

Logistics Level and Debt Pressure: Empirical Analysis Based on Regional Panel Data

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Abstract: After the supply chain has gradually become a popular concept for research and attention, its core—logistics system and the debt of enterprises therein have also been the subject of continuous discussion in the industry and academia. This study centers on the level of logistics in the supply chain and the debt pressure of industrial and commercial enterprises, analyzes the relationship between the two from the supply chain perspective, adopts the literature review method to put forward theoretical hypotheses, and constructs an econometric model and a system of related variables, and uses inter provincial panel data to carry out empirical demonstration of fixed-effects regression analysis. The results found that the logistics level alleviates the pressure of industrial and commercial liabilities, further analyzes the internal mechanism from the perspective of debt generation and debt realization in each logistics link, and puts forward corresponding measures, which contributes new perspectives to the study of supply chain finance and explains the connection between the two key elements.

Keywords: Logistics level, Industrial and commercial debt, Supply chain finance, Interprovincial panel data, Fixed-effects regression model

1. Introduction

In recent years, as SC (Supply Chain) has become a Chinese strategy, and promoting supply chain finance has been a key path, the supply chain efficiency of enterprises and even regions has been increasingly emphasized, and the level of logistics is the core element of the supply chain efficiency, which is subject to the focus of the industry and academia to examine the attention. The problem of industrial and commercial debt is moreover one of the pain points plaguing the upstream and midstream of the supply chain all year round, which is a real problem facing the real economy and a frontier direction of research and innovation. This research's purpose is to study the endogenous relationship between the logistics level and industrial and commercial liabilities in the supply chain system, to discover and explain the systematic problems of supply chain dynamics, and to make a valuable marginal contribution to the exploration of supply chain finance. Both subjects involved in this study have been the subject of academic attention and research, from the logistics-economic perspective, the links between the level of logistics and the growth in economy has become a common topic of discussion, some scholars have also explored the relationship with the recycling economy from the perspective of green logistic, these studies basically take a macro perspective and land on the economic theme [1-3]. In the supply chain-debt perspective, the main subjects of research are the

SC-failure's influence of on debt-equity, the analysis of debt in the supply chain and other corporate, technical topics, focus mainly on the management of the science and efficiency of the problem [4-5]. However, the existing research relatively lacks a combined macro and micro perspective to explore the linkage of the two themes within the supply chain, which has the limitation of the research horizon. Based on the achievements and shortcomings of the above studies, this paper innovatively adopts a mesoscopic perspective, linking logistics efficiency and industrial and commercial debt pressure within the supply chain, re-examining China's inter-provincial panel data from a new perspective, analyzing the linkage between the two main bodies of logistics and debt, and filling the gap in the research on the supply chain. For the current situation in the 21st century decade, this paper selects 2010-2020 as the time span. For making the data source easily available and credible, finally the inter-provincial logistics and industrial and commercial debt panel data of 31 provinces during the 10-year period of 2011-2020 are used as the object of the study, and the link between the level of logistics and the pressure of debt within the supply chain system is the theme. Firstly, the literature on logistics levels and industrial and commercial debt stress was studied, and the literature study method was used to theoretically demonstrate the connection and mechanism of action between the two in the supply chain and to formulate hypotheses accordingly. Next, the collected panel data of 31 provinces and cities for the period of 2011-2020 are standardized and weighted by the entropy weighting method, and the theory and basis of core variables measurement and data sources are given. Subsequently, descriptive statistics and correlation analysis are carried out for each variable, and finally, the relationship between the variables is measured by panel data OLS regression fitting, and regression analysis attaching robustness test, and the results show that the two are in a significant negative correlation and robust, and then the corresponding interpretation of the results is given in combination with the assumptions made in the previous article. At the end of this paper, we propose a path of measures to improve the industrial and commercial debt pressure from the logistics level.

2. Hypothesis

Combined with the relevant research of scholars over the years, the impact of logistics level on industrial and commercial debt pressure within the supply chain can be analyzed mainly from two perspectives: the function of logistics and logistics cost. From the view of the function of logistics, logistics is part of the supply chain, covering the "goods from the place of supply to the receiving place of the entity flow process", in the supply chain is the financing of debt immediately after the link, but also to realize the sale of goods, capital back immediately before the link [6]; At the same time in the concept of the extension of logistics belongs to the circulation One of the "four flows" - logistics, business flow, cash flow, information flow - is often accompanied by the flow of funds between the two parties in the process of "transfer of goods", i.e., to complete the transfer of payment from one party to the other, which can realize the transfer of debt. The transfer of goods from one party to another, can realize the debt filling. In its core link of transportation and warehousing efficiency is directly related to the flow of goods on the road time and whether the timely supply and not out of stock, so the improvement of logistics efficiency means a more effective and smoother supply chain so that the production-circulation-consumption of the cycle and the industrial-commercial-consumer supply chain can be fluent, in this sense, "Logistics In this sense, "logistics" allows "goods" to be recycled into monetary capital, which in turn closes the debt loophole created by the production process, such as borrowing, and reduces debt pressure. From the perspective of logistics costs, logistics includes transportation, warehousing, loading, and unloading handling, and other aspects of expenditure will be included in the overall production and operating costs of industry and commerce, and thus the increase in logistics expenditures to take up funds will enhance the debt pressure [7]. At the same time, the logistics process also includes the management of demand forecasting, and inventory control, which can even affect the production and operation of the

enterprise's strategic decision-making issues, which in turn extends to the corresponding debt level of the final account. If you can reasonably control the cost of logistics, logistics costs, and ordering expenses from the corresponding control, the enterprise's cost burden will be reduced, and then the corresponding debt pressure can also be reduced. To summarize, as the core link of the supply chain, the low level and high cost of logistics will make the supply chain in the industrial and commercial debt pressure increase, combined with the assumptions of the two different perspectives, this paper suggests the following hypothesis:

There is a significant negative correlation between the level of logistics and the level of industrial and commercial indebtedness.

3. Data, Methods and Results

3.1. Logistics Level

Referring to Wang et al.'s research on logistics infrastructure and Engblom et al.'s analysis of logistics cost structure, the measurement of logistics level revolves around four major aspects, namely, logistics infrastructure resources, logistics financial resources, logistics human resources, and performance of the logistics industry, and a total of seven items of data are selected to measure the level of logistics in the regional supply chain [7-8] (See Table 1). Drawing on Zhou's methodology, entropy weighting is used as a way of deciding weights, which is standardized and then compounded by transformational calculations to arrive at a comprehensive logistics level [9]. After substituting the collected data into the calculation, the final six data are compounded into a logistics level indicator.

Table 1: Logistics level system metrics data division

Guideline level	Indicator level	Unit	Meaning	weight
Logistics infrastructure resources	Length of transport routes	km	Miles of graded roads	0.0632
	Land area for warehousing	Km ²	Land area for urban logistics warehousing	0.0747
Logistics capital resources	Logistics investment level	billion	Investment in fixed assets in logistics	0.4412
Logistics human resources	Logistics practitioners	person	Sum of persons employed in rail transport, road transport, water transport, air transport, pipeline transport, stevedoring, postal services, multimodal transport and forwarding, warehousing, and other transport services	0.0749
Logistics performance	volume of cargo transportation	10000 tons	Absolute volume of goods transported in the region	0.0919
	Cargo turnover	100 million tons /km	Turnover of cargo transportation in the region	0.1560
	Value added to logistics	billion	Value added of transportation, warehousing, and postal services	0.0981

3.2. Methods and Results

Econometric modeling: In order to empirically study the correlation between logistics level and industrial and commercial debt pressure, according to the previous hypothetical situation and the relevant variables set, this study constructs the following equation (1) with reference to Zhou's study [9]:

$$\text{Debt}_{it} = c + \beta_1 \text{Logi}_{it} + \beta_2 \text{control}_{it} + \delta_i + \gamma_i + \varepsilon_{it} \quad (1)$$

Among them, Debt_{it} is the explanatory variable, expressed as the ratio of the total liabilities of the wholesale industry above quota, the total liabilities of the retail industry above quota, and the total liabilities of industrial enterprises above quota to GDP, representing the level of industrial and commercial liabilities, and Logi_{it} expresses the logistics explanatory variable, representing the level of logistics development. control_{it} is the control variable, and it is selected as the government intervention level Gov_{it} , the level of opening up to the outside world Open_{it} , the level of investment Invest_{it} , the level of technology Tech_{it} , and the level of human resources HR_{it} . c is a constant term, δ_i is a year dummy variable, γ_i is an individual dummy variable, and ε_{it} is a random interference term, to characterize the impacts of other non-specific factors. If the previous hypotheses are valid, it is expected that $\beta_1 < 0$ and passes the test of significance.

Data description: Since the panel data used in this study are composed of annual statistics at the regional provincial and municipal levels, the data come from the national or regional statistical yearbooks of the past years; the data related to the debt level government intervention level, the level of opening up to the outside world and the technological level measure are obtained from the official website of the National Bureau of Statistics; the data related to the investment level measure and the human resources measure come from the China Statistical Yearbook; and the data related to the logistic level measure are obtained from the China Logistic Yearbook.

Empirical results and analysis: According to the variable indicator system constructed above, statistical calculations were made to obtain descriptive statistics for each variable in Table 2.

Table 2: Results of descriptive statistics of variables

Var	Meaning	Obs	Mean	SD	Min	Median	Max
Debt	Debt Pressure	310	1.10	0.471	0.195	0.980	2.518962
Logi	Logistics Level	310	0.18	0.141	0.010	0.148	0.777
Gov	Government Intervention Level	310	0.30	0.210	0.120	0.238	1.354
Open	Level of Opening Up	310	0.40	0.417	0.010	0.229	2.165
Invest	Investment Level	310	0.85	0.292	0.211	0.870	1.597
Tech	Technological Level	310	0.02	0.027	0.000	0.006	0.176
HR	Human Resources Level	310	0.02	0.006	0.008	0.019	0.041

The correlation coefficients of the variables were also measured using Stata to obtain the correlation coefficient matrix in Table 3.

Table 3: Matrix of variable correlation coefficients

	Debt	Logi	Gov	Open	Invest	Tech	HR
Debt	1						
Logi	-0.230***	1					
Gov	0.010	-0.469***	1				
Open	0.160***	0.283***	-0.333***	1			
Invest	0.014	-0.279***	0.463***	-0.586***	1		
Tech	0.333***	-0.014	-0.122**	0.149***	-0.344***	1	
HR	0.172***	0.130**	-0.428***	0.222***	-0.209***	0.532***	1

Note: * indicates $p < 0.1$, ** indicates $p < 0.05$, and *** indicates $p < 0.01$.

Considering that this study uses inter-provincial panel data to study the relationship between logistics level and industrial and commercial debt pressure, Hausman test was conducted, and referring to Zhuang et al.'s research results, the fixed-effects panel regression model was selected for regression analysis [10]. The results of the analysis are shown in Table 4.

Table 4: Regression analysis

	No control variables considered	Considering control variables
	Debt	Debt
Logi	-0.263*** (-3.22)	-0.353*** (-3.87)
Gov		1.396*** (4.98)
Open		-0.040 (-0.66)
Invest		0.282*** (7.05)
Tech		-1.705 (-1.63)
HR		3.372 (0.88)
cons	1.146*** (68.96)	0.484*** (4.35)
N	310	310
R2	0.036	0.291
Adj. R2	-0.07	0.20

Note: * indicates $p < 0.1$, ** indicates $p < 0.05$, and *** indicates $p < 0.01$.

1. Correlation description. The Pearson correlation coefficient of the variable $Debt_{it}$ and the variable $Logi_{it}$ in the correlation coefficient matrix of Table 3 is -0.230 and passes the test of 1% significance level, which proves that the two have a significant negative linear correlation.

According to the results of Table 4, the coefficient β_1 of logistics level variable $Logi_{it}$ is -0.263 and -0.353 respectively before and after considering the control variables, which indicates that there is a negative correlation between the level of logistics and debt pressure and passes the 1% significance level test, and the empirical results of the data are consistent with the theoretical hypothesis results. Accordingly, it can be shown that the hypothesis is valid, that is, the improvement

of the logistics level has a significant effect on the alleviation of industrial and commercial debt pressure.

2. Robustness test. COVID-19 virus outbreak in late 2019 to early 2020, with reference to the findings of the scholar Liu, it is found that the epidemic has a huge impact on the level of logistics, and also based on the findings of Gopalakrishnan, the epidemic has also made the liabilities of the enterprises increase significantly, so we believe that the data after 2019 received the epidemic [11-12]. The impact of the epidemic and fluctuations, so we choose to exclude the data after 2019 (i.e., the first year of the epidemic), and then conduct the regression analysis again.

As shown in Table 5, the development of logistics level before the epidemic also has a significant mitigating effect on debt stress, while the magnitude of β_1 shows that the mitigating effect of logistics on debt stress was stronger before the epidemic added pressure on industrial and commercial debt, indicating the robustness of the empirical results.

Table 5: Regression analysis for selected samples 2011-2018

	Debt
Logi	-0.582***
	(-4.50)
Gov	1.529***
	(4.69)
Open	0.048
	(0.69)
Invest	0.308***
	(6.59)
Tech	-1.994
	(-1.29)
HR	15.529**
	(2.58)
cons	0.193
	(1.33)
N	248
R2	0.373
Adj. R2	0.27

Note: * indicates $p < 0.1$, ** indicates $p < 0.05$, and *** indicates $p < 0.01$.

Referring to Wang et al.'s approach to the division of the panel data into eastern and western regions and based on the official website of the Finance Bureau of each province and city and the Bureau of Statistics originating from each province and city, the debt ratio of 31 provinces and municipalities in 2022 is calculated by calculating the proportion of the overall liabilities of the province to the GDP [13]. Combined with its ranking, the first 16 provinces and cities are taken as the high-debt group, and the last 15 provinces and cities are the low-debt group, keeping other things unchanged to group regression of the original panel data, and the empirical results are shown in Table 6.

As Table 6 shows, the regression analysis was performed again after grouping the data, and it can be seen that the sign of β_1 is still negative and significant at the 1% level as well, and the results of the previous hypotheses and analyses have not changed, which can also show that the previous empirical results are robust.

Meanwhile, comparing the data of the two groups of high and low debt groups, it can be seen that in the regression results of the high debt group, the value of β_{1H} is equivalent to twice the value of β_{1L} of the low debt group, which indicates that the alleviation of industrial and commercial debt pressure by the improvement of the logistics level is more significant, and at the same time, the value of R2 of this equation is higher than that of the high debt group than that of the low debt group, which also indicates that the model is more representative and applicable in the high-debt region, and this model provides us with inspiration to alleviate the pressure on the commercial and industrial debts of high-debt regions.

Table 6: Subgroup regression analysis based on debt stress

	Low-debt group	High-debt group
Logi	-0.361*** (-3.52)	-0.793*** (-2.99)
Gov	1.176*** (2.72)	1.524*** (3.99)
Open	-0.035 (-0.58)	-0.025 (-0.15)
Invest	0.252*** (3.71)	0.292*** (5.52)
Tech	-1.223 (-0.94)	-2.715 (-1.58)
HR	11.505* (1.95)	6.719 (0.99)
_cons	0.429** (2.54)	0.397** (2.17)
N	150	160
R2	0.239	0.353
Adj. R2	0.12	0.25

Note: * indicates $p < 0.1$, ** indicates $p < 0.05$, and *** indicates $p < 0.01$.

4. Discussion

According to the empirical results of the previous paper and combined with the relevant literature and theory to expand and extend, divided into various logistics links to explain the logistics level of industrial and commercial debt level of the intrinsic mechanism of the industrial and commercial logistics can be divided into four links of procurement logistics, production logistics, sales logistics, distribution logistics, corresponding to the hypothesis of the role of logistics and logistics costs, from the speed of the debt and the creation of the debt in the two aspects of the explanation.

4.1. Procurement Logistics

According to Roberta et al.'s research, procurement logistics in industrial enterprises is mainly the purchase of raw materials, while for commercial enterprises is the ordering of the desired goods, procurement logistics in the production and management chain is the manufacturing and dismantling and re-sale of the immediately preceding link [14]. From the point of view of debt realization speed, with higher logistics efficiency, the purchased materials can be quickly transferred from the upstream body to the downstream body quickly, and the cash receivable/payable between business entities will be more rapid, thus reducing the overall supply chain indebtedness pressure, procurement as a supply

chain at the upper end of the supply chain, but also reduce the production line empty rate and the downstream of the out-of-stock rate, which will lead to the whole chain of rapid return of funds and reduce the whole chain of In this way, it can lead to the rapid return of funds and reduce the pressure of liabilities of the whole chain.

From the perspective of debt creation, referring to Spiegel's research results on the relationship between procurement logistics and debt, the level of forecasting of the amount of purchasing required in procurement management and demand forecasting is related to the enterprise's overall business investment and debt level, so as to more accurately forecast the actual amount of goods required, omit the part that is no longer capable of production or sales, and maintain a relatively reasonable level of inventory, thus reducing the redundant purchasing investment and inventory spending. Redundant purchasing investment and inventory spending can reduce debt pressure at the source of cost [15].

4.2. Production Logistics

Production logistics mainly refers to the process of transferring raw materials and semi-finished products within an industrial enterprise or between groups and subcontractors in the production process, according to Qu et al. from a systems perspective on the role of production logistics, production logistics is closely related to the enterprise's production efficiency and working hours of the logistics sector [16]. From the point of view of the speed of debt realization, more efficient production logistics means more efficient production, so that in other production technology level has been fixed in the case of the product more quickly produced and manufactured factory distribution, so that their own for the purchase of raw materials for production and payment of various types of costs raised by the debt is paid off more quickly, at the end of the industrial enterprises to maintain a lower debt pressure. From the point of view of debt creation, the logistics costs in production are often accounted for in the cost of the product, in the process, if high-cost and inefficient logistics activities, industrial enterprises will have to pay more costs for the production of products of equal utility, and raise more debt, improve the level of logistics in this segment, is the same as for the production of cost-effective, reduce the production unit of the product requires investment and debt.

4.3. Sales Logistics

Combined with Gimenez's research on the integration of production and distribution logistics, the distribution logistics mentioned in this study mainly covers the logistics links from industrial enterprises to commercial enterprises and within commercial enterprises, which is a pure distribution process in the middle of the supply chain and mainly serves wholesale activities [17]. In terms of the speed of debt realization, faster sales transshipment allows goods to be circulated to the next body in the supply chain in a shorter time, and, as in the case of purchasing logistics, their contracts and bills can be honored faster, thus reducing the pressure of liabilities. From the debt creation point of view, this stage for different batches needs to collect and distribute goods, but also related to loading and unloading handling, logistics of packaging, and distribution processing. Better collection and distribution management and more advanced packaging machinery, in and out of the warehouse loading and unloading handling, and transshipment equipment can make the enterprise in these links to spend less circulation costs and lower mismatch, and loss rate, in the circulation of the link to the budget can be reduced, and thus reduce the creation of debt in the circulation.

4.4. Distribution Logistics

Distribution logistics service is the process from the retail enterprise to the final consumer, that is, the last link in the supply chain, due to the relatively decentralized distribution of consumers at the end of the distribution characteristics and small-volume consumption characteristics, combined with

Pirttilä's research and the reality of the situation, the existence of its pain points are usually outlined as the "last kilometer" problem [18]. Problems. In terms of the speed of debt realization, many retailers now use the form of "use first, pay later" or "deposit pre-sale", which creates a debt from consumers to retailers, and a faster speed of end-of-line delivery allows consumers to get the goods they need earlier and pay off the payment due. Faster end-of-line delivery allows consumers to get the goods they need sooner, so they can pay off what they owe, allowing the debt to be realized faster and the company to make the transition from goods to money. According to Liu's research results, debt creation is mainly reflected in reverse distribution logistics, i.e., after-sale logistics, if the consumer decides to return the goods after purchasing the goods in full because the logistics time is not on schedule, then it creates the retailer's liabilities to the consumer, which means that the low level of the end-of-pipe distribution logistics reduces the sales and at the same time, it creates a debt burden for itself [19].

5. Conclusions and Outlook

5.1. Conclusions

In the supply chain logistics and debt problems become the focus of attention of the academia and the industry, synthesize the theoretical and empirical research results of this study and its interpretation, the authors from the perspective of the supply chain to carry out the study, that the level of logistics in the 4 major logistics links through the impact of the creation of debt and the speed of debt encashment of the industrial and commercial enterprises of the debt pressure has an inverse impact. The construction of the SC and the operation of the main bodies should pay attention to the development of logistics, which can reduce the debt level through the alleviation of the role of logistics, to consolidate the logistics infrastructure and strengthen the demand forecasting, and to solve the problem of end-of-line distribution according to the local conditions. It puts forward a different development direction for the innovation of supply chain financial service form and makes a marginal contribution to the research of supply chain wholeness and its financial innovation.

5.2. Research Limitations and Prospects

This study has ensured that the data sources are publicly available and credible while the econometric model is robust, but it also has some objective limitations.

In terms of data and variable system construction, the level of logistics should conceptually encompass a wider range of specific operations; the variable construction of the level of debt should have included a structural analysis. However, both could not be considered together in their variable system due to the difficulty of data collection and maintaining systematicity. In terms of research perspectives, the choice of econometric models in this study does not allow for the study of their two-way interaction.

It is hoped that this study will inspire more scholars in related fields to utilize new tools for data collection and processing, construct a more comprehensive variable indicator system based on the original foundation, simultaneously, focus on the two-way interaction, consider the situation in different periods of time, and put forward new initiatives to solve the supply chain debt problem with logistics methods, contributing to a new approach that promotes the change and development of supply chain finance.

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