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A Study on the Current Status and Bottlenecks of Digital and Intelligent Supply Chains in the Manufacturing Sector of the Beijing-Tianjin-Hebei Region: A Case Study of Smart, Connected New Energy Vehicles

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ABSTRACT

The Beijing-Tianjin-Hebei region has established a manufacturing division of labor characterized by "R&D in Beijing, commercialization in Tianjin, and manufacturing in Hebei." Smart, connected new energy vehicles are the sector where this division has been implemented most deeply; however, digital and intelligent supply chain collaboration among the three regions remains at a superficial stage, marked by "local coordination but no region-wide synergy." Using Xiaomi Auto and Tesla's Shanghai factory as comparative cases, this paper analyzes three underlying causes of the lack of coordination. At the government level, tax assessment barriers lead each region to "do its own accounting," and interprovincial collaboration lacks a benefit-sharing mechanism. At the major-manufacturer level, fear of data leaks and the absence of subsidies cause firms to "shut their doors and protect themselves," producing a "drive-blockage" effect. At the small-manufacturer level, a "passive wait-and-see" attitude stems from limited funds and risk aversion, compounded by a triple fear of data exposure, failure, and insufficient returns. These three factors reinforce one another, creating a vicious cycle in which the chain leader's inability to drive progress and small and medium-sized manufacturers' reluctance to transform are causally intertwined. The paper proposes practical solutions-cross-provincial tax revenue sharing and subsidies, an intermediary platform for data security, and on-site assistance from major manufacturers-to break the deadlock in digital and intelligent supply chain collaboration in the Beijing-Tianjin-Hebei manufacturing sector.

KEYWORDS: *Beijing-Tianjin-Hebei; digital and intelligent supply chain; regional collaboration; chain leader-driven growth; transformation of small and medium-sized enterprises.*

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I. INTRODUCTION

The coordinated development of the Beijing-Tianjin-Hebei region has been underway for many years. The basic pattern of industrial division among the three regions is "Beijing for R&D, Tianjin for commercialization, and Hebei for manufacturing." This division is most evident in the smart, connected new energy vehicle sector: Beijing hosts Xiaomi Auto and Beijing Mercedes-Benz, which handle vehicle R&D and final assembly; Tianjin handles core component manufacturing and port logistics; and Hebei hosts a large number of small and medium-sized supporting processors. In theory, the tighter the integration of the three regions' industrial chains, the easier it should be to coordinate digital and intelligent supply chains. In reality, however, total logistics costs as a share of GDP in the region remain higher than in the Yangtze River Delta. Because of limited cross-regional data interoperability, disconnected order systems, and uncoordinated production capacity, collaboration largely remains at the level of component supply. Full-chain data—including R&D

data, production plans, inventory scheduling, and after-sales logistics—has not been truly integrated.

Where does the problem lie? Existing research has largely attributed the issue to technology, standards, and infrastructure. Technical issues, however, are relatively easy to resolve; the real challenges lie in three areas: people, money, and authority. Governments worry about tax revenue leakage; large manufacturers fear data breaches without receiving compensation; and small manufacturers worry that their investments will be wasted. Unless these three issues are thoroughly addressed, no amount of platforms or standards will be effective. Taking smart, connected new energy vehicles as a starting point, this paper first describes the current division of labor among the three regions, then analyzes the three major obstacles, and finally proposes targeted solutions, with the aim of clarifying underlying causes and offering actionable recommendations.

II. LITERATURE REVIEW

Overseas research focuses on the implementation of technologies such as blockchain, the Internet of Things, and AI-based scheduling in supply chains, emphasizing digital collaboration within global supply chains. Such research, however, offers limited explanatory power for urban agglomerations like Beijing-Tianjin-Hebei, which are characterized by prominent administrative barriers and distinct industrial gradients. Domestic research has concentrated on regions with strong collaborative foundations, such as the Yangtze River Delta and the Pearl River Delta. Studies on Beijing-Tianjin-Hebei have largely focused on a single region or a single industry; few have examined full-chain bottlenecks by integrating the division of labor across the three regions, and there is a particular lack of focus on the psychology of transformation among small and medium-sized enterprises (SMEs). Existing findings mostly remain at the level of policy calls to "strengthen collaboration," lacking actionable, tiered, and categorized solutions.

In terms of theoretical tools, the theory of the integration of the four chains (innovation, industrial, capital, and talent) is suitable for explaining factor mismatches, while regional coordination theory is suitable for explaining administrative barriers and institutional integration. Both theories, however, lean toward "structure" and fail to adequately explain the behavior of actors—for example, "why chain leaders are reluctant to open up" or "why small factories are afraid to take on orders."

Building on these two frameworks, this paper introduces two behavioral perspectives: the "chain-leader driving paradox" and the "triple structure of transformation anxiety." The former refers to the phenomenon in which the stronger a chain leader's own digital and intelligent capabilities, the more its core systems tend toward internal closed loops, resulting in weaker data openness and technology spillovers to supporting enterprises. The latter refers to overlapping fears among SMEs—fear of data, fear of failure, and fear of insufficient returns—which make "not daring to transform" a more intractable challenge than "not knowing how to transform." Using Xiaomi Auto as a case study of a supply chain leader and focusing on small and medium-sized supporting enterprises in the Tianjin-Hebei region, this paper directly addresses these gaps in the literature.

III. ANALYSIS OF THE CURRENT SITUATION: DIVISION OF LABOR IS ESTABLISHED, BUT COLLABORATION REMAINS LIMITED

A. Policies in the Three Regions Cover Different Segments; Roles Are Clear, but Coordination Is Lacking

Beijing's policies lean toward "technology supply," relying on Zhongguancun and Haidian to support R&D in autonomous driving, vehicle-to-everything communication, and the industrial internet. Tianjin's policies lean toward "transit and integration," relying on the Binhai New Area and the Port of Tianjin to facilitate the implementation of Beijing's technologies and to promote the digital and intelligent integration of manufacturing and logistics. Hebei's policies focus on "practical application," concentrating on the digital transformation of traditional industries such as steel, machinery, and building materials, as well as the transformation of SME clusters. Langfang and Handan have been selected as national pilot cities for the digital transformation of SMEs, receiving 100 million yuan in central government grants and subsidies.

While the roles of the three regions are clear, their policies operate in silos: Beijing manages R&D, Tianjin manages commercialization, and Hebei manages implementation. No clear lead entity is responsible for coordinating cross-provincial interests, standardizing data interfaces, or providing psychological support to SMEs. Policy stratification does not equate to policy coordination; this is the institutional backdrop for the three major obstacles discussed below.

Table 1. Policy Positioning of Digital and Intelligent Supply Chains in the Three Regions

Dimension	Beijing	Tianjin	Hebei
Policy Positioning	Technology Supply	Transfer Connections	Practical Applications
Key Areas of Focus	Digital Technology R&D, Industrial Internet Platforms, and Pilot Programs for High-End Manufacturing	Smart Manufacturing Demonstrations, Technology Commercialization, and Supply Chain Collaboration	Digital Transformation of Traditional Industries, Digital and Intelligent Upgrades of Logistics Parks, and Transformation of SME Clusters
Through various platforms	Zhongguancun, Haidian	Binhai New Area, Tianjin Port	Xiong'an New Area, Shijiazhuang, Tangshan
Exemplary Policies	Autonomous Driving Road Tests, Industrial Internet Special Projects	Special Fund for Smart Manufacturing, Supply Chain Innovation Pilot Program	"10,000 Enterprises Moving to the Cloud" and Pilot Program for the Digital Transformation of Small and Medium-Sized Enterprises

B. Leading Enterprises Take the Lead, but the Spillover Effect Is Limited

At the level of leading enterprises, several pioneering demonstration models have emerged in the Beijing-Tianjin-Hebei region, but they differ significantly in their stage of digital and intelligent transformation and in their capacity to drive growth. Jinyu Jidong Cement is a benchmark for digital and intelligent transformation in traditional manufacturing; its internal supply chain has achieved the integration of warehousing, logistics, and procurement and has obtained national-level certification. The scope of its empowerment, however, is primarily limited to within the enterprise, with limited spillover to upstream and downstream SMEs. Lingyun Industry has established a comprehensive presence across the region in the automotive parts sector, supplying vehicle manufacturers such as Beijing Mercedes-Benz and Xiaomi Auto. It has achieved localized data coordination and order synchronization within its supply chain, serving as a typical example of "localized integration by supporting enterprises." JD Industrial (Beijing), as a provider of digital and intelligent supply chain solutions, primarily serves manufacturing enterprises in Hebei; it focuses on empowering individual stages rather than fostering full-chain coordination.

In contrast, Xiaomi Auto (Beijing) is a benchmark for regional collaboration in digital and intelligent supply chains within the smart automotive sector. Its super factory in Tongzhou, Beijing, produces one SU7 model every 76 seconds and has established linkages with more than 50 supply chain enterprises across the region. Approximately 22% of its components come from suppliers in Tianjin and Hebei, with more than 120 enterprises in Tianjin and more than 220 in Hebei deeply integrated into its supply chain system. This has laid the preliminary groundwork for a model featuring "vehicle R&D and final assembly in Beijing + core component manufacturing in Tianjin + supporting processing in Hebei." The company has also independently developed industrial robots and intelligent scheduling systems to achieve digital and intelligent control over production processes. It is worth noting, however, that its core digital and intelligent control system currently operates only within a closed internal loop; it has not opened data interfaces or technical standards to upstream and downstream suppliers, and the chain leader's catalytic effect has not yet been fully realized. Overall, while leading enterprises have largely achieved "leading by example," the drive to "drive the entire chain" remains in its infancy.

C. Most SMEs Still Rely on "Manual Coordination"

In industrial clusters such as Renqiu's gear manufacturing, Tangshan's steel industry, and Cangzhou's pipeline sector in Hebei, only a few enterprises have implemented basic systems; the majority still rely on manual coordination, leaving little to no collaboration across the supply chain. In 2023, the cloud adoption rate for industrial equipment in Hebei reached 20.6%, maintaining the top position nationwide; the overall cloud adoption rate among SMEs, however, remains relatively low. In terms of infrastructure, Beijing has well-developed 5G networks, industrial internet, and computing centers, followed by Tianjin, while the equipment connectivity rate in county-level manufacturing clusters in Hebei is significantly below the national average, creating a marked "technological gradient gap" among the three regions.

D. Cross-Regional Collaboration: "Local Interconnections, but No Region-Wide Coordination"

The Nanshan Automotive Industrial Base in Zhangjiakou has established a "5-minute industrial circle," reducing parts transportation time to less than 5 minutes and compressing warehouse turnover cycles by more than 60%—a positive example. Overall, however, most industries across the three regions operate in isolation. Even in the smart automotive sector, coordination is limited to parts supply; data across the entire supply chain—including R&D, production planning, inventory, and after-sales logistics—remains unintegrated, and digital and intelligent coordination remains superficial.

Table 2. Comparison of Logistics Costs and Supply Chain Response in Beijing-Tianjin-Hebei and the Yangtze River Delta

Indicators	Beijing-Tianjin-Hebei Region	Yangtze River Delta	Gap
Total Social Logistics Costs as a Percentage of GDP (2023)	14.5%	Approximately 12.0% (estimate)	About 2.5 percentage points higher
Supply Chain Response Time	Longer	Shorter	An increase of more than 15%
Cloud Adoption Rate for Industrial Equipment	Hebei: 20.6% (Ranked first nationwide)	Generally higher	The adoption rate of cloud computing among small and medium-sized enterprises remains relatively low

IV. ANALYSIS OF INFLUENCING FACTORS: THREE MAJOR OBSTACLES LOCKING IN COLLABORATION

The current situation is characterized by an "established division of labor but shallow collaboration." On the surface, this appears to be a lack of technical standards and platforms; at a deeper level, it stems from the three key players each calculating their own interests and harboring mutual distrust. The three perspectives are explained below.

A. The Government Focuses on "Tax Revenue": Evaluation Barriers Make Cross-Provincial Collaboration a "Whoever Moves First Loses" Scenario

Each of the three regions has its own tax revenue targets and GDP performance metrics. If a Beijing-based automaker places an order with a supplier in Hebei, the output value and tax revenue are credited to Hebei, while Beijing sees no direct benefit; conversely, Hebei fears it will merely serve as a "contract manufacturing site" and fail to retain added value. This has led to a peculiar phenomenon: while everyone pays lip service to collaboration, when it comes to specific projects, everyone fears that "the benefits will flow to outsiders." The root causes of redundant construction in interprovincial industrial parks, cutthroat competition in investment promotion, and the development of separate data platforms all lie here. Without a mechanism for interprovincial tax revenue sharing and benefit sharing, collaboration remains nothing more than a concept on paper.

B. Major Manufacturers Prioritize "Security": Fearing Data Leaks and Lacking Subsidies, They "Shut Down to Protect Themselves"

Opening core digital and intelligent systems to suppliers means exposing production plans, inventory cycles, quality parameters, and even cost structures. Competition in the smart automotive industry is fierce, and such data is the lifeblood of firms. More practically, opening systems requires investment in upgrades and entails operation and maintenance costs once suppliers are integrated; yet government subsidies mostly flow toward automakers' capacity expansion and R&D projects, with very little dedicated to subsidizing "chain-leader open platforms." Consequently, the choice of major manufacturers is rational: the more robust their systems, the more they favor internal closed loops, and suppliers can only passively accept orders without being integrated into the system. This is the "drive-blockage" effect—not that major manufacturers do not want to lead, but that openness offers no benefits, data leaks pose risks, and they would bear liability in the event of an incident. In contrast, Tesla's Shanghai factory dares to build an open platform and provide lightweight, free tools to small and medium-sized suppliers because it is backed by unified standards in the Yangtze River Delta, mature supply chain finance, and a fully competitive market structure. The Beijing-Tianjin-Hebei region currently lacks the external conditions that would "empower major manufacturers to open up."

C. Small Manufacturers Calculate the "Risk Equation": Short on Funds and Afraid of Failure, They "Sit Back and Wait"

The mindset of small and medium-sized suppliers can be broken down into three layers. The first is fear of data exposure: costs, orders, and customers are their lifeblood, and connecting to the chain leader's platform is

equivalent to revealing their hand, raising concerns about being forced to accept lower prices, being replaced, or having their operations "choked off." The second is fear of failure: a single system can cost hundreds of thousands of yuan, and when hardware, training, and downtime for debugging are included, it may take two to three years to see results; small manufacturers have weak risk-bearing capacity and cannot afford to lose. The third is fear of insufficient returns: even if they invest, they have no certainty that orders will increase or prices will rise, so they prefer to maintain the status quo. With these three fears compounded, the psychological barrier of "not daring to transform" is harder to overcome than the practical barrier of "not knowing how to transform." High upfront costs, limited financing channels, and stringent loan requirements—together with the fact that government subsidies are primarily directed toward leading automakers—leave small manufacturers unable to secure funding, and the significant funding gap for initiating transformation makes "giving up" a rational choice.

D. A Three-Way Deadlock: Chain Leaders Refuse to Open Up, Small Manufacturers Are Afraid to Participate, and the Government Struggles to Coordinate

These three issues are not isolated. The government, fearing a loss of tax revenue, hesitates to vigorously promote cross-provincial supply chain collaboration; major manufacturers, concerned about data leaks and lacking subsidies, refuse to open their systems; and small manufacturers, wary of risks and short on funds, decline to connect to platforms. The result is a two-way deadlock: chain leaders fear losing bargaining power if they open up, while small manufacturers worry about being forced to lower prices or being replaced if they share data. Amid this standoff, data sharing is trapped in a dilemma where "whoever opens up first loses out." Because AI cannot achieve intelligent coordination across the entire supply chain, digital and intelligent supply chains remain limited to the digitization of individual segments. This is the structural contradiction of "superficial collaboration, deep isolation."

Table 3. Comparison of Digital and Intelligent Supply Chains: Xiaomi Auto and Tesla's Shanghai Factory

Dimensions of Comparison	Xiaomi Motors (Beijing-Tianjin-Hebei)	Tesla Shanghai Factory (Yangtze River Delta)	Core Gaps
Platform Openness	The core system operates in a closed loop and is not open to the public.	Build an open platform that allows companies across the entire supply chain to connect	No open ecosystem; weak technology spillover
Coordinated Support Model	Only basic component compatibility, with limited data interoperability	Real-time sharing of end-to-end data and synchronized scheduling	The level of collaboration is shallow, and the entire chain has not been integrated.
Empowering Small and Medium-Sized Suppliers	No dedicated lightweight solutions, no technical support	Free access tools provided; unified standards	Small and Medium-Sized Factories Lack Support for Transformation
Regional Coordination	The three regions develop their own plans, with no unified coordination mechanism in place.	Coordinated Integration of the Yangtze River Delta, Unified Standards	Administrative Barriers Hinder Collaboration
Delivery Cycle	Longer	40% shorter	There is a significant gap in efficiency
Logistics Costs	Higher	25% reduction	The cost gap is significant

V. Policy Recommendation

A. Calculating the "Tax Account": Interprovincial Tax Revenue Sharing and Subsidies to Make Collaboration Rewarding

Led by the industry and information technology, finance, and tax departments of the three regions, pilot an interprovincial tax revenue-sharing program in the smart vehicle sector. When Beijing-based vehicle manufacturers outsource orders to supporting enterprises in Tianjin and Hebei, the additional tax revenue should be shared among the three regions according to an agreed ratio; for jointly built cross-border supporting industrial parks, implement a system of "separate output value accounting and shared tax revenue." At the same time, government subsidies should shift from "subsidizing industry leaders" to "subsidizing supporting enterprises" and "subsidizing collaboration": reward vehicle manufacturers that source a certain percentage of their parts from Tianjin and Hebei, and provide

interest-subsidized loans or special subsidies to enterprises in Tianjin and Hebei that take on spillover orders from Beijing, making collaboration financially worthwhile.

B. Building a "Middle Platform": A Data Security Platform That Encourages Large Manufacturers to Open Up and Small Manufacturers to Share

It is recommended that the industry and information technology departments of the three regions take the lead—with participation from industry associations and chain leaders—to establish a regional public digital and intelligent supply chain platform and to formulate the Beijing-Tianjin-Hebei Manufacturing Digital and Intelligent Supply Chain Data Interoperability Specifications and the Digital and Intelligent Transformation Evaluation Standards, with pilot programs launched first in the smart vehicle sector. The key is to use technology to provide "insurance" for both sides: introduce privacy-preserving computing and blockchain to achieve "data usable but not visible," so that chain leaders can open order, inventory, and quality data while cost data remains encrypted by default, and supporting enterprises' cost data is shared in anonymized ranges for quotation and price comparison. At the same time, establish a mechanism for chain leaders' responsibility in data openness: chain leaders that receive special government subsidies or land incentives must commit to opening data interfaces, technical standards, and lightweight tools; chain leaders that proactively open data and drive the upgrading of supporting enterprises will receive tax incentives or special rewards. This ensures that those who open up do not lose out while putting pressure on those that remain on the sidelines.

C. Implementing "On-Site Assistance": Support from Large Manufacturers Combined with Lightweight Tools to Help Small Manufacturers Take the First Step

To address small manufacturers' reluctance to transform, funding alone is insufficient; a sense of security and concrete examples are also needed. First, establish a risk compensation mechanism for failed transformations: the government will provide a certain percentage of compensation to SMEs undertaking their first digital and intelligent transformation. Second, select SaaS-based, lightweight tools that require minimal investment and deliver quick results, and promote them through a "government subsidy + platform discount + enterprise co-payment" model, enabling small factories to go live without purchasing hardware or building in-house teams. Third, organize technical experts from leading enterprises to provide on-site assistance, guiding supporting enterprises step by step through diagnostics, system integration, and data configuration; at the same time, organize testimonials from companies that have successfully transformed to alleviate fears about returns through real-life examples. Fourth, implement a "Beijing R&D talent + Tianjin-Hebei operational talent" pairing program and establish digital and intelligent supply chain training bases in Tianjin and Hebei to address the shortage of multidisciplinary talent.

D. Defining Roles and Advancing in Stages to Avoid Uncoordinated Rushes

Beijing will focus on core R&D and final assembly, leveraging Xiaomi Auto and Beijing Mercedes-Benz to build a hub for vehicle final assembly and regional coordination. Tianjin will focus on technology commercialization and core component manufacturing, serving as a platform for implementing Beijing's technologies. Hebei will focus on supporting processing and warehousing/logistics, promoting lightweight digital and intelligent upgrades for small and medium-sized parts manufacturers. The three regions will pursue complementary development toward a common goal, using smart vehicles as a breakthrough point. Once this sector matures, they will expand into traditional manufacturing sectors such as steel, machinery, and building materials, avoiding homogeneous competition and redundant construction.

VI. Conclusion

The crux of the problem with digital and intelligent supply chains in the Beijing-Tianjin-Hebei manufacturing sector lies not in technology but in three unresolved issues: the government fears tax revenue leakage; large manufacturers fear that without subsidies their trade secrets will be compromised; and small manufacturers fear that without funding they will face financial risks. With these three issues locked in a vicious cycle, it becomes a rational choice for chain leaders to "lead without moving forward" and for small manufacturers to "dare not make the transition." The solution does not lie in building more platforms or issuing more policy documents, but in making collaboration financially worthwhile in terms of taxation, ensuring data security through open sharing, and providing risk mitigation for transformation. Interprovincial tax revenue sharing, an intermediary platform for data security, and on-site assistance from major manufacturers are none of them new concepts. Only by effectively implementing these three measures, however, can digital and intelligent supply chain collaboration in the smart vehicle sector truly evolve from "localized coordination" to "comprehensive

collaboration," thereby providing a replicable model for other manufacturing sectors in the Beijing-Tianjin-Hebei region.

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