



Supply Chain Network and Corporate Leverage Manipulation

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Abstract. Supply chain networks affect the information environment of the sector in which enterprises are located, and thus have an impact on the level of corporate leverage manipulation. Based on the analysis method of social networks, this paper uses inter-industry input-output data to construct China's supplytrade network, and uses the data of Chinese listed companies from 2010 to 2019 as a sample to study the impact of supply chain network centrality on corporate leverage manipulation. The study found that the closer the sector is to the center, the more complex the information environment it faces. For the companies located in it, the greater the degree of information asymmetry between outsiders and insiders, and the greater the space for companies to engage in leverage manipulation out of selfish motives. This paper not only provides a new perspective of economic networks for the study of corporate leverage manipulation, but also improves the research on the information mechanism of input-output networks, and provides policy recommendations for China's "deleveraging" work.

Keywords: supply chain network, leverage manipulation , information asymmetry

1 Introduction

High leverage has become one of the main risk factors facing the Chinese economy, affecting the stability of China's financial system. Excessive leverage of enterprises will not only increase corporate capital costs and weaken corporate profitability, but also increase corporate bankruptcy risks (DeAngelo et al. , 2018)^[1]. In the long run, removing unreasonable corporate leverage and improving China's structural capital mismatch will help guide funds to more efficient enterprises, improve the efficiency of social capital allocation, and achieve high-quality economic development; in the short term, deleveraging will inevitably increase corporate financial pressure, which may lead to them cutting capital expenditures, reducing the number of employees and employee salaries ,and thus exerting downward pressure on economic development (Kaalhaug , 2015)^[2]. Therefore, in order to avoid recession, enterprises may not completely reduce leverage by substantially reducing debt or increasing equity, but

partially reduce book leverage through leverage manipulation, thereby achieving formal deleveraging.

It is worth noting that leverage manipulation with diverse means, clear objectives and strong concealment can help enterprises to deleverage in the short term, but in fact it is an opportunistic behavior of enterprises to cover up the real leverage risks. More importantly, the distortion of book leverage information caused by leverage manipulation will mislead shareholders, creditors and government and other external information users to make relevant decisions, and may also lead to a higher degree of micro-enterprise risks and macro-systemic financial risks. Therefore, in the context of the central government's current proposal to prevent and resolve major risks, in-depth exploration of the relevant mechanisms of corporate leverage manipulation is of great practical significance for effectively preventing enterprises from falsely deleveraging and reducing risks in the macro-financial system.

At the same time, there is a growing body of evidence that industry characteristics affect many decisions of firms, including financial policies(MacKay and Phillips, 2005)^[3], internal capital markets(Lamont, 1997)^[4], and corporate governance(Giroud and Mueller, 2010)^[5]. And whether leverage manipulation, as a financial decision of firms, is similarly affected by certain industry characteristics is the question we want to explore.

Indeed, production networks linked between industries through input-output relationships form the basis of economic operations. Previous studies have shown that economic operation is a complex network system in which industries do not exist in isolation, but are interwoven through trade links, constituting a complex industrial network. Substituting the research perspective of this paper, on the one hand, by introducing the industrial network, we can analyze the leverage manipulation behavior of enterprises from the industry level, which is of greater reference value than the previous research on the motives or influencing factors of leverage manipulation only from the micro characteristics of enterprises. As we all know, industry-level information is crucial for company analysis, and even experienced institutional investors are often limited by the boundary of information processing capacity, which makes it difficult for them to conduct a comprehensive analysis of all companies in the industry, and instead focus on common information at the industry level in order to pursue economies of scale. On the other hand, leverage manipulation, as a typical class of opportunistic behavior, the information asymmetry between corporate insiders and outsiders is a major prerequisite for corporate executives or shareholders to implement leverage manipulation. Related to this, the center industry and peripheral industries in the industrial network often have great differences in the information environment (Noh, 2014)^[6], which provides an extremely valuable research context for this paper to study the leverage manipulation behavior of enterprises. Firms in center industries tend to have greater information asymmetry compared to peripheral industries. So, do firms in center industries have more incentives to engage in leverage manipulation? This is a question worth analyzing and is the focus of this paper.

2 Sample Selection and Descriptive Statistics

2.1 Sample Selection

This paper selects the annual data of all A-share listed companies from 2010 to 2019 as the research sample. The purpose of selecting this time period is to match the annual period of China's input-output table, while excluding the impact of the COVID-19 pandemic on the capital market in 2020. The enterprise-level data and industry-level data of this paper are derived from the CSMAR database and the Ruisi Financial Database, and the inter-industry input-output data are derived from the "China Input-Output Table" published by the National Bureau of Statistics. In order to improve the validity of the data, this paper excludes ST companies, financial sector companies and samples with missing data on key variables, and obtains a total of 21,608 company-year samples. At the same time, in order to avoid the influence of extreme values, this paper winsorizes all continuous variables by 1% up and down.

2.2 Model Design and Variable Definition

Model design. In order to test the impact of supply chain network position and the information asymmetry it causes on the degree of corporate leverage, this paper establishes the following regression model of sector characteristic vector centrality and corporate leverage (1):

$$FLEVM_{i,j,t} = \alpha + \beta * Eigenvector_{j,t} + \gamma X_{i,t} + \varepsilon_{i,t} \quad (1)$$

Among them, the subscripts i , j , and t represent the company, sector, and year, respectively. F is the degree of leverage manipulation of company i in sector j in period t , $Eigenvector_j$ is the characteristic vector centrality of sector j in period t , $X_{i,t}$ is the control variable, and ε represents the residual term. In addition, this paper controls the company fixed effect and time fixed effect in the regression, and performs cluster adjustment on the standard error at the company level.

Variable Definition. This paper involves the explained variable corporate leverage manipulation (LEVM), the core explanatory variable sector centrality (Eigenvector), and several control variables, as shown in the table 1.

Table 1. Variable design and definition

Variable name	Variable Definition
LEVM	The basic XLT-LEVM method only considers leverage manipulation using off-balance sheet liabilities and equity-equity financing.
Eigenvector	$Eigenvector_i = \frac{1}{\lambda} * \sum_j A_{ij} Eigenvector_j$
LEVB	The ratio of the total liabilities of the enterprise at the end of the year to the total assets of the enterprise at the end of the year
SIZE	The natural logarithm of the total assets of the enterprise at the end of the year

SOE	It represents a state-controlled company, and 0 represents a non-state-controlled company
FIRST	The company's largest shareholder's shareholding in the company's total share capital
CFO	The ratio of the company's net cash flow from operating activities to total assets at the end of the period
ROA	The ratio of a company's operating profit to its total assets at the end of the period
CURRENT	The ratio of the company's ending current assets to ending current liabilities
FIRMAGE	$\ln(\text{current year} - \text{listing year} + 1)$
LOAN	The ratio of the sum of a company's short-term and long-term loans to total assets
GROWTH	The growth rate of the company's current period operating income compared to the previous period operating income

Descriptive Statistics. Table 2 reports the descriptive statistics of the main variables of the full sample. The mean of the leverage degree of companies (taking LEVM as an example) from 2010 to 2019 is 0.116 and the standard deviation is 0.196 , which shows that the degree of leverage between companies varies greatly. The mean of the centrality of the sector characteristic vector is 0.031 , the standard deviation is 0.019 , and the median is 0.026 . The centrality between industries varies greatly, and the mean is slightly higher than the median, indicating that the overall trend is right-skewed.

Table 2. Descriptive statistics of main variables

variable	N	Mean	SD	Min	p50	Max
<i>LEVM</i>	21608	0.116	0.196	-0.000	0.044	1.543
<i>Eigenvector</i>	21608	0.031	0.019	0.004	0.026	0.087
<i>LEVB</i>	21608	0.460	0.204	0.081	0.451	0.943
<i>SIZE</i>	21608	22.229	1.278	19.723	22.062	25.876
<i>SOE</i>	21608	0.381	0.486	0.000	0.000	1.000
<i>FIRST</i>	21608	0.345	0.149	0.091	0.324	0.731
<i>CFO</i>	21608	0.041	0.068	-0.159	0.041	0.227
<i>ROA</i>	21608	0.035	0.066	-0.264	0.036	0.200
<i>CURRENT</i>	21608	1.959	1.526	0.280	1.517	9.212
<i>FIRMAGE</i>	21608	2.209	0.742	0.693	2.303	3.258
<i>LOAN</i>	21608	0.156	0.132	0.000	0.133	0.549
<i>GROWTH</i>	21608	0.187	0.432	-0.555	0.113	2.732

3 Empirical Results

This article performs regression based on model (1). The regression results are shown in Table 3. It can be seen that the coefficient of Eigenvector is always significantly positive. From an economic sense, in column (2), the coefficient of the core explanatory variable Eigenvector is 0.443, indicating that for every one standard deviation increase in centrality (0.018), the level of corporate leverage manipulation will increase by about 0.008 (0.443×0.018), which is equivalent to 6.8% of the mean (0.118) (ie $0.008/0.118$). It can be seen that, whether from the point of view of statistical significance or from the point of view of economic significance, the increase in the degree of centrality of the supply chain network will significantly increase the level of leverage manipulation of enterprises, which in turn verifies the previous conjecture that enterprises located in the center of the sector tend to have a greater asymmetry of information, and the insiders of the enterprise will have a greater informational advantage, and at this time, in order to satisfy the internal assessment or external regulatory requirements, it is more likely to be self-serving motives to carry out leverage manipulation.

Table 3. Regression analysis

VARIABLES	LEV1	LEV2
<i>Eigenvector</i>	0.287*** (2.53)	0.402*** (3.53)
<i>Controls</i>	No	YES
<i>Firm FE</i>	YES	YES
<i>Year FE</i>	YES	YES
<i>Observations</i>	21,608	21,608
<i>R-squared</i>	0.363	0.380

****, ***, and * indicate significance at the 1%, 5%, and 10% levels respectively.

4 Conclusion and Policy Recommendations

Based on the analysis method of social networks, this paper uses inter-industry input-output data to construct China's supplytrade network, and uses the data of Chinese listed companies from 2010 to 2019 as a sample to study the impact of supply chain network centrality on corporate leverage manipulation. The study found that the closer the sector is to the center, the more complex the information environment it faces. For the companies located in it, the greater the degree of information asymmetry between outsiders and insiders, and the greater the space for companies to engage in leverage manipulation out of selfish motives. This paper not only provides a new perspective of economic networks for the study of corporate leverage manipulation, but also improves the research on the information mechanism of input-output networks and provides policy recommendations for China's "deleveraging" work. Specif-

ically, the research conclusions of this paper have the following implications for regulators and market participants:

Firstly, regulatory authorities ought to intensify their supervision over corporate leverage manipulation, particularly for enterprises in core industries. Given that core enterprises are confronted with a more intricate information environment, their leverage manipulation might be more concealed. Thus, regulatory authorities are required to strengthen the supervision of these enterprises to safeguard market fairness and transparency.

Secondly, investors and analysts are in urgent need of enhancing their proficiency in identifying corporate leverage manipulation. Beyond merely fixating on apparent financial ratios like debt - to - equity ratio, they should meticulously examine the footnotes in financial statements, which often hold vital clues about off - balance - sheet liabilities. Additionally, in - depth scrutiny of management discussions can reveal underlying motives. By conducting longitudinal analysis of a company's data over several fiscal years and benchmarking it against industry peers, they can effectively discern abnormal leverage - related alterations that might otherwise go unnoticed.

Thirdly, enterprises should improve information disclosure. Clear and comprehensive disclosure can reduce information asymmetry. For example, publishing detailed quarterly reports with explanations of major financial decisions can help investors better understand the company's financial situation. This increased transparency will boost investors' confidence, limit the room for excessive leverage, and contribute to the healthy development of the capital market.

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