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The Impact of Supply Chain Transparency on Corporate Financial Risk: A Regression Analysis Approach

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Abstract. With the globalization and the increasing complexity of supply chain management, the financial risks faced by enterprises show the characteristics of diversification and multi-level. Supply chain transparency is considered to be one of the important factors affecting the financial health of enterprises. Through regression analysis, this paper discusses the impact of supply chain transparency on enterprise financial risk. The results show that there is a significant negative correlation between supply chain transparency and enterprise financial risk. Every unit of supply chain transparency increases, the financial risk of the enterprise (measured by the financial leverage ratio) will be reduced by 0.280 units. The analysis shows that the stability of enterprise scale and capital structure also has a significant impact on financial risk. Larger enterprises usually face lower financial risk, while the instability of capital structure will aggravate financial risk. This finding provides important practical enlightenment for enterprises and policy makers, and shows that improving supply chain transparency and optimizing capital structure are effective ways to reduce financial risk.

Keywords: Supply Chain Transparency, Financial Risk, Regression Analysis, Corporate Governance, Information Asymmetry

1. Introduction

With the globalization and the increasing complexity of supply chain management, the financial risks faced by enterprises show the characteristics of diversification and multi-level. In this context, supply chain transparency has become an important factor affecting the financial health of enterprises. Supply chain transparency (SCT) means that an enterprise can clearly and accurately disclose information about its supply chain activities, risks, supplier information and production process in open channels. In recent years, supply chain transparency has been regarded as an important mechanism for managing supply chain risks, improving decision-making efficiency and reducing enterprise financial risks [1].

1.1. The impact of supply chain transparency on financial risk

Financial risk usually refers to the risk that the financial situation of an enterprise is unstable due to business activities, market fluctuations or changes in the external economic environment, which will

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affect its profitability, solvency and financial stability. Many scholars have discussed the impact of supply chain transparency on financial stability, especially in reducing information asymmetry, enhancing investor trust and improving supply chain efficiency [2]. For example, supply chain transparency can help enterprises identify potential market fluctuations and production bottlenecks through a clear supply chain view, so as to optimize resource allocation and reduce financial risks [3].

1.2. Research background and motivation

In recent years, with the gradual prevalence of investment concepts related to environment, society and Governance (ESG), supply chain transparency is not only a concern of the management, but also an important indicator for investors to assess the financial risk of enterprises. Many companies have begun to realize the important role of supply chain transparency in reducing financial risks, improving enterprise sustainability and attracting external capital. However, most of the existing studies focus on supply chain management and efficiency improvement, and there are still relatively few quantitative studies on how supply chain transparency affects enterprise financial risk.

This study aims to fill this research gap, using regression analysis method to explore the impact of supply chain transparency on enterprise financial risk. Through regression analysis of company data in different fields around the world, we aim to reveal the relationship between supply chain transparency and financial risk, and provide operable risk management strategies for enterprises through empirical results.

1.3. Research objectives and issues

The main objective of this study is to explore the role of supply chain transparency in reducing enterprise financial risk through empirical analysis. We will focus on the following two issues:

- Does supply chain transparency significantly affect the financial risk of enterprises?
- Does supply chain transparency affect financial risk differently in different industries and market environments?

1.4. Overview of research methods

In order to achieve the above research objectives, this study uses regression analysis method to analyze multinational companies from multiple industries using big data technology. Data sources include enterprise annual report, supply chain transparency index and relevant financial data. Research methods include multiple linear regression analysis, data cleaning, analysis and model validation using python (such as pandas, statsmodels and other libraries).

Data support and analysis methods：In this study, we will use the data from many multinational companies around the world, including the supply chain transparency index (SCTI) and the financial risk indicators of enterprises (such as financial leverage, asset liability ratio, etc.). The data will be preprocessed by python, cleaned by pandas library, and regressed by statsmodels library.

Data source: Enterprise financial data: from global databases, such as Compustat and Bloomberg.

Supply chain transparency data: use the existing supply chain transparency index, or collect through public enterprise annual reports and third-party audit reports.

Industry classification data: classified according to SiC (standard industry classification) and NAICS (North American industry classification system).

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2. Literature review

2.1. Supply chain transparency (SCT)

As a management mechanism, supply chain transparency (SCT) has received more and more attention in academia and practice in recent years. Supply chain transparency can be defined as the degree of information sharing in each link of the supply chain, including supplier selection, raw material procurement, production process, transportation and distribution, risk management and other information. In recent years, the improvement of supply chain transparency is considered to be one of the key factors to enhance supply chain toughness, reduce operational risk and improve enterprise performance [4].

Research shows that a transparent supply chain can help enterprises respond quickly in the face of supply chain disruption, thereby reducing the risk caused by information asymmetry. Supply chain transparency helps to reduce uncertainty and improve the trust relationship between suppliers and enterprises, so as to optimize the allocation of resources, reduce production costs and improve the financial stability of enterprises [5]. For example, by openly and transparently sharing the supply chain management process, production capacity and supplier audit results, enterprises can reduce supply chain risks, thereby reducing financial volatility.

2.2. Corporate financial risk

Financial risk refers to the financial uncertainty faced by enterprises due to external economic fluctuations or internal mismanagement. It is usually measured by financial leverage, earnings volatility, capital structure, liquidity and other indicators. Many studies have shown that financial risk management is crucial to the long-term survival and competitiveness of enterprises [6]. Especially in the context of globalization, the financial risk of enterprises is affected by multiple factors, including market demand fluctuations, currency risk, poor supply chain management and so on.

According to Froot et al [7]., the increase of financial risk may not only affect the market value of enterprises, but also reduce their financing ability and increase the cost of capital. In addition, excessive exposure to financial risks may also affect the profitability and financial stability of enterprises. Especially in the case of asymmetric information, enterprises are prone to higher financial risks. The opacity of supply chain management often leads to information distortion, which exacerbates this risk .

2.3. Relationship between supply chain transparency and financial risk

Many scholars have studied the relationship between supply chain transparency and enterprise financial risk. It is generally believed that supply chain transparency can help reduce the financial risk of enterprises by enhancing the sharing and flow of information. First, transparency improves the availability of information in the supply chain, helps enterprises to identify risks and bottlenecks in time, and thus reduces the financial fluctuations caused by risk accumulation [1]. For example, supply chain transparency has a positive effect on the risk management and control of enterprises. Especially in the case of financial crisis and market fluctuations, supply chain transparency can help enterprises respond and make decisions faster and reduce financial losses.

In addition, a transparent supply chain can also improve the trust of external investors and shareholders, thereby reducing the cost of capital and financing risks. On the contrary, the opacity of

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supply chain tends to aggravate the problem of information asymmetry, increase the uncertainty of supply chain management, and then enhance the financial risk. For example, if an enterprise fails to disclose the potential risks that may exist in the supply chain, it will distort the financial report, thus aggravating the volatility and financial instability of the capital market.

Table 1 lists some recent studies and discusses how supply chain transparency affects the financial risk of enterprises through different mechanisms.

Table 1. Research on the impact of supply chain transparency on financial risk

Researchers	Findings	Data Sources
Zhao & Lee (2020)	Supply chain transparency helps reduce financial risk, especially during market fluctuations.	2020 China corporate financial data
Xie & Lin (2019)	Transparent supply chains improve supply chain efficiency and reduce financial leverage risk.	Global Fortune 500 companies financial data
Shou et al. (2020)	Increasing supply chain transparency significantly reduces financing costs, particularly in industries with high information asymmetry.	2020 U.S. stock market corporate data
Wagner & Bode (2020)	Supply chain transparency reduces financial risk volatility by decreasing information asymmetry within the supply chain.	2019-2020 German industrial companies data

2.4. Research gaps and contribution of this study

Although some studies have proposed the potential impact of supply chain transparency on financial risk, there are still some gaps in the existing research. First of all, most of the existing literatures focus on the discussion of supply chain management efficiency and supply chain performance, and the quantitative analysis of financial risk is still lacking [1]. Secondly, most studies only discuss the impact of supply chain transparency on financial risk from the theoretical level, lacking systematic empirical analysis [2]. Therefore, empirical research based on regression analysis can fill this gap and provide a deeper understanding of this relationship.

This study aims to quantitatively analyze the impact of supply chain transparency on enterprise financial risk through regression analysis. Specifically, this study will build a multivariable regression model, use the actual data such as enterprise financial data and supply chain transparency index to explore the relationship between them, and control the impact of other variables such as industry and company size.

3. Methodology

3.1. Theoretical framework

Based on agency theory and information asymmetry theory, this study explores how supply chain transparency affects the financial risk of enterprises. Agency theory points out that there is information asymmetry between enterprise managers and shareholders, and supply chain transparency can be used as an effective mechanism to reduce this information asymmetry, so as to reduce the financial risks faced by enterprises [8]. Specifically, when an enterprise's supply chain becomes more transparent, the management can more effectively identify and respond to potential risks in the supply chain, thereby reducing financial uncertainty [9].

According to the theory of information asymmetry, supply chain transparency can reduce the moral hazard and adverse selection problems caused by information asymmetry [10]. By improving the availability of information, supply chain transparency enables managers and investors to identify

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potential risks in the supply chain earlier and make more informed judgments in financial decisions [4]. Therefore, we assume that there is a negative correlation between supply chain transparency and financial risk, that is, the higher the transparency of the supply chain, the lower the financial risk faced by the enterprise.

3.2. Data collection

In order to test the hypothesis of this study, we collected the public financial data, supply chain transparency data and other relevant variables of multinational enterprises. Data sources include but are not limited to the following aspects:

Enterprise financial data: financial data from Compustat and Bloomberg are used, which covers enterprises in many industries around the world from 2000 to 2023. We selected common financial indicators that affect financial risk, such as the leverage ratio, volatility of capital structure, current ratio, etc [6].

Supply chain transparency index (SCTI), released by several research institutions, covers enterprises in many industries and countries around the world. SCTI mainly measures the transparency of enterprises in supply chain management, including the degree of information disclosure in supplier selection, production process, quality control and environmental impact [3].

Industry and region variables: to control industry and region differences, we used SiC code (standard industry classification) and NAICS code (North American industry classification system) to classify the sample enterprises. In addition, the size and geographical location of enterprises are also included in the model as control variables [5].

3.3. Variable definition

The main variables of this study include supply chain transparency (independent variable), financial risk (dependent variable) and several control variables. Specific definitions are as follows:

Dependent Variable (Financial Risk)

The financial risk of an enterprise is measured by the following indicators:

- Leverage ratio: refers to the ratio of corporate debt to assets, reflecting the financial risk of the enterprise [6].

- Volatility of capital structure: it measures the volatility of an enterprise's capital structure and reflects the volatility of capital risk.

- Current ratio: an indicator to measure the short-term solvency of an enterprise as a supplementary measure of financial risk.

Independent Variable (Supply Chain Transparency, SCT)

Supply chain transparency is measured by the supply chain transparency index (SCTI). SCTI scores the transparency of enterprises in different dimensions, including supplier audit, production process disclosure, environmental impact assessment and social responsibility report [3].

3.4. Data analysis method

In this study, a multiple linear regression model will be used to examine the relationship between supply chain transparency (SCT) and financial risk. The regression model is specified as follows:

$$FinancialRisk_i = \alpha + \beta 1 * SCT_i + \beta 2 * Size_i + \beta 3 * Leverage_i + \beta 4 * Volatility_i + \varepsilon_i \quad (1)$$

Where:

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- Financial Risk: The dependent variable, representing the financial risk of the firm.
- SCT: The independent variable, representing the supply chain transparency of the firm.
- Size: Control variable, representing the firm size (measured by total assets).
- Leverage and Volatility: Control variables, representing the firm's capital structure and its volatility.
- ε_i: The error term.

In data analysis, we first use the pandas Library in Python to clean up the data, deal with missing values and abnormal values, and standardize the data. Then, we use the statsmodels library for multiple regression analysis to test the relationship between supply chain transparency and financial risk.

3.5. Model assumptions and diagnostics

During regression analysis, this study will carry out a series of diagnostic tests to ensure the effectiveness of the regression model and the reliability of the results. Specific diagnosis includes:

- Multicollinearity test: use variance inflation factor (VIF) to test whether there is multicollinearity between independent variables.
- Heteroskedasticity test: use white standard errors to test heteroscedasticity.
- Normality of residuals: check whether the model conforms to the assumption of normal distribution through the normality test of residuals.

4. Results

4.1. Descriptive statistics and data overview

In this study, we collected enterprise data from multiple industries from 2000 to 2023. The sample includes annual data of 1000 enterprises from 500 companies around the world, covering a number of industries (such as manufacturing, retail, technology, etc.). Data mainly include financial leverage ratio, capital structure volatility, liquidity ratio and supply chain transparency index. The sample data are from Compustat, Bloomberg and SCTI databases [3].

Firstly, this paper makes a descriptive statistical analysis of the collected data to understand the distribution and basic characteristics of each variable. The following are the descriptive statistical results of the main variables:

Table 2. Descriptive statistics of key variables

Variable	Mean	Standard Deviation	Minimum	Maximum
Financial Risk (Leverage Ratio)	0.45	0.12	0.22	0.78
Supply Chain Transparency (SCTI)	0.65	0.15	0.32	0.91
Firm Size (Total Assets)	2.32	1.47	0.34	10.76
Volatility (Capital Structure)	0.22	0.18	0.02	0.55

According to table 2, we can see that the average leverage ratio of financial risk is 0.45, indicating that most of the sample companies are at the medium level of financial risk. The average value of the supply chain transparency index is 0.65, indicating that these enterprises perform well in the transparency of supply chain management. In addition, the average value of enterprise size is 2.32 (logarithm of total assets), indicating that most companies are in the middle scale in the sample.

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4.2. Regression analysis results

In the regression analysis, we use the multiple linear regression model to test the impact of supply chain transparency on financial risk. The regression results of the model are as follows:

$$FinancialRisk_i = \alpha + \beta 1 * SCT_i + \beta 2 * Size_i + \beta 3 * Leverage_i + \beta 4 * Volatility_i + \varepsilon_i \quad (2)$$

Table 3. Regression analysis results

Variable	Coefficient	Standard Error	t-Statistic	p-value
Intercept	0.195	0.078	2.50	0.013
SCT (Supply Chain Transparency)	-0.280	0.065	-4.31	0.000
Firm Size	-0.102	0.030	-3.40	0.001
Leverage	0.350	0.092	3.80	0.000
Volatility	0.215	0.068	3.16	0.002

It can be seen from table 3 that there is a significant negative correlation between supply chain transparency (SCT) and financial risk (p-value=0.000), indicating that the financial risk (expressed in leverage ratio) of an enterprise will decrease by 0.280 unit for each unit of supply chain transparency. The negative value of the regression coefficient supports our hypothesis that supply chain transparency can effectively reduce the financial risk of enterprises.

In addition, enterprise size and capital structure volatility also have a significant impact on financial risk. The impact of enterprise size on financial risk is negative, indicating that larger enterprises usually have better financial stability. The impact of capital structure volatility on financial risk is positive, indicating that the instability of capital structure will increase the financial risk of enterprises.

4.3. Model fit and diagnostics

In order to test the effectiveness of the regression model, we conducted a number of diagnostic tests. The following are the fitting indexes of the regression model:

R-squared: 0.42

Adjusted R-squared: 0.41

F-statistic: 45.23 (p-value = 0.000)

These diagnostic results show that the fitting degree of the model is good, R-squared is 0.42, which means that about 42% of the financial risk variation can be explained by supply chain transparency and other control variables. The F-statistic is 45.23, and the P-value is less than 0.05, indicating that the regression model is significant as a whole.

At the same time, we conducted a heteroscedasticity test and used white standard errors. The results showed that there was no significant heteroscedasticity problem (p-value>0.05). In addition, through the variance expansion factor (VIF) test, we found that there was no multicollinearity problem (all Vif values were less than 5).

4.4. Discussion of results

The regression analysis results of this study support the hypothesis that supply chain transparency has a negative impact on enterprise financial risk. Specifically, the improvement of supply chain

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transparency significantly reduces the financial risk of enterprises. This finding is consistent with the research of Shou et al [3].. They also found that information transparency helps to reduce financial volatility. In addition, enterprise size and capital structure volatility are also important factors affecting financial risks. Larger enterprises are usually better able to cope with external financial risks due to better resource allocation and risk management capabilities [5].

5. Discussion and conclusion

5.1. Summary of key findings

The regression analysis results of this study show that supply chain transparency (SCT) has a significant negative impact on enterprise financial risk. Specifically, every unit of supply chain transparency increases, the financial risk of the enterprise (measured by the financial leverage ratio) will be reduced by 0.280 units. This finding shows that improving the transparency of the supply chain can effectively reduce the financial risks caused by information asymmetry and poor supply chain management. In addition, the stability of enterprise scale and capital structure also has a significant impact on financial risk. Larger enterprises usually have more resources and stronger risk management capabilities, so they can better cope with market fluctuations and reduce financial risks. On the contrary, the instability of the capital structure increases the financial risk of the enterprise, especially when the market fluctuates greatly or the interest rate changes, the debt paying pressure of the enterprise increases, and the financial stability is threatened.

These findings support the positive role of supply chain transparency in reducing enterprise financial risk, and provide an empirical basis for enterprise risk management in financial decision-making.

5.2. Comparison with existing literature

The existing literature focuses on the impact of supply chain transparency on operational risk and supply chain performance, but the quantitative analysis of financial risk is less [2]. For example, Wagner and Bode [1] found that supply chain transparency helps reduce supply chain operational risk, but did not discuss its specific impact on financial risk. This study reveals the relationship between supply chain transparency and financial risk through regression analysis, filling this research gap. Especially in industries with large fluctuations in capital structure, the improvement of transparency has a significant effect on the reduction of financial risk, which is consistent with the research conclusion of Shou et al [3]., and further verifies the importance of transparency in reducing financial volatility.

In addition, Kim and Lee [6] pointed out that financial risk management can significantly affect the financial stability of enterprises. This study further confirms this view, indicating that transparent supply chain management helps to enhance the trust of external investors, reduce financing costs, and enhance the financial toughness of enterprises.

5.3. Policy implications

The results of this study provide valuable practical guidance for policy makers and enterprise management. The following are some policy suggestions based on the research results:

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5.3.1. Promote supply chain transparency

The government and regulators should encourage enterprises to improve the transparency of supply chain, especially in supplier selection, production process, quality control and environmental impact. By formulating relevant policies and regulations, requiring enterprises to disclose key information in supply chain management can not only help enterprises improve operational efficiency, but also reduce financial risks caused by information asymmetry [3]. Improving the transparency of the supply chain will enhance investors' trust in enterprises, thereby reducing the cost of financing and capital, and enhancing the market competitiveness of enterprises.

5.3.2. Strengthen the management of enterprise capital structure

Enterprises should allocate debt and equity reasonably to avoid excessive dependence on debt financing, especially in the case of unstable capital structure. Enterprises can reduce financial risks caused by interest rate fluctuations or market changes by optimizing the capital structure. Research shows that the stability of capital structure is crucial to the control of financial risk, and enterprises should pay attention to the balance of capital cost and capital structure to enhance financial stability [7].

5.3.3. Enterprises should strengthen financial risk management

In industries with high information asymmetry, enterprises should strengthen the construction of financial transparency and supply chain transparency. Through open and transparent information disclosure, enterprises can reduce the financial risk caused by the opaque supply chain and enhance the trust of shareholders and investors. Enterprises can also use data analysis technologies, such as big data and machine learning, to further enhance the ability to predict and control financial risks [1].

5.3.4. Support SMEs to improve supply chain transparency

Although large enterprises usually perform well in terms of supply chain transparency, many small and medium-sized enterprises still face great challenges in this regard. The government can help SMEs improve the transparency of supply chain by providing financial support, training and technical support. The improvement of supply chain transparency not only helps to reduce financial risks, but also enhances the competitiveness of SMEs in the market [2].

5.4. Limitations and future research directions

Although this study reveals the significant impact of supply chain transparency on financial risk, there are still some limitations. First of all, the sample of this study is mainly from large companies and concentrated in specific industries and regions, which may not fully reflect the situation of all types of enterprises. Future research can expand the sample range to cover more industries and regions, especially SMEs and emerging markets, so as to verify the wide applicability of the research results.

Secondly, this study only uses the financial leverage ratio as a measure of financial risk. Future studies can consider using other financial risk indicators, such as capital cost, credit risk or default probability, to comprehensively measure the financial risk of enterprises. In addition, structural

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equation modeling (SEM) or machine learning algorithm can be used in future research to further improve the prediction accuracy and flexibility of the model.

Finally, supply chain transparency is a multi-dimensional concept. Future research can further explore the specific impact of different dimensions of supply chain transparency (such as supplier transparency, production transparency, transportation transparency, etc.) on financial risk, so as to further enrich the relationship between supply chain transparency and financial risk.

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