward or downward earnings management behavior of the company in the case of poor performance to affect the cost stickiness, the variable of whether net profit is less than zero is also controlled in the robustness test and added into the model for regression. The robustness results are basically

consistent with the above.

If there is an undisclosed affiliate transaction between an affiliated supplier and a listed company, it may increase the operating income of the listed company and increase the risk level of the listed company. For example, the IPO of Linhua Medical was postponed due to the suspected failure to disclose the supplier association relationship. In order to avoid the risk caused by the associated suppliers to affect the cost stickiness, based on the research of Wang Xiongyuan et al., this paper firstly regression the standard deviation of the ROA in the previous three years with the supplier relationship variables, and found no effect of the associated supplier variables on the risk of listed companies. Then, risk variables were added into the model to control the impact of the risk on the results (Wang & Gao, 2017). The robustness results are basically consistent with the above.

The fixed effect model was used to estimate the parameters, and the robustness results were basically consistent with the empirical results above. Due to the space limitation of this paper, the above robustness test will not list the relevant results.

4.3. Further Analysis

1) Analysis of supplier cooperation effect under environmental uncertainty

When the uncertainty of the operating environment is high, managers are difficult to predict the future income, which will have a negative impact on the procurement and production links of enterprises, and eventually lead to low capacity utilization rate and excessive inventory (Wang & Gao, 2017). The uncertain business environment makes the company's sales revenue fluctuate greatly, which also provides an excuse for managers to hold more resources to deal with the higher sales revenue that may be obtained in the future, thus aggravating the agency problem (Yu et al., 2018). The uncertainty of the operating environment will also increase the degree of information asymmetry between managers and shareholders and between managers and suppliers, thus increasing managers' self-interest behaviors. According to the resource-dependent theory, enterprises tend to form cooperative relationships with external stakeholders to cope with environmental uncertainty, improve information transparency and enhance their competitive advantages. Enterprises deal with uncertainty through cooperation (Wang & Gao, 2017). Therefore, this paper believes that, compared with low uncertainty, in the case of high environmental uncertainty, the establishment of a closer correlation with suppliers helps to reduce cost stickiness, and the high influence of associated suppliers can significantly exert the "cooperation effect".

Accordingly, with reference to the research of Lin and Pan (2019), this paper uses the ratio of standard deviation and average value of operating revenue in recent three years to measure the uncertainty of operating environment, which

can exclude the influence of company size on the standard deviation of operating income. According to the industry median, the samples were then divided into two groups: high environmental uncertainty and low environmental uncertainty. Table 5 presents the regression results of the two groups of samples. The data show that the coefficients of SP * lnRev * D and SPSC * lnRev * D are both significantly positive in the samples with high environmental uncertainty, while they are not significant in the samples with low environmental uncertainty. It shows that in the case of high environmental uncertainty, enterprises can effectively deal with the external environmental uncertainty through cooperation. The greater the influence of the associated suppliers, the more significantly the cost stickiness will be reduced. The "cooperation" effect of the associated suppliers only exists in the case of high environmental uncertainty.

Table 5. Analysis of supplier cooperation effect under environmental uncertainty.

Variable	lnCost	lnCost	lnCost	lnCost
	(1) low	(2) high	(3) low	(4) high
constant	0.006	−0.002	0.005	−0.002
	(0.43)	(−0.12)	(0.37)	(−0.11)
lnRev	0.907***	0.917***	0.907***	0.918***
	(41.03)	(41.95)	(41.09)	(41.96)
D	−0.01	−0.023*	−0.009	−0.023*
	(−0.80)	(−1.79)	(−0.71)	(−1.77)
lnRev * D	−0.181***	−0.202***	−0.176***	−0.201***
	(−3.27)	(−4.09)	(−3.20)	(−4.09)
SP * lnRev * D	0.005	0.024**		
	(0.26)	(2.18)		
SP*lnRev	−0.005	−0.010**		
	(−0.89)	(−2.23)		
SP*D	−0.004	0.003		
	(−0.74)	(1.43)		
SPSC * lnRev * D			−0.000	0.001**
			(−0.12)	(2.33)
SPSC * D			−0.000*	−0.000**
			(−1.94)	(−2.51)
Control variables	control	control	control	control
Year	control	control	control	control
Obs	1715	1913	1715	1913
R-squared	0.895	0.9	0.895	0.901

Note: The values in parentheses are T values. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

2) Analysis of property right nature

This paper divides the samples into state-owned enterprises and non-state-owned enterprises according to the nature of property rights. Table 6 presents the regression results of the two groups of variables. The data show that the coefficients of SP * lnRev * D and SPSC * lnRev * D are both significantly positive in the samples of state-owned enterprises, while they are not significant in the samples of non-state-owned enterprises.

The natural close relationship between SOEs and the government enables the government to give priority to allocation of scarce resources to SOEs, which will enhance the negotiation ability of SOEs with suppliers (Yu et al., 2017). Compared with state-owned enterprises, non-state-owned enterprises are more likely to have financial problems such as financing constraints. When suppliers

Table 6. Analysis of property right nature.

Variable	lnCost	lnCost	lnCost	lnCost
	(1) SOEs	(2) non-SOEs	(3) SOEs	(4) non-SOEs
constant	0.015	−0.025	0.015	−0.025
	(1.25)	(−1.39)	(1.24)	(−1.37)
lnRev	0.900***	0.985***	0.900***	0.986***
	(51.43)	(28.33)	(51.54)	(28.34)
D	−0.014	−0.012	−0.014	−0.011
	(−1.35)	(−0.69)	(−1.35)	(−0.58)
lnRev * D	−0.137***	−0.293***	−0.137***	−0.284***
	(−3.37)	(−3.68)	(−3.37)	(−3.59)
SP * lnRev * D	0.007	0.027**		
	(0.46)	(2.41)		
SP * lnRev	−0.013**	−0.001		
	(−2.40)	(−0.27)		
SP * D	−0.003	0.004**		
	(−0.51)	(2.38)		
SPSC * lnRev * D			0.000	0.001**
			(0.78)	(2.23)
SPSC * D			−0.000***	−0.000
			(−3.23)	(−0.17)
Control variables	control	control	control	control
Year	control	control	control	control
Obs	2772	856	2772	856
R-squared	0.888	0.926	0.888	0.926

Note: The values in parentheses are T values. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

cooperate with enterprises, they may have defensive mentality, which may increase transaction costs and communication costs, making enterprises' adjustment costs larger. So, compared with non-state-owned enterprises, state-owned enterprises can better exert the "cooperation" effect by establishing the association relationship with suppliers, so as to conduct better cost management.

5. Research Conclusions and Deficiencies

5.1. Main Research Conclusions

As an important stakeholder of the company, suppliers affect the procurement, production and other links of the company, and will have an impact on the cost of the company to a large extent. This paper explores the impact of external enterprises on the cost stickiness of listed manufacturing companies from different perspectives of supplier relations. The results are as follows: 1) When the main supplier is an affiliate, joint venture or subsidiary of the listed company, the supplier correlation is significantly negative with the cost stickiness of the listed company; 2) the greater the influence of the associated suppliers, the greater the cooperation effect, and the lower the cost stickiness of the listed company; 3) the degree of supplier volatility will significantly improve the cost stickiness of listed companies; 4) further research shows that, compared with low environmental uncertainty, related suppliers can exert more cooperation effect under high environmental uncertainty. External stakeholders will cooperate to cope with environmental uncertainty and reduce cost stickiness; 5) compared with non-state-owned enterprises, state-owned enterprises can better handle the cooperative relationship with related suppliers by taking advantage of their own advantages, and related suppliers can better cooperate with state-owned enterprises to adjust costs.

5.2. The Enlightenment

Based on the above conclusions, this paper puts forward the following policy recommendations:

1) Do a good job in supply chain management and strengthen the integration of upstream and downstream of supply chain.

Enterprises should learn to continuously strengthen process innovation, establish a cooperative partnership with suppliers, and prevent the fluctuating supplier relationship from causing adverse effects on enterprises. For example, Huawei integrates the supply chain through process innovation, uses modern information technology, establishes a direct procurement system, and realizes the docking with the logistics and information flow of international telecommunications companies. Process optimization makes Huawei and Motorola and other international giants become close and equal business competition and partners. The efficient operation process has reduced the procurement cost of Huawei by more than 2 billion yuan every year. Product procurement is the

starting point of the supply chain, Haier seizes the upstream of the supply chain, starts from the source, and takes a variety of ways to consolidate the relationship with suppliers, to achieve the effect of optimization and integration of the supply chain. In addition, when integrating supply chain, enterprises can also start from process transformation, such as transformation of planning process, logistics operation process and order delivery process, so as to improve planning accuracy and logistics transportation efficiency. Moreover, enterprises can also introduce flexible supply chain to improve the flexibility of supply chain.

2) Use cooperation effect to deal with environmental uncertainty.

In today's environment of high external uncertainty, enterprises should actively form cooperative relations with external enterprises to form their own competitive advantages. Give full play to the "alliance effect" and "cooperation effect" to effectively deal with the uncertainty in the business environment. For example, enterprises can implement unified procurement, invite some powerful suppliers to participate in the design and development of front-end products, establish associated relations with suppliers, and jointly face the fierce competition in the terminal market.

3) Improve market mechanisms.

The disadvantages of non-state-owned enterprises in obtaining human, financial and material resources should be improved, so that non-state-owned enterprises can better deal with the supply chain relationship. While state-owned enterprises can take advantage of their own advantages to strengthen cooperation with external enterprises and establish close relationship with suppliers, so as to reduce cost stickiness.

4) CSRC should continue to strengthen the disclosure of supply chain information.

Enterprises should be required to fully disclose more information about related parties in the supply chain. At the same time, the enterprise itself should also improve the level of corporate governance and the quality of internal control, strengthen the supervision and incentive to the management. Avoid collusion between the related parties and the management or shareholders, so that the associated relationship in the supply chain can play a more positive role.

5.3. Deficiencies

This study has some shortcomings: 1) Considering the control problems caused by over-association of suppliers, there may be a critical point at which their effect on cost stickiness may be reversed, which has not been determined in this study. 2) Cost stickiness is only studied from the perspective of supplier relationship, without considering customer relationship. In the future, the impact of different characteristics on cost stickiness can be studied from the perspective of the whole supply chain. 3) We only obtained the "cooperation effect" of associated suppliers in reducing cost stickiness, but did not conduct empirical analysis on its causes and mediating effects. We can conduct research on this point in

the future.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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