The Impact of Industrial Clusters on Supply Chain Resilience: The Moderating Role of Supply Chain Concentration

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Abstract: This study aims to explore the relationship between industrial agglomeration and supply chain resilience. This study is built upon a theoretical framework grounded in the effects of industrial agglomeration, including the scale effect, industry correlation effect, and spillover effect. Through analyzing industrial agglomeration phenomena, the study posits that the clustering of numerous related enterprises within specific geographical areas may lead to increased supply chain resilience. The significance of supply chain concentration is essential as it acts as a moderating factor in this association, potentially enhancing the resilience of the supply chain. This research hypothesizes that such clustering incentivizes enterprises to establish collaborative relationships with nearby suppliers to reduce transportation costs and streamline supply chain complexity, enhancing theoretical research on the influence of industrial agglomeration on supply chain dynamics constitutes a significant aspect of this study. Therefore, this study will provide new theoretical perspectives in related fields and important references for firms to improve supply chain resilience.

Keywords: Industrial agglomeration, Agglomeration theory, Supply chain concentration.

1. Introduction

In the contemporary landscape of global trade and commerce, the resilience of supply chains has emerged as a critical determinant of organizational success and economic stability. Supply chain resilience refers to the ability of supply chains to endure and bounce back from disruptions, ranging from natural disasters to geopolitical tensions and unforeseen market shifts [1, 2]. As researchers and professionals explore the intricacies of supply chain management, there is a growing focus on understanding the influence of different elements on supply chain resilience.

One such factor that has attracted considerable interest is the phenomenon of industrial agglomeration. Industrial agglomeration, characterized by geographic concentrations of interconnected firms and supporting institutions within a particular industry, has long been recognized for its potential to stimulate innovation, enhance productivity, and foster economic growth [3]. However, their influence on supply chain resilience remains a subject of ongoing inquiry and debate.

This study aims to examine how industrial agglomerations impact the resilience of supply networks in the face of disruptions, specifically focusing on the moderating role of supply chain

concentration. Existing literature has offered useful insights into the separate impacts of industrial agglomeration and supply chain concentration on resilience, more attention needs to be devoted to examining how these factors interact and potentially shape the resilience outcomes of supply chains. Moreover, the conditions that cause changes in this spatial impact still need to be comprehensively comprehended. However, it primarily emphasised the significance of the size and status of a business inside the supply chain. [4].

Several key questions are addressed in this study: First, what is the relationship between industrial agglomeration and supply chain resilience? Are these two phenomena interconnected, and if so, in what ways? Second, what is the specific impact of supply chain concentration when acting as a moderating variable? What is the impact of industrial clusters on the robustness of supply chains?

Thus, this research puts forward two hypotheses. The first group presents contrasting views on the impact of industrial clusters on supply chain resilience. While proponents argue that clustering fosters collaboration, knowledge exchange, and resource pooling, skeptics point to potential risks associated with dependency and vulnerability within concentrated industrial ecosystems. The second group extends the analysis to consider how the concentration of supply chain activities may interact with industrial clusters to shape their impact on supply chain resilience. The interplay between clustering effects and supply chain concentration levels presents an intriguing avenue for exploration, offering insights into the nuanced mechanisms underlying supply chain dynamics.

Through in-depth exploration in this field, it can better comprehend the intricate relationship between industrial agglomeration and supply chain resilience, offering comprehensive strategic guidance to business decision-makers. Furthermore, this study offers a new theoretical insights for academia to investigate the intricate correlation between industrial agglomeration and supply chain resilience, offering important insights for future research endeavors.

2.   Literature Review

The notion of agglomeration was initially developed by, highlighting the advantages of industrial agglomeration in fostering knowledge spillovers, information sharing, and optimizing infrastructure and production factors, such as labor [5, 6]. Within these industry agglomerations, associated service enterprises converge, establishing a specialized and substantial labor market and codifying various knowledge and information within the agglomeration. The productivity of labor, capital, energy, and other resources factor alignments is consequently enhanced when the reciprocal sharing of information lowers the cost of information seeking and factor matching [7]. These positive externalities improve production efficiency, consolidate knowledge and technology, stimulate innovation and accelerating technological progression. Which, in turn, strengthens the competitiveness of the entire supply chain, enabling rapid adaptation to market fluctuations and evolving demands. For instance, it explored the positive correlation between industrial agglomeration and technological innovation using per capita GDP as an intermediate variable [8]. Similarly, the influence of foreign trade factors on industrial agglomeration and economic growth was investigated, and a nonlinear relationship model was constructed based on threshold effects [9].

Supply chain resilience refers to the innate capacity of agents within a supply chain network to effectively react to unforeseen circumstances and restore regular operations. It involves addressing malfunctions, maintaining satisfactory service throughout the repair process, and actively diagnosing and preventing potential risks and errors [1, 10]. The current research primarily focuses on the enterprise's operational and financial performance [11]. However, the significance of industrial agglomeration on the resilience of supply chains has been greatly overlooked.

Supply chain concentration refers to the level of focus a company place on its suppliers and customers, particularly in terms of the importance of key suppliers and customers [12, 13]. Supply chain concentration enhances a company's competitive edge from its synchronized processes with

suppliers [14]. The trust and behavioral norms that result from interdependent actions should protect collaborative companies from opportunistic behavior, ensure fair distribution of benefits even without comparative market contracts, and decrease the risk of disruptions in the supply chain [15]. High levels of supply chain concentration suggest that a company relies heavily on a small number of key suppliers for a significant portion of its purchases, or that it sells a large proportion of its products to a small number of main customers [16].

3. Hypothesis Development and Model Design

3.1. Hypothesis Development

In microeconomic terms, the scale effect epitomizes the concept of economies of scale, fundamentally characterized by the cost benefits accrued by enterprises due to the magnitude of their operations [17]. This advantage stems from a comprehensive resource pool encompassing financial, human, and technological assets, which collectively empower companies to adeptly navigate and recover from disruptions in the supply chain [18]. According to Chen et al., the scale effect can be classified into two categories: the human resources scale effect and the land resources scale effect [18]. The former underscores the value of a large and diverse workforce, enabling robust problem-solving and innovation. The latter pertains to the advantages of extensive land holdings, which can facilitate operational diversification and resilience against localized disruptions. However, an over-dependence on specific processes or technologies, a byproduct of the scale effect, can inadvertently lead to rigidity within the system. This inflexibility potentially heightens the vulnerability of supply chains to certain types of disruptions, underscoring the need for a balanced approach in leveraging the scale effect to enhance supply chain resilience [10, 19]. According to the analysis provided, this research proposes two hypotheses.

Hypothesis 1: Industrial agglomeration has beneficial direct impacts on supply chain resilience.

The literature highlights that the spillover effect often shifts demand from platforms to direct channels [20]. As noted by Hsu et al., spillover effects intensify with higher industry concentration [21]. On the other hand, the literature also suggests that the spillover effect could reduce demand for sales platforms, indicating a potential shift in the balance of power within supply chains [20]. Additionally, Yu et al. find that the operational values of Blockchain Technology regarding supply chain enterprises and its spillover effects on the workforce vary with customer demand correlation [22]. While industrial clusters foster interconnectedness and knowledge sharing [23], they also create an environment of interdependence [24, 25]. This interdependence, at higher levels of supply chain concentration, might introduce vulnerabilities or dependencies that attenuate the positive influence of industrial agglomeration on resilience. Based on the above analysis, the study provides two hypotheses.

Hypothesis 2: Supply chain concentration acts as a moderator in the relationship between industrial agglomeration and supply chain resilience. A higher level of supply chain concentration enhances the favorable effect of industrial agglomeration on resilience.

3.2. Model Design

Based on the theoretical analyses and research hypotheses, this study devised a testing model to explore the process by which agglomeration's effect on resilience.

$$Resilience_{it} = \alpha_0 + \alpha_1 agglomeration_{ij} + \alpha_2 Controls_{it} + v_{it} \tag{1}$$

$$Resilience_{it} = \beta_0 + \beta_1 agglomeration_{ij} + \beta_2 Controls_{it} + \beta_3 SCC + \beta_4 agglomeration_{ij} \times SCC + \varepsilon_{it} \tag{2}$$

3.3. Variable Construction

3.3.1. The Location Quotient

Referring to existing research, seven effective methods for measuring the industrial agglomeration level have been summarized. These include location quotient, industrial agglomeration index, industry concentration, Herfindahl index, spatial Gini coefficient, and E-G index. After repeated comparisons, it was found that the industrial agglomeration index requires not only a large number of calculations but also overlooks the impact caused by business size, industry concentration is easily affected by seasons; the Herfindahl index has a weaker measure of spatial association; the spatial Gini coefficient ignores the difference in business size; the E-G index, which is based on the spatial Gini coefficient, has a problem of incomplete statistics. Therefore, this paper will employ the location quotient as a metric to quantify industrial agglomeration [26]. The formula for calculating the location quotient is as follows.

$$agglomeration_{ij} = \frac{q_{ij}/\sum_i q_{ij}}{\sum_j q_{ij}/\sum_i\sum_j q_{ij}} \tag{3}$$

The i represents industry, j represents region, and q_{ij} represents output indicators. As the value of industrial agglomeration increases, so does the level of agglomeration.

3.3.2. Supply Chain Resilience

References Dormady et al., and Jiang et al., were consulted [27, 28]. The study examines the application of production functions for assessing the level of supply chain resilience. This is because they analyse the distribution of resources and the corresponding degrees of efficiency, elucidating how the relationships between inputs and outputs change based on scale. The degree of change in current productivity relative to previous productivity can effectively measure resilience [10].

$$Resilience_{it} = TFP_{it} - TFP_{it-1} \tag{4}$$

The variable i represents the firm, the variable t indicates the period, and TFP stands for the total factor productivity of firm i in period t, and TFP_{it} serves as the residual for firm-level regression.

3.3.3. Supply Chain Concentration

Customer and supplier concentration are both components of supply chain concentration. In accordance with the findings of the previous investigation [29-31], the mean is determined through the aggregation of the proportions of sales revenue generated from the top five consumers and purchases made from the top five suppliers.

$$SCC = \frac{\sum_{j=1}^{5}(\frac{Purchase_{ij}}{Purchase_i}) + \sum_{j=1}^{5}(\frac{Sales_{ij}}{Sales_i})}{2} \tag{5}$$

While $Sales_{ij}$ and $Purchase_{ij}$ represent the total sales and purchases, $Sales_{ij}$ and $Purchase_{ij}$ indicate the sales made by enterprise i to major customer j and purchases from major supplier j, respectively. Lower values indicate a lower degree of concentration, whereas higher values indicate higher concentration.

3.3.4. Control Variables

As in the prior literature [12, 32, 33], to enhance comparability with previous literature and control for uncertainties caused by external factors, this paper employs several variables: company age (Age), measured as the natural logarithm base of the number of years since initial public offering plus one; cash flow operations (Cfo); the proportion of independent directors (IND); CEO-chairman duality (Dual), coded as 1 if the same person holds both positions and 0 otherwise; board size (Boa), treated by taking the logarithm of the quantity representing the number of board members; enterprises growth ability (Growth); company(Size); total debt ratio (TDR); ownership concentration, represented by the largest shareholder's stake (OC_1) and the top ten shareholders' combined stake (OC_10); fixed assets (PPE); return on assets (ROA); net working capital (NWC); and the annual growth rate of primary business income (ROI).

4.   Conclusion

The forthcoming phase of this research involves gathering data and performing empirical tests. Our approach includes compiling data from various dimensions, primarily focusing on Chinese A-share listed companies, spanning 2010 to 2022. The China Stock Market & Accounting Research Database (CSMAR) will be used for data collecting. Specifically, this study aims to integrate industry agglomeration, supply chain resilience, and supply chain concentration data, aligning them with the stock codes of these A-share listed entities. The sample refinement process will exclude firms lacking vital data, those within the financial sector, and companies classified as ST, ST*, or PT. For a robust analysis, this study will consider only those samples that maintain a consistent data record for at least three consecutive years. A winsorizing technique will be applied to all continuous variables at the 1% extremities to control for statistical outliers.

The empirical analysis represents a crucial direction for future research. Consequently, this research intends to enhance empirical studies, providing ample and rigorous data support to substantiate the findings.

This study could enrich knowledge on industrial agglomeration and its impact on supply chain resilience. It introduces new perspectives, including the scale effect, industry correlation effect, and spillover effect as crucial factors in understanding industrial agglomeration. Furthermore, it underscores the moderating influence of supply chain concentration within this particular framework, thereby potentially expanding the scope of theoretical constructs in the discipline.

From practical sights, the research findings could provide valuable insights for both enterprises and policymakers. Companies may better comprehend how their geographical location and relationships with local suppliers influence their supply chain resilience. Meanwhile, policymakers can use these findings to create conducive environments for industrial agglomeration, improving overall supply chain resilience in an area or industry.

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