The Impact of Supply Chain Structure on Manufacturing Firms

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Abstract. The structure of the supply chain will affect the cost stickiness of manufacturing enterprises. This paper builds a supply chain structure network using input-output data and takes Chinese manufacturing listed companies before the epidemic as samples to examine the relationship between the supply chain network structure and the cost stickiness of enterprises. The research finds that the risks of enterprises in the central position of the supply chain are magnified, leading to a reduction in the cost stickiness of enterprises. This paper takes the structural characteristics of the supply chain as a new perspective to study the behavior of manufacturing enterprises and reveals the impact of supply chain uncertainty and risk on enterprise behavior from the meso-level of the supply chain. This paper provides policy suggestions for manufacturing enterprises on how to deal with an unstable supply chain environment.

Keywords: Supply chain, Manufacturing industry, Structural effect .

1 Introduction

Enhancing the stability of the supply chain is an essential part of coordinating security and development under China's "second centenary" goal. In fact, economic operation is a complex system (Jackson, 2008) [1]. Firms and industries do not exist in isolation. The intricate input-output relationships among industries decides an supply chain structure to transmit and amplify shocks (Acemoglu et al., 2012; Wu et al., 2023)[3, 13], constantly threatening the security and stability of industries. However, the key to ensuring the stability of the industrial chain still lies in the behavior of enterprises, as the main economic entities, to manage risks and maintain stable operations. Nevertheless, existing research on supply chain structures mainly focuses on supplementing models (Herskovic, 2018; Sharifkhani & Simutin, 2021) [4, 9], as well as explaining peer effects (Ahern & Harford, 2014) [5]. There is a lack of research on how enterprises themselves proactively manage risks.

At the same time, the comprehensive rise in factor costs and the change in cost structure have compressed the profit margins of enterprises. The traditional extensive growth model that relies on factors and low-cost competition is no longer sustainable. Since 2015, the central and local governments have introduced a series of policies and

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measures around the goal of "reducing excess capacity, reducing inventory, deleveraging, lowering costs, and strengthening areas of weakness". The National Development and Reform Commission, the Ministry of Industry and Information Technology, the Ministry of Finance, and the People's Bank of China have jointly issued notices on cost reduction for seven consecutive years, emphasizing the deepening of supply-side structural reform and the creation of effective demand through high-quality supply. Therefore, how enterprises achieve cost reduction and efficiency improvement is not only an inevitable condition for maintaining a stable and progressive growth model in the new situation, but also an inevitable requirement for promoting the steady progress of the macroeconomy along the path of high-quality development, which is worthy of study.

This paper intends to investigate the cost stickiness level of manufacturing enterprises in China's industrial supply chains. We believe that firms in the central industries will reduce cost stickiness to fend off risk. From a rebalancing cost perspective, management needs to weigh the tuning cost of cutting redundant resources against the opportunity cost of retaining committed resources. From the perspective of agency issues, under pressure from shareholders and creditors, managers will engage in earnings management to avoid losses or declining earnings, or to cater to earnings forecasts from financial analysts, and accelerate the reduction of resources when business volumes decline, making costs sticky. From the perspective of management's expectations, industrial cyber risks will weaken management's optimistic expectations for sustained revenue growth in the future. In the case of increased unpredictability of market demand and economic environment, the management takes risk reduction and survival as the main task, adopts a more conservative business strategy, prudently invests resources when the short-term business volume rises, and reduces the committed resources when the business volume declines to stabilize revenue, so that the cost stickiness shows a downward trend.

We use the data of listed companies in China to construct research samples to explore the relationship between the supply chain structure and firms' sticky cost behavior. This paper finds that enterprises with higher centrality face greater risks, and enterprises reduce cost stickiness to defend against risks. This paper's contributions are as follows: We study the influencing factors of enterprise cost stickiness from the perspective of supply chain structure for the first time. Existing studies are based on macroeconomic environment (Jin & Wu, 2021) [6] and the characteristics of enterprises themselves (Chen & Xu, 2023) [7] analyzed the influencing factors of cost stickiness and the economic consequences(Yang et al., 2022; Hong et al., 2021; Quan & Li, 2022) [10, 11, 12], but ignored the impact of differences in risk exposure caused by different supply chain locations on cost stickiness. This paper attempts to make up for this shortcoming. Second, this paper expands the related research of supply chain risk. This paper discusses the influence of supply chain structure on enterprise operation management and cost management from the perspective of cost stickiness.

2 Data, Variables and Research Design

2.1 Data and Sample

Annual data of all A-share listed companies from 2002 to 2019 are selected as research samples. The purpose of selecting this time interval is to match the annual interval of China's input-output table and avoid the impact of the epidemic after 2019. The enterprise-level data in this paper come from CSMAR database, and the industry-level input-output data come from China Input-Output Table published by the National Bureau of Statistics. To improve the data effectiveness, we also processed the samples as follows: (1) Eliminate the samples of ST companies, financial industry companies and key variable data missing; (2) Excluding samples that have just been listed for one year; (3) In order to avoid the influence of extreme values, Winsorize all continuous variables by 1% quantile, and finally obtain 21330 annual observations of the company.

2.2 Independent Variables

We refer to previous studies (Anderson et al., 2003) [8] to measure cost stickiness, that is, to conduct regression analysis and observe the coefficient through equation (1) to judge the existence and change trend of cost stickiness.

$$\Delta lnCost_{i,j,t} = a_0 + a_1 \Delta lnSales_{i,j,t} + a_2 \Delta lnSales_{i,j,t} * Dec_{i,j,t} + \varepsilon_{i,j,t} \quad (1)$$

Where $Cost$ is the sum of the selling expenses and administrative expenses of the enterprise, and Sale is the operating income of the enterprise. $\Delta lnCost_{i,j,t}$ and $\Delta lnSales_{i,j,t}$ respectively represent logarithmic changes in enterprise selling expenses and administrative expenses, logarithmic changes in operating income.$Dec$is a dummy variable, if the company's revenue in the current year is lower than last year, it is 1, and if not, it is 0. Therefore, according to the definition of cost stickiness, if the coefficient a_2 is significantly less than 0, that is, the increase of cost when revenue rises is greater than the decrease of cost when revenue falls, it indicates that cost stickiness exists; the smaller the coefficient a_2, the more serious the cost stickiness is .

2.3 Dependent Variables

Supply chain centrality can reflect the relative importance of each industrial node in the industrial network. We use eigenvector centrality to measure the relative importance of an industry's position in the network, because eigenvector centrality is the weighted sum of the centrality of the industry directly connected with it, which reflects not only the number of connections in the network, but also the strength and importance of connections. We refer to Bonacich's (1972) [2] research to construct the index of supply chain centrality where s_{ij} represents the elements in the direct flow table, and represents the value of the product produced by industry i directly consumed by industry j in production. The first two parts of the formula describe how

important the industry j is as a consumer of the industry i, and the last two parts describe how important the industry i is as a consumer of the industry j.

$$\text{Eigenvector}_i = \frac{1}{\lambda} * \sum_j \left[\frac{1}{4} * \left(\frac{s_{ij}}{\sum_k s_{ik}} + \frac{s_{ij}}{\sum_k s_{kj}} + \frac{s_{ji}}{\sum_k s_{jk}} + \frac{s_{ji}}{\sum_k s_{ki}} \right) \text{ Eigenvector}_j \right] \quad (2)$$

2.4 Methodology

On the basis of model (1), we construct the following model (3) to investigate how the cost stickiness of enterprises changes with supply chain structure.

$$\Delta lnCost_{i,j,t} = b_0 + b_1 \Delta lnSales_{i,j,t} * Dec_{i,j,t} + b_2 \Delta lnSales_{i,j,t} * Dec_{i,j,t} * Eigenvector_{j,t} + \sum b_3 \, \Delta lnSales_{i,j,t} * Dec_{i,j,t} * Economic_{Var\,i,j,t} + \sum Control\_Var_{i,j,t} + \varepsilon_{i,j,t} \quad (3)$$

Among them, $\text{Eigenvector}_{j,t}$ stands for supply chain structure centrality, measured by feature vector centrality. The regression coefficient b is observed. If it is significantly greater than zero, it indicates that enterprises with higher supply chain structure centrality have lower cost stickiness.

3 Empirical Results

Table 1 presents the baseline regression results of supply chain structure centrality on firms' cost stickiness. Column (1) and (2) are the regression results of model (1), which show that the coefficient of $\Delta lnSales$*Dec is significantly negative, indicating that China's A-share listed companies have sticky cost behavior. Columns (3) and (4) are listed in the regression results of model (3), showing that the coefficients of Eigenvector*ΔlnSales*Dec are 6.308 and 5.946 respectively, and both are significant at the level of 1%, indicating that the higher the degree of industry centrality will promote the decrease of the cost stickiness of enterprises, which supports the hypothesis H1a.

Table 1. Supply Chain Structure and firms' cost stickiness

	ΔlnCost	ΔlnCost	ΔlnCost	ΔlnCost
	(1)	(2)	(3)	(4)
Eigenvector*ΔlnSales*Dec			11.142***(3.47)	7.853***(2.60)
ΔlnSales*Dec	-0.358***(-8.37)	-0.693***(-3.25)	-0.669***(-6.37)	-0.892***(-3.99)
Constant	0.079***(2.68)	-0.774***(-4.24)	0.032(1.05)	-0.827***(-4.57)
Controls	No	Yes	No	Yes
Year FE	Yes	Yes	Yes	Yes

Firm FE	Yes	Yes	Yes	Yes
N	13233	13233	13233	13233
Adj R^2	0.423	0.437	0.428	0.440

*Notes.*T-statistics are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

4 Conclusion

This paper uses China's input-output table to build supply chain structure networks, and takes China's A-share listed companies as research samples to empirically test the relationship between supply chain structure centrality and firm cost stickiness. This paper finds that the higher the degree of centrality of supply chain network, the greater the degree of systemic risk exposure faced by enterprises in the industry, and enterprises will control risks by reducing cost stickiness. Therefore, government departments should pay close attention to the risk amplification effect caused by the structural characteristics of supply chain structure networks, and accelerate the construction of a regulatory system to prevent systemic risks. In the current environment of increasing external uncertainties and increasingly fierce international industrial competition, it is more important to grasp the asymmetric structural characteristics of supply chains, build a scientific risk prevention and supervision system, and improve the financial security defense line and risk emergency response mechanism. Enterprises should adopt more flexible cost management strategies and resource allocation strategies, reduce asset structure mismatch, enhance enterprise value, and promote the realization of the goal of high-quality development. On the one hand, this paper's research indicates that under the background of industrial network risks, cost reduction by enterprises not only can ‘reduce burdens’ but also can ‘increase efficiency’. The ‘Notice on Doing a Good Job in Key Cost Reduction Work in 2023’ issued by the National Development and Reform Commission and other departments clearly states that efforts should be made to promote high-quality development, guide enterprises to strengthen cost control throughout the process and implement refined management, and support enterprises in transforming and upgrading to reduce costs. On the other hand, this paper's research finds that non-diversified enterprises, non-group member enterprises, and enterprises without close bank-enterprise relationships are more inclined to take measures to reduce cost stickiness for risk control. Therefore, for enterprise managers, in order to improve the enterprise’s risk tolerance, they should fully consider the enterprise’s own operating characteristics and the characteristics of the industry it is in, enhance sensitivity to industry shocks and systemic risks, and adopt multiple risk control measures simultaneously. Timely adjust the enterprise's cost structure, strengthen the quality of internal control and maintain a certain level of asset liquidity, and form a comprehensive and multi-level risk control system.We should focus on giving full play to the role of key industries and key enterprises in stabilizing and strengthening the industrial chain. The ‘stabilizing the chain’ work needs to focus on the key industries and enterprises at the center of the network. This article’s research finds that industries with more intense competition and enter-

prises in the follower position within the industry are more strongly affected by supply chain network risks. Therefore, relevant policies to assist enterprises and alleviate their difficulties should be inclined towards the above-mentioned enterprises, promoting fair competition and advancing the integrated development of the industrial chain and supply chain network.In the current environment where external uncertainties are increasing and international industrial competition is becoming more intense, it is even more important to focus on grasping the asymmetric structural characteristics of networks, build a scientific risk prevention and supervision system, identify, warn, detect and handle risks early, and strive to prevent and defuse risks in key areas, strengthen risk source control, and improve the financial security line and risk emergency response mechanism.

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