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From Risk to Resilience: A Data-Driven Mediation Analysis of Supply Chain Risk Management and Firm Performance in Chinese Manufacturing

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Abstract: This paper investigates whether supply chain resilience serves as a mediator in the relationship between supply chain risk management and firm performance in China's manufacturing industry, leveraging big data analytics and digital technologies to fill the theoretical void on how risk management practices contribute to financial performance in the digital era. Applying resource-based theory and dynamic capabilities theory approaches to guide theory development constructs an integrated framework in which supply chain resilience serves as the key conduit or mediation variable that translates diversified strategies to better organizational effectiveness. Using panel data from 347 Chinese A-share listed manufacturing firms (2,418 firm-years, 2015–2023) drawn from the China Stock Market and Accounting Research (CSMAR) database, this study employs panel regression and bootstrap mediation analysis to test the proposed framework. Supply chain risk management is operationalized through supplier and customer diversification, while supply chain resilience is captured by financial slack, operational efficiency, supply chain redundancy, and relationship stability. Results from panel regression and bootstrap mediation analysis confirm that supply chain risk management significantly enhances firm performance, with supply chain resilience serving as a significant partial mediator that substantially channels the effect. The findings are robust across alternative variable specifications, lagged models, and winsorized samples. The findings suggest that building supply chain resilience is the primary channel through which risk management investments translate into improved financial performance.

Keywords: Supply Chain Risk Management; Supply Chain Resilience; Firm Performance; Digital Technologies; Data Analytics; Chinese Manufacturing Industry

1. Introduction

The Chinese manufacturing industry, which generated 28% of the world's total manufacturing output in 2023, is increasingly susceptible to risks associated with its supply chain, which may be attributed to geopolitical tensions, the lasting effects of the COVID-19 pandemic, and the ambiguity of international trade policies. For instance, the

U.S.-China trade tensions, which emerged in 2018, affected the supply chain of over 60% of the surveyed Chinese manufacturers. Recent studies indicate that supplier as well as customer concentration influences strategies as well as financial aspects of companies [1]. This is especially true for Chinese publicly listed manufacturing companies, for whom the patterns of concentration in their supply chains have been found to influence their corporate financialization behavior and decision-making processes [2]. The increasing number of disruptions that have occurred affecting the supply chain, from the effect of geopolitical tensions to that of pandemics, has sparked interest in research that sheds light on the effect certain risk factors have upon the supply chain and, by consequence, the performance of the firm itself [3]. In this context, understanding how firms manage supply chain concentration risks and develop resilience capabilities has become a pressing research question for the manufacturing sector.

Taking into consideration the above, supply chain resilience has emerged as a relevant area of research, which helps in resisting, responding to, and recovering from any type of disruption. Research using data from Chinese manufacturers has shown that the relationship between supply chain resilience dimensions and performance indicators is neither direct nor universal, but context-dependent [4]. Research further suggests that supply chain resilience is a context-dependent construct, influenced by firm-level strategies and institutional factors [5,6].

The theoretical foundations of supply chain risk management are deeply rooted in the resource-based view and dynamic capabilities approach, which provide an integral framework for comprehending the use of internal resources for dealing with external uncertainties. Studies have proved that supplier concentration affects corporate innovation capabilities, as the risk-taking attitude and available resources limit exploratory efforts [7]. Studies have demonstrated that integrated risk management approaches enhance firm resilience, particularly during periods of significant disruption such as the COVID-19 pandemic [8]. Worth noting, for instance, are the asymmetrical impacts of the degree of customer and supplier concentration on the robustness of the firm, where resource dependence and balancing of power play significant moderating roles [9].

The interaction between supply chain structure and the performance of firms has been widely researched, but there are important uncertainties regarding the exact relationship between risk management practices and their outcome. The relationship between customer concentration and the financial performance of the supplier, for example, exhibits an inverted U-shaped relationship, which means that the optimal point of interdependencies lies somewhere between collaboration and independence [10]. Integration of enterprise risk management and supply chain performance has had a positive relationship, and the capability of firm resilience acted as an important mediating factor for influencing risk management efforts and exerting them on performance [11]. The transformation of manufacturing supply chains has been recognized as an important driver of both innovativeness and performance improvement, and supply chain resilience appears as an important mediating factor in such processes [12].

Although the literature has made considerable progress in comprehending the individual elements within the supply chain risk, resilience, and performance relationship, there are certain obvious gaps and shortcomings that are worth exploring. Existing research efforts have mainly focused on the direct association between the investment aspects of risk management and performance, without the due consideration of the mediating and magnifying effects of the capability aspect of risk management. The integration of resource-based theories and dynamic capabilities approaches, especially concerning the interaction of static resource structure and dynamic adaptive processes, remains an uncharted territory for research on the management of supply chains. Empirical research efforts based on objective financial information, especially in emerging markets, are less common, as the existing research efforts are based on subjective information derived from surveys. Although there are efforts to examine the association between risk management practices and performance based on the development of resilience, the underlying processes for the manufacturing industry in China are not yet well understood.

This research fills the above gaps by proposing and testing an integrated theoretical model, where the mediating role of supply chain resilience is assumed between supply chain risk management and firm performance. The proposed study relies on panel data gathered from the CSMAR database system for Chinese A-share listed manufacturing firms and uses the following indicators for supply chain risk management, which are supplier and customer diversification, and for supply chain resilience, which are financial slack, operational efficiency, supply chain redundancy, and relationship stability [13]. The analytical technique combines direct effect testing and mediation analysis, allowing for the examination of the relationship between practices of risk management and performance outcomes as factors that influence the development of resilience capability [14]. Through the integration of the resource-based view and dynamic capabilities theoretical perspectives, the study offers an integrated explanation

for the reasons and means through which the management of supply chain risk serves as a strategic resource for improving the performance of the firm through the development of resilience as a dynamic capability [15]. This study contributes to the field by demonstrating the empirical viability of the risk-resilience-performance framework using large-scale archival data, with implications for data-driven supply chain management practices.

The current study makes three contributions to supply chain management theory. First, this study empirically supports the mediating effects of supply chain resilience on the relationship between risk management and performance, thereby bridging the gap between the resource-based theory and the dynamic capabilities perspective. Second, this study adopts a more objective financial-based approach to testing hypotheses rather than a more subjective survey-based study that is more susceptible to errors and less generalizable to other populations, especially Chinese listed companies. Thirdly, this research provides useful managerial implications to manufacturing managers by finding that supply chain risk management investments generate their primary source of value through supply chain resilience building. The structure of this paper is as follows: Section 2 is the introduction to the background and hypotheses, Section 3 is the data and methodology section, Section 4 is the results section, Section 5 is the discussion section, and Section 6 is the conclusions section.

2. Theoretical Background and Hypothesis Development

2.1. Resource-Based View and Supply Chain Risk Management

The resource-based view (RBV) argues that businesses can attain sustained competitive advantage based on the deployment of resources that are valuable, scarce, inimitable, and non-substitutable [16]. In the context of supply chains, diversification of supplier and customer relationships can be regarded as a strategic resource that helps in reducing reliance on a single partner and consequently minimizes concentration risks that may occur in the process [1,9]. Businesses that make resource allocation decisions in diversification strategies can effectively manage supply chain disruptions, as the loss of a single partner in supply chains will be less detrimental to the overall supply chain due to the diversification aspect. In this context, supply chain risk management can be regarded as a resource deployment decision with performance implications. When supply chains diversify their supplier and customer networks, they can effectively manage input price risks, bargaining power, and alternative supply options that can ultimately enhance their financial performance [7,10]. Based on these arguments:

H1. *Supply chain risk management has a significant positive effect on firm performance.*

2.2. Dynamic Capabilities and Supply Chain Resilience

Dynamic capabilities theory has extended the RBV by describing the process of change in the resource profile in response to environmental changes [17]. Supply chain resilience, as the ability to anticipate, absorb, adapt to, and recover from disruptions, represents a dynamic capability that transforms resource configurations into adaptive capabilities [4,15]. The process through which risk management practices build supply chain resilience follows several mechanisms. Supplier diversification provides redundancy in the supply chain in the event of supply disruptions. Customer diversification provides stability in revenue streams. Resources built up from diversification create an ability to manage uncertainty that manifests as supply chain resilience [8,14]. Empirical evidence from the manufacturing sector provides evidence for the resource-to-capability transformation in building supply chain resilience for firms that have adopted proactive risk management practices [11,18]. Accordingly:

H2. *Supply chain risk management has a significant positive effect on supply chain resilience.*

2.3. Supply Chain Resilience and Firm Performance

Supply chain resilience improves firm performance through various routes. Financial slack helps to generate the liquidity required to quickly react to unexpected disruptions in the supply chain, enabling the firm to take advantage of opportunities or cope with disruptions without disrupting normal operations [6]. Operational efficiency, as represented by inventory management competency, ensures that there is continuous movement of materials, hence lowering holding costs, thereby improving profitability. Supply chain redundancy, as represented by the number of suppliers in the supply chain, helps to develop alternative supply routes that can sustain operations in the face of disruptions. These dimensions of supply chain resilience work together to help the firm sustain nor-

mal operations in different economic conditions, hence improving financial performance compared to less resilient competitors [11,12]. Therefore:

H3. *Supply chain resilience has a significant positive effect on firm performance.*

2.4. The Mediating Role of Supply Chain Resilience

Integrating the RBV with the Dynamic Capabilities Theory (DCT) provides the theory to explain the indirect route through which risk management can affect performance. The RBV theory provides the basis to explain that diversified strategies represent the deployment of valuable resources, whereas the DCT provides the basis to explain how this can be converted into an adaptive capability within the organization [15,19]. The mediation perspective implies that the route to the development of performance benefits associated with supply chain risk management is not solely the result of the direct effects of risk reduction but is largely the result of the development of resilience as an organizational capability [14,20]. This theoretical reasoning leads to the following mediating hypothesis:

H4. *Supply chain resilience mediates the relationship between supply chain risk management and firm performance.*

3. Data and Methodology

3.1. Data Source and Sample

This research utilizes data from the China Stock Market and Accounting Research (CSMAR) database (<https://www.csmar.com/en/>), one of the most popular financial databases for research on Chinese listed companies. CSMAR is jointly developed by GTA Information Technology (Shenzhen GTA Education Tech Ltd.), the University of Hong Kong, and the Hong Kong Polytechnic University, covering supply chain structure and financial statement information for Chinese listed companies. The modules of the CSMAR database for our research are Supply Chain Research Database (supplier and customer concentration ratio) and Financial Research Database (financial statement information). The stock code of firm is available for linking supply chain structure information and financial information together.

The selection process follows a systematic filter approach. Starting with the population of about 2,800 A-share manufacturing firms that were listed on the stock market and had operated at least once between 2015 and 2023 according to the industry standards set by the China Securities Regulatory Commission, the first filter is the availability of supply chain data. Due to securities regulations in China, manufacturing firms must disclose their top five supplier and customer concentration ratios only if the proportion of their transactions with a single entity exceeds a certain threshold. As a result, about 2,350 firms (about 84% of the original population) are excluded because they failed to disclose their supply chain concentration data in at least one of the sampling years. This is in line with other supply chain research based on CSMAR data, as supply chain information is not mandatory and usually disclosed on a voluntary basis by a minority of listed manufacturing firms. Out of the remaining 450 firms, 38 firms under Special Treatment (ST/*ST, where "ST" denotes Special Treatment applied by the Shanghai and Shenzhen Stock Exchanges to listed firms reporting net losses for two consecutive fiscal years or otherwise showing abnormal financial conditions, and the asterisk prefix "*" in "*ST" further indicates that the firm has been issued a delisting-risk warning after meeting statutory delisting triggers such as three consecutive years of losses) are excluded due to financial distress. Another 65 firm-year observations are excluded due to missing data on important financial variables or negative shareholders' equity. In total, the final sample consists of an unbalanced panel of 347 manufacturing firms with 2,418 firm-year observations (on average about 7.0 years per firm in the nine-year period).

3.2. Variable Measurement

The indicators that are utilized for the measurement of Supply Chain Risk Management are based on the degree of diversification that offsets the risk of concentration for both upstream and downstream exchanges. Supplier diversification, for example, is measured as one minus the percentage of the total value of purchases from the top five suppliers, while the corresponding customer diversification can be calculated as one minus the percentage of total revenue from the top five customers. These two factors are standardized and then combined, on average, for the creation of the Supply Chain Risk Management index. The underlying theoretical basis for the measurement of Supply Chain Risk Management can be traced to the Resource Dependence Perspective, which argues that high

levels of concentration for exchange relationships increase the sensitivity of the firm.

Supply chain resilience is defined as a multidimensional construct and measured using various indicators that represent different dimensions of the adaptive process. Financial slack, calculated as cash and cash equivalents to total assets, represents the degree to which financial resources are available and can be allocated immediately to an unexpected situation. Operational efficiency, calculated using the inventory turnover ratio, indicates the degree to which the supply chain management is efficient, and it can ensure the continuous and optimal material flow process. Supply chain redundancy, calculated as the natural logarithm of the number of disclosed suppliers plus one, represents the degree to which buffers are created and are available for use in the supplier network. Relationship stability, calculated as the proportion of overlapping suppliers retained from the prior year, captures the continuity and reliability of established supply chain partnerships. These indicators are standardized and combined using the principal component analysis (PCA) technique, a widely used data analytics and machine learning method for dimensionality reduction, along with weighted averaging.

Firm performance is measured using several financial ratios that focus on various aspects of firm productivity. Return on assets (ROA) is calculated as net earnings divided by the average total assets. Return on equity (ROE) is calculated as earnings divided by the average shareholders' equity. Tobin's Q is calculated as the sum of the market value of total assets and the book value of total liabilities divided by total assets. Revenue growth rate is calculated as the percentage increase in operating revenue from the last fiscal year. The control variables that are included in the research design are the size of the firm (natural logarithm of the total assets) and the age of the firm (natural logarithm of the number of years the firm has been operating plus one). In addition, financial leverage, which is total liabilities divided by total assets, and state ownership, which is a dummy for state-owned enterprises, are control variables.

3.3. Model Specification

The empirical study uses panel data regression equations that utilize both the cross-sectional and temporal dimensions for the testing of the proposed relationships. The baseline model regresses firm performance on Supply Chain Risk Management (SCRM), a set of control variables, firm fixed effects, year fixed effects, and an idiosyncratic error term. The model choice for either the fixed or the random effects model uses the Hausman specification test.

The mediation analysis follows Baron and Kenny's stepwise approach as a referential framework, with bootstrap resampling serving as the primary inference method given its superior performance under non-normal sampling distributions of indirect effects. Step 1 involves the regression of firm performance on SCRM and controls (total effect). Step 2 involves the regression of Supply Chain Resilience (SCR) on SCRM and controls (path a). Step 3 involves the regression of firm performance on SCRM, SCR, and controls, which gives the direct effect (path c') and allows us to calculate the indirect effect ($a \times b$).

Mediation is supported if SCRM is a significant predictor of firm performance in Step 1, SCR is a significant predictor of SCR in Step 2, SCR is a significant predictor of firm performance controlling for SCRM in Step 3, and the coefficient for SCRM becomes less significant when controlling for SCR. The indirect effect is calculated as the product of paths a and b coefficients.

3.4. Analytical Strategy

The analytical approach combines multiple complementary analyses to improve the robustness and validity of the empirical results. The indirect effect is analyzed employing the bootstrap technique using 5,000 resampling cycles—a computationally intensive data analytics approach—allowing for the creation of bias-corrected confidence intervals, which provide a stronger foundation for statistical inference compared to standard testing, as the sampling distribution of the indirect effect frequently fails to satisfy the normal distribution assumption. Robustness analyses are conducted replacing the original measures for the variables, choosing, for example, individual performance data as opposed to composite scores, to ensure that the findings are not dependent on the specification of the model. The problem of potential endogeneity, either due to reversed causality and omitted variables, is primarily addressed through the incorporation of lagged independent variables, along with firm and year fixed effects to control for unobservable confounders. Subsamples are divided following the characteristics of ownership structure and the size of the firms, enabling the examination of the heterogeneity that exists regarding the hypothesized links for varying contexts. The standard errors are clustered for the firm-level analysis. The analy-

sis is implemented in Python using pandas for data manipulation, statsmodels for panel regression, and scipy for bootstrap resampling.

4. Results

4.1. Descriptive Statistics and Correlation Analysis

Table 1 shows the descriptive statistics. The final sample consists of 2,418 firm-years from 347 manufacturing firms listed on China’s A-share stock exchange from 2015 to 2023. The mean ROA is 0.052 (S.D. = 0.068), suggesting significant differences in profitability among firms in the industry. The range of ROE is from -0.586 to 0.452 (mean = 0.078), again suggesting significant differences in financial performance among firms in the industry. The mean Tobin’s Q is 2.156, suggesting firms in our sample are, on average, valued at more than their book assets. The mean SCRM index is 0.482, suggesting 48% of procurement and sales partners are outside the top five partners, indicating intermediate supply chain diversification. The PCA-based resilience index is standardized (mean = 0, S.D. = 1). Among the control variables, the mean size (ln(total assets)) is 22.348, and the mean leverage is 0.428. State-owned enterprises comprise 34.2% of our sample.

Table 1. Descriptive Statistics.

Variable	N	Mean	S.D.	Min	Max
ROA	2,418	0.052	0.068	-0.245	0.289
ROE	2,418	0.078	0.124	-0.586	0.452
Tobin’s Q	2,418	2.156	1.084	0.856	8.742
Revenue Growth	2,418	0.126	0.284	-0.521	1.856
SCRM	2,418	0.482	0.198	0.052	0.924
SCR	2,418	0.000	1.000	-2.854	3.126
Financial Slack	2,418	0.168	0.112	0.012	0.586
Operational Efficiency	2,418	5.842	4.256	0.524	28.462
Supply Chain Redundancy	2,418	2.148	0.682	0.693	4.025
Relationship Stability	2,418	0.682	0.185	0.125	1.000
Firm Size	2,418	22.348	1.256	19.524	26.842
Firm Age	2,418	2.856	0.452	1.386	3.892
Leverage	2,418	0.428	0.186	0.048	0.892
SOE	2,418	0.342	0.475	0.000	1.000

Notes: ROA = Return on Assets; ROE = Return on Equity; SCRM = Supply Chain Risk Management; SCR = Supply Chain Resilience (PCA composite of Financial Slack, Operational Efficiency, Supply Chain Redundancy, and Relationship Stability); SOE = State-Owned Enterprise.

Figure 1 displays the distributional properties and bivariate relationships. Panel (a) displays kernel density plots for the three focal variables: SCRM and ROA have normal distributions, while SCR has a slightly positively skewed distribution. Panel (b) displays the Pearson correlation matrix. The correlation between SCRM and ROA ($r = 0.186$) lends initial support for the existence of a positive risk management-performance relationship. The correlations between SCRM and SCR ($r = 0.224$) and between SCR and ROA ($r = 0.312$) support the proposed mediation model. The correlations between all pairs of variables fall below 0.70, and the variance inflation factors are well under 10, indicating that multicollinearity is not a problem.

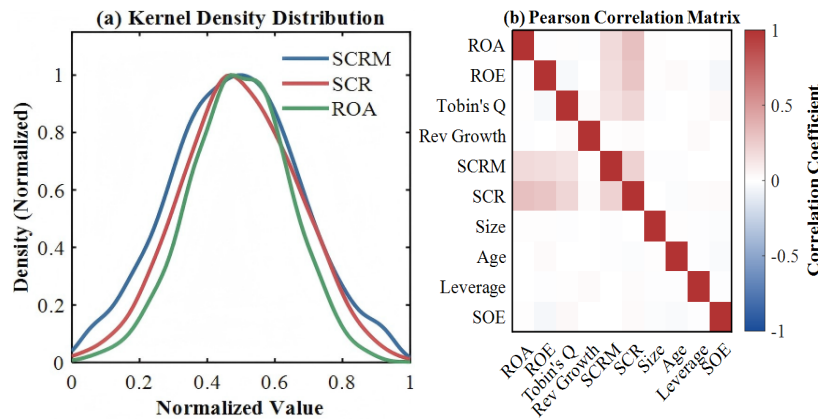


Figure 1. Distribution and Correlation Analysis of Key Variables.

4.2. Main Effects Tests

Table 2 displays the panel regression estimates with firm and year fixed effects, where standard errors are clustered at the firm level. The Hausman Test supports the use of fixed effects ($\chi^2 = 68.42, p < 0.001$). In Model 1, SCRM is found to have a significant and positive impact on ROA ($\beta = 0.048, p < 0.01$), suggesting that for every one standard deviation increase in supply chain diversification, profitability improves by 4.8% points, thus supporting H1. In Model 2, SCRM is found to significantly predict SCR ($\beta = 0.312, p < 0.001$), thus validating H2, where higher levels of supplier and customer diversification lead to higher levels of firm-level resilience capacity. In Model 3, it is evident that SCR is a significant predictor of ROA ($\beta = 0.086, p < 0.001$), controlling for SCRM and validating H3. Among the control variables, leverage is consistently and negatively related to ROA across all three models, whereas firm size is negatively related but with small coefficients, possibly due to decreasing returns to scale. SOE is found to be statistically insignificant.

Table 2. Main Effects Regression Results.

Variable	Model 1 (ROA)	Model 2 (SCR)	Model 3 (ROA)
SCRM	0.048*** (0.012)	0.312*** (0.045)	0.021** (0.010)
SCR	—	—	0.086*** (0.018)
Firm Size	-0.008** (0.003)	0.124*** (0.028)	-0.012*** (0.003)
Firm Age	-0.004 (0.006)	-0.056 (0.048)	-0.002 (0.006)
Leverage	-0.142*** (0.024)	-0.286*** (0.086)	-0.118*** (0.022)
SOE	0.003 (0.008)	0.042 (0.062)	0.002 (0.008)
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
R ² (within)	0.124	0.186	0.168
Observations	2,418	2,418	2,418
Firms	347	347	347

Notes: Standard errors clustered at the firm level in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Figure 2 provides a visualization of the results. In panel (a), standardized path coefficients with 95% confidence intervals for the hypothesized paths are provided. In panel (b), the predicted ROA as a function of SCRM with other variables held at their means is provided.

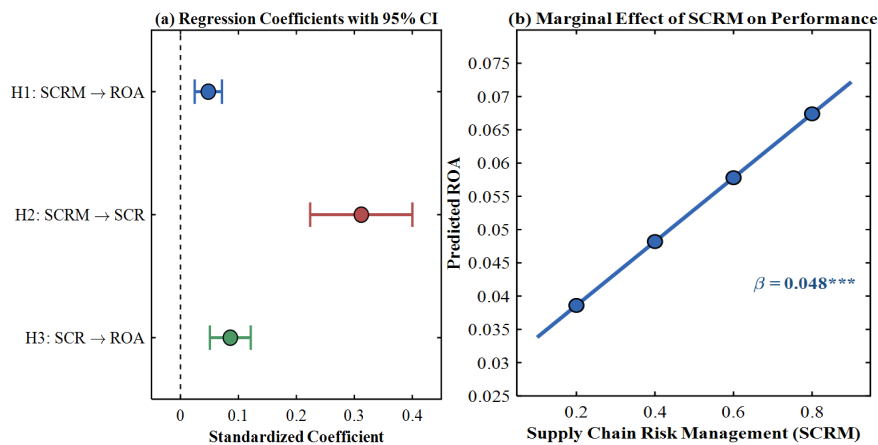


Figure 2. Main Effects Analysis.

4.3. Mediation Effect Test

Table 3 follows Baron and Kenny’s approach to analyze the total effect of SCRM on ROA and its decomposition into direct and indirect effects. The total effect of SCRM on ROA is divided into direct and indirect effects. The total effect is denoted by $c = 0.048$; its direct component is represented by $c' = 0.021$, and its indirect component is

represented by $a \times b = 0.312 \times 0.086 = 0.027$. The bootstrap test for assessing the significance of the indirect effect with 5,000 replications and a bias-corrected 95% confidence interval [0.014, 0.042] validates its significance. The Sobel test also supports this finding with a Z statistic of 4.286 and $p < 0.001$. The mediation ratio is 56.25%, which is higher than 50% and suggests that more than half of the performance gain from risk management is through building resilience. However, as the direct effect is also significant, we conclude that the relationship is partially mediated because diversification affects profitability directly as well as indirectly through building resilience.

Table 3. Mediation Effect Decomposition.

Effect Type	Coefficient	Boot SE	Boot 95% CI	Percentage
Total Effect (c)	0.048***	0.012	[0.025, 0.071]	100.00%
Direct Effect (c')	0.021**	0.010	[0.002, 0.040]	43.75%
Indirect Effect (a × b)	0.027***	0.007	[0.014, 0.042]	56.25%
Path a (SCRM → SCR)	0.312***	0.045	[0.224, 0.400]	—
Path b (SCR → ROA)	0.086***	0.018	[0.051, 0.121]	—
Sobel Test Z	4.286***	—	—	—

Note: Bootstrap results based on 5,000 iterations. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Another set of visualizations is offered in **Figure 3**. In this case, panel (a) represents a structural model of paths with standardized coefficients, while panel (b) presents a bootstrap sampling distribution of the indirect effect with values centered around 0.027 and all values being positive.

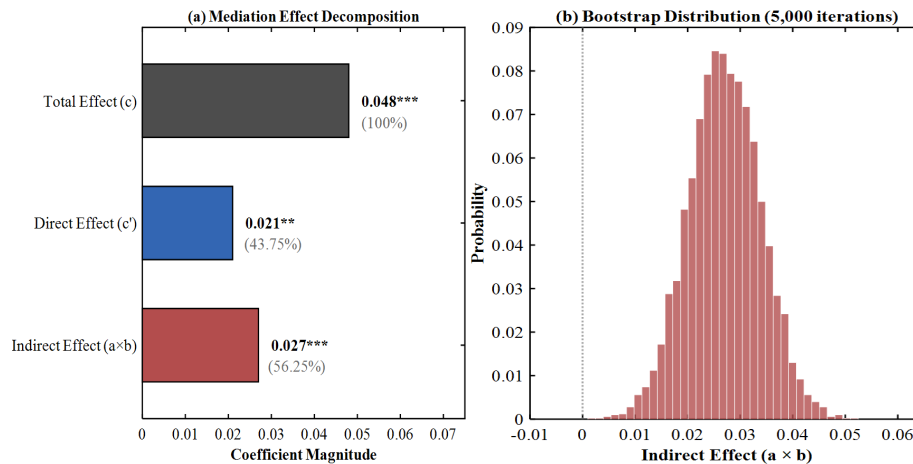


Figure 3. Mediation Effect Analysis.

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

4.4. Robustness Tests

Table 4 summarizes four robustness checks. First, replacing ROA with ROE as the dependent variable preserves the significant indirect effect (0.035, 95% CI [0.018, 0.054]; mediation ratio 56.45%). Second, in the lagged model where current period performance is regressed on prior period SCRM, the total effect is 0.042 and the indirect effect is 0.024 (57.14% mediated), which supports the hypothesized direction of causality. Third, winsorizing all continuous variables at the 1st and 99th percentiles results in almost identical results (indirect effect = 0.026, 56.52% mediated). Fourth, substituting simple averaging for PCA in constructing the resilience index retains a significant indirect effect of 0.025 (54.35% mediated). Across all specifications, the bootstrap confidence intervals exclude zero and the mediation ratios consistently exceed 50%.

Table 4. Robustness Test Results.

Specification	Total Effect	Direct Effect	Indirect Effect	Boot 95% CI	Mediation %
Baseline (ROA)	0.048***	0.021**	0.027***	[0.014, 0.042]	56.25%
Alt. DV (ROE)	0.062***	0.027**	0.035***	[0.018, 0.054]	56.45%

Table 4. Cont.

Specification	Total Effect	Direct Effect	Indirect Effect	Boot 95% CI	Mediation %
Lagged IV (t - 1)	0.042***	0.018**	0.024***	[0.012, 0.038]	57.14%
Winsorized (1%)	0.046***	0.020**	0.026***	[0.013, 0.041]	56.52%
Alt. Mediator	0.046***	0.021**	0.025***	[0.012, 0.040]	54.35%

Notes: Bootstrap results based on 5,000 iterations. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Figure 4 visualizes the robustness results. Panel (a) plots indirect-effect estimates with 95% confidence intervals across the four specifications, all of which lie above zero and overlap substantially with the baseline. Panel (b) compares mediation ratios, confirming that resilience consistently explains more than half of the total effect.

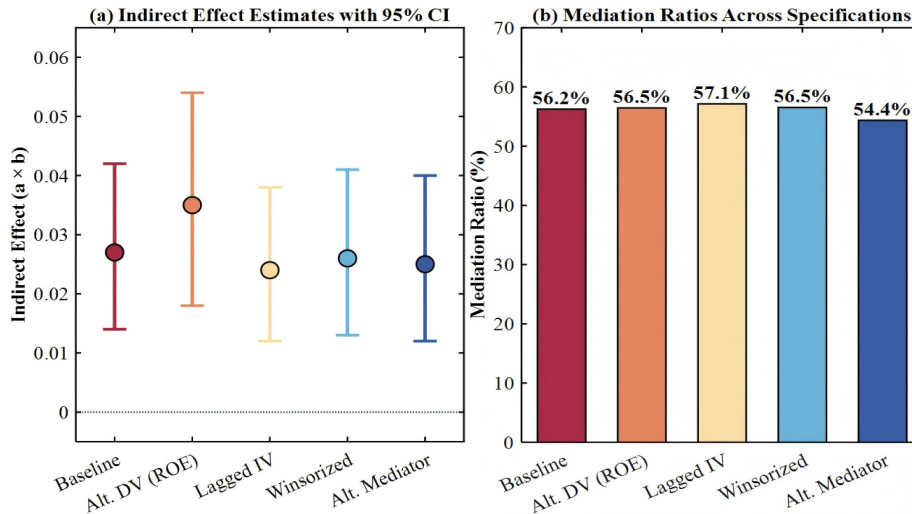


Figure 4. Robustness Test Comparison.

5. Discussion

The findings offer full support to all four hypotheses. SCRM has a positive impact on firm performance (H1: $\beta = 0.048$), supply chain resilience (H2: $\beta = 0.312$), which in turn affects profitability (H3: $\beta = 0.086$), with the mediation of supply chain resilience on 56.25% of the total effect (H4). These findings verify that the performance effects of supplier and customer diversification in Chinese manufacturing are largely transmitted through the development of supply chain resilience and not merely through the direct mitigation of risks.

The positive link between SCRM and firm performance is consistent with recent findings that integrative supply chain strategies enhance organizational resilience against threats and disruptions [21]. The magnitude of the total effect is consistent with systematic reviews examining the operational impact of COVID-19, which demonstrate that proactive risk management practices yield measurable performance improvements [22]. The high value of the path coefficient between SCRM and SCR, i.e., 0.312, affirms the theoretical assumption that diversification of the supply chain helps develop resilience capacities that act as a buffer against environmental uncertainties [18]. The study makes an addition to the existing literature by accepting that the relationship is not confined to situations of crises, but it is applicable over a broad time frame that encompasses situations of stability as well as turbulence. The study is in conformity with the existing literature on research on risks in the supply chains that are driven by the sustainability paradigm. The study accepts that dynamic management practices are of significance in countering the adverse impacts of risks in the supply chains [23].

Theoretically, the findings advance understanding of how the Resource-Based View operates within the supply chain management context. The mediating pathway, which accounts for 56.25% of the total effect, confirms that risk management practices serve as strategic vehicles for capability building [19]. This study further refines the existing framework for the Resource-Based View by demonstrating that the performance benefits accruing from the supply chain structures are not direct but, in fact, are indirect, with an underlying attribute of creating and

developing resilience [24]. The 0.086 path coefficient of the association between supply chain resilience and performance reveals that for every unit increase in the capacity of resilience, there are accompanying financial gains. This study bridges the resource-based view and dynamic capabilities perspectives. This addresses the criticism levied against studies that concentrate exclusively on one theory since it aims to offer a comprehensive theory framework in which the impact of static capabilities on the emergence of dynamic advantages is explored [25]. The partial mediation result—whereby the direct effect (0.021) remains significant but is smaller than the total effect (0.048)—indicates that the performance benefit of diversification strategy comes in different forms, of which the resilience factor would be but one [20]. This context is pertinent to debates on whether supply chain resilience is viewed as a distinct capability or whether it arises from organizational configurations.

This study also adds to the body of knowledge regarding the relationship that exists between the structure of supply chain management and the resultant performance, termed as the risk-resilience-performance nexus, in the context of developing markets, particularly in the case of the Chinese market. The Chinese manufacturing industry has some distinct features, such as the high concentration of the supply chain network, the focus of the government on supporting strategic industries, and the digitalization initiatives taken by the government. Though the present study does not examine the digital supply chain management capabilities, past studies suggest that the application of big data analytics and artificial intelligence may be able to improve adaptive orientations and dynamic responsiveness, which are vital for supply chain resilience [26]. The findings regarding the risk-resilience-performance nexus, as well as the consistency of the findings across alternative performance and robustness, confirm the validity of the risk-resilience-performance nexus, indicating that the relationship may be independent of the measurement approach and the robustness of the findings. Similar findings regarding the positive relationship between diversification and profitability are consistent with the past study, indicating that the supply chain of diversified businesses tends to be more financially stable during the course of the economic cycle [27]. These findings are also consistent with the theoretical propositions that risk management investments create financial returns not just through risk protection but also through the development of adaptive orientations [28].

The implications of the above findings, as they relate to managerial decision-making, are of particular interest. Bearing in mind that the indirect effect of the diversification of the supply chain on the improvement of profitability, which is mediated by the resilience mechanism, was found to be stronger (0.027) than the direct effect (0.021), it is recommended that manufacturing managers should focus on the development of resilience as the main value creation channel of risk management investments, a view that is in line with the findings of research that strategic corporate actions aimed at addressing constraints in the supply chain are major drivers of the sustainable growth of the enterprise [29]. The manager should be aware that the main returns of the investment in the development of resilience are indirect, with the improvement of the performance of the enterprise achieved over time, as opposed to directly, as could intuitively be expected, as the improvement of the performance is the result of the development of the capabilities of the enterprise, not the direct result of the investment in the resilience mechanism itself, as could intuitively be expected. The findings of the study suggest that the development of the resilience of the enterprise should be recognized as a strategic priority, as the main channel of the improvement of the performance is this process [30]. In the case of organizations that aspire to improve the resilience of their supply chains, the efforts aimed at the development of the digital economy, through the implementation of IoT systems, cloud computing, as well as intelligent data analytics, could prove fruitful, as the development of the digital economy was shown to have a positive effect on the resilience of the industry chain [31]. The implementation of AI and machine learning technologies in the management of the supply chains could prove fruitful, as this is in line with the principles of Industry 4.0, with the findings of the study showing that the implementation of AI technologies in the development of the intelligent system has a major effect on the resilience of the manufacturing industry chain [32]. The Chinese manufacturers could improve the development of the resilience of their enterprises, as well as the development of the infrastructure of the country, satisfying at the same time the agendas of the sustainability of the supply chains of the enterprises of the country.

In spite of the above-listed contributions of the study, there are some limitations of the research that are worth mentioning. Firstly, the study relies on proxy variables such as financial slack, operational efficiency, and supply chain redundancy, which are extracted from the financial statements but may not entirely capture the complex nature of the concept of resilience as a multidimensional construct. Future studies could incorporate perceptual measures of resilience using survey-based variables [33]. Secondly, the context of the Chinese manufacturing sec-

tor could be considered as having limitations in terms of generalizability to other contexts or industries. Future studies could conduct comparative analyses of various nations to assess the possibility of the study being context-dependent on the institutional context and the presence of universal tendencies [34]. The variables related to the measures of risk management only incorporate the diversification dimension but exclude other dimensions such as the integration of processes, information sharing, and collaborative planning [35]. Future studies could assess the combined effect of the different strategies of managing risks on the development of resilience.

Additionally, the dynamic nature of the relationship between risk, resilience, and performance also has to be explored in greater detail. While the lagged specification has helped mitigate the issue of reverse causality, the exact time period for which risk management investments lead to resilience and performance improvements is uncertain. The lagged specification has given an indirect effect of 0.024, as opposed to 0.027 for the direct specification, which indicates a certain level of temporal attenuation that has to be explored in greater detail. Longitudinal research design has to be adopted for exploring such dynamic aspects in greater detail [36]. The scope for certain characteristics of firms, industry, and environmental factors potentially acting as moderators for the proposed relationship offers certain new avenues for research. Studies on the moderating effects of factors such as ownership, technological intensity, and competition, along with the strength of the risk-resilience relationship, are expected to improve the theoretical formulations [37]. The digitalization of supply chains and sustainability concerns offer certain new directions for research on the role of digital capabilities and sustainability performance in interacting with traditional risk management as determinants of corporate resilience. The rise in geopolitical events and the reverberations of supply chain transformation on the Chinese manufacturing industry support the continued research focus on the concept of corporate resilience.

6. Conclusion

This study investigates the mediating role of supply chain resilience in the relationship between supply chain risk management and firm performance, employing big data analytics approaches with panel data from 347 Chinese A-share listed manufacturing companies encompassing 2,418 firm-year observations during 2015–2023. This evidence supports the claim that the link between risk management and performance is partially mediated by supply chain resilience, with more than half of the benefits to performance coming from the development of resilience. Path analysis showed that risk management has a strong positive influence on the development of supply chain resilience, which has a strong positive influence on profitability. Results are robust for variable definitions, lagged regressions, and winsorized datasets. This research advances supply chain management literature by applying RBV theories of dynamic capabilities in understanding risk-and-resilience dynamics. For the case of manufacturing managers, the study implies that the most profitable investments in terms of supplier and customer diversification are those that are done alongside efforts to build up their resilience, such as the need to maintain financial slack and to build alternative supplier networks. It is recommended that policymakers explore the possibility of incentivizing supply chain diversification programs to enhance the resilience of the Chinese manufacturing base.

Author Contributions

Conceptualization, M.L.; methodology, M.L.; software, M.L.; validation, M.L., N.Z., M.Z.H., M.Z.M.S. and X.C.; formal analysis, M.L.; investigation, M.L.; resources, M.L.; data curation, M.L.; writing—original draft preparation, M.L.; writing—review and editing, M.L.; visualization, M.L.; supervision, N.Z., M.Z.H., and M.Z.M.S.; project administration, M.L.; funding acquisition, M.L., N.Z., M.Z.H., M.Z.M.S. and X.C. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement

Not applicable. This study was based entirely on secondary, anonymized, firm-level data made publicly available by the World Bank Enterprise Surveys program, and did not involve any new interaction with human participants or animals.

Informed Consent Statement

Not applicable. The World Bank Enterprise Surveys obtained informed consent from participating firms during the original data collection, and the present study analyzed only de-identified aggregate records.

Data Availability Statement

The firm-level data that support the findings of this study are openly available from the World Bank Enterprise Surveys at <https://www.enterprisesurveys.org>. Processed datasets and SmartPLS model files are available from the corresponding author on reasonable request.

Conflicts of Interest

The authors declare no conflict of interest.

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