Accounting and Corporate Management (2025)
Clausius Scientific Press, Canada

DOI: 10.23977/acccm.2025.070214
ISSN 2523-5788 Vol. 7 Num. 2

Research on the Path and Mechanism of Dual-Chain Integration Driving the High-Quality Development of Specialized, Refined, Unique and Innovative Enterprises in Xi'an

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Keywords: Unique and Innovative Enterprises; Innovation Chain; Industrial Chain; Specialized, Refined, High-Quality Development of Enterprises

Abstract: This article focuses on the path and mechanism of driving the high-quality development of "specialized, refined, distinctive, and innovative" enterprises in Xi'an through the "dual-chain" (integration of industrial chain and innovation chain). It reveals the core characteristics, existing bottlenecks, and systematic solutions. The research shows that Xi'an, relying on strategic emerging industries such as aerospace and semiconductors, has cultivated 162 national-level "specialized, refined, distinctive, and innovative" enterprises. However, it is facing challenges such as "hollowing out" of core technologies, low patent conversion rate (30.5%), and insufficient international competitiveness of brands. By constructing a four-dimensional development path of "specialization, refinement, characteristic, and innovation", Xi'an uses the "dual-chain" collaboration to solve the problems: at the professional level, InnoTech fills the domestic gap in unmanned systems for unmanned aircraft, Kangtuo Medical breaks through 3D printing implant technology (with an R&D investment ratio of 8.9%); at the refined level, new materials enterprises achieve domestic substitution through "chain leader + universities" to jointly build a carbon-based material platform; at the characteristic level, Meilanxin Materials introduces customized solutions for photovoltaic thermal fields; at the innovative level, Yuanjie Semiconductor arranges 322 high-value patents around optical chip technology. Mechanically, the market-driven mechanism is activated by state-owned enterprises leading (such as Shaanxi Automobile driving 400+ private enterprises to collaborate) and new technology application ; the platform support mechanism relies on Qinchuangyuan to integrate government, universities, and industry resources to accelerate the transformation of achievements; the policy guarantee mechanism provides gradient cultivation (rewarding national-level "little giants" in the high-tech zone with 200,000 yuan) and "chain leader system" to coordinate the synergy of the industrial chain. In the future, it is necessary to strengthen cross-regional technical collaboration, international standard alignment, and full-chain penetration of digital technology, to elevate the "Xi'an experience" to the national "dual-chain" integration model, and to support the dual goals of technological self-reliance and self-strengthening and industrial upgrading.

1. Introduction

The shift from high-speed growth to high-quality development is a distinct feature and inevitable requirement of China's economic development in the new era. As the vanguard of China's self-reliance and self-strengthening in science and technology, "specialized, refined, distinctive and innovative" enterprises have become an important driving force for high-quality development, a key stabilizer for the new development pattern, and a vital force for an innovative country. In November 2021, The State Council issued the "List of Practical Things to Do for 'Specialized, Refined, Unique and Innovative' Small and Medium-sized Enterprises", putting forward a combination of strategic measures to support the high-quality development of "specialized, refined, Unique and innovative" enterprises. In October 2022, the report of the 20th National Congress of the Communist Party of China further pointed out: "We should implement the industrial foundation reconstruction project and the major technological equipment breakthrough project, and support the development of specialized, refined, distinctive and innovative enterprises." The introduction of the above-mentioned policies marks that "specialized, refined, distinctive and innovative" enterprises have become the key players in high-quality economic development. Industry is the carrier of economic development, and innovation is the primary driving force for development. The deep integration of the industrial chain and the innovation chain (referred to as "dual-chain" integration) not only profoundly reveals the inherent requirement that scientific and technological innovation must be integrated with industrial development, but also provides a possible direction for the high-quality development of "specialized, refined, distinctive and innovative" enterprises. Therefore, how the integration of the "dual chains" can drive the high-quality development of "specialized, refined, distinctive and innovative" enterprises has become an important issue that needs to be urgently addressed[1].

Xi 'an, as the "bridgehead" of the national Western Development strategy and the core area of the "Belt and Road Initiative", is also an important advanced manufacturing base of the country and has established a relatively complete modern industrial system. In recent years, relying on its own advantages in factor endowment, the "lowland" effect of preferential policies, and the outwardly developed model of actively integrating into the "Belt and Road Initiative", the industrial development has entered a fast lane, technological innovation has become increasingly active, and "specialized, refined, distinctive and innovative" enterprises have flourished. As of April 2023, Xi 'an has 162 national-level "specialized, refined, distinctive and innovative" small and medium-sized enterprises and 593 provincial-level "specialized, refined, distinctive and innovative" small and medium-sized enterprises[2]. A number of typical demonstration enterprises of "specialized, refined, distinctive and innovative" have emerged, such as Fast, Shanggu and Qinchuan Machine Tool. However, the development level of "specialized, refined, distinctive and innovative" enterprises in Xi 'an still lags significantly behind that of regions such as Guangdong, Jiangsu and Zhejiang. The overall quality and efficiency of "specialized, refined, distinctive and innovative" enterprises remain at a relatively low level, presenting typical characteristics of being "big but not strong, numerous but not refined, comprehensive but not excellent". How to promote the high-quality development of "specialized, refined, distinctive and innovative" enterprises has become the key to leading the high-quality economic development of Xi 'an. In conclusion, it is extremely urgent to study the path and mechanism of the integration of the "dual chains" to drive the high-quality development of "specialized, refined, distinctive and innovative" enterprises in Xi 'an[3].

2. Literature Review

After literature review, it is found that the research related to the high-quality development of "specialized, refined, distinctive and innovative" enterprises mainly focuses on two aspects: the

realization path and the guarantee mechanism:

(1)Research on the high-quality development path of "specialized, refined, distinctive and innovative" enterprises mainly focuses on the perspectives of industrial collaboration and innovation-driven development. From the perspective of industrial collaboration, "specialized, refined, distinctive and innovative" enterprises should accelerate structural adjustment internally, reshape the R&D, production and sales models, and integrate into the industrial collaboration network externally, deeply participating in the links of "supplementing, strengthening, stabilizing, unblocking and optimizing the industrial chain" (Liu Zhibiao and Xu Tianshu, 2022) Li Xiaomei et al., 2023, Promoting the integrated Development of large, medium and small enterprises and the ecological Development of industrial clusters (Research Group of Institute of Industrial Economics, Chinese Academy of Social Sciences and Shi Dan, 2022; Zhang Fan et al., 2024. From the perspective of innovation-driven development, "specialized, refined, distinctive and innovative" enterprises should not only focus on the transformation directions and breakthrough points of cutting-edge technologies, but also empower R&D innovation with new technologies, new models and new business forms (Jessica et al., 2021; Knig et al., 2022. It is also necessary to attach importance to participating in the collaborative innovation system of industry, academia and research, and accelerate the transformation of scientific research achievements and large-scale commercial application (Dong Zhiyong and Li Chengming, 2021).

(2)Research on the high-quality development mechanism of "specialized, refined, distinctive and innovative" enterprises mainly focuses on the institutional environment and the perspectives of finance, taxation and finance. From the perspective of the institutional environment, the government should establish an information sharing mechanism and an intercommunication mechanism for industrial chains and supply chains for "specialized, refined, distinctive and innovative" enterprises (Liu Zhibiao, 2022; Xu Yaping and Shi Yiming, 2024), Optimizing the Policy Implementation Mechanism (Cao Hongjian et al., 2022; Shen Jie and Chang Zhongze (2024), creating a favorable ecological environment for the high-quality development of "specialized, refined, distinctive and innovative" enterprises. From the perspective of finance, taxation and finance, by optimizing the financial supply structure, improving fiscal award and subsidy policies, and perfecting the credit management mechanism, we will continuously enhance financial support and tax and fee reduction efforts for "specialized, refined, distinctive and innovative" enterprises to ensure their high-quality development (Hu Jianmei, 2022; Shan Wei et al., 2025.

As can be seen from the above, the existing research has achieved certain results, but it also has limitations: First, there are more studies on the high-quality development path from a single perspective such as industrial collaboration or innovation-driven, and there is a lack of research results on the "dual-chain" integration driving the "specialization, refinement, uniqueness and novelty (innovation)" development of enterprises. Second, there are many studies on the fiscal subsidy and tax incentive mechanisms for high-quality development, but there is a lack of research results based on the coordinated interaction of multiple levels such as market-driven, platform support, and policy guarantee.

3. Analysis of the Actual Situation, Problems and Obstacles of "Specialized, Refined, Distinctive and Innovative" Enterprises in Xi 'an

3.1. Analysis of the Actual Situation of "Specialized, Refined, Unique and Innovative" Enterprises in Xi 'an

The "specialized, refined, distinctive and innovative" enterprises in Xi'an City vividly embody the remarkable current characteristics of "core technology leadership, in-depth industrial chain collaboration, outstanding quality and efficiency, and accelerated brand service upgrade", which not

only showcase the city's vibrant economic development momentum but also highlight its crucial role in driving technological innovation and industrial progress[4]. When it comes to core technology, these enterprises have their sights firmly set on strategic emerging industries. Sectors such as aerospace, semiconductors, and new materials have become their key areas of focus. With a remarkable research and development intensity reaching 8.9%, these companies are investing heavily in innovation[5]. On average, each enterprise holds 15.7 invention patents, a clear indication of their strong technological capabilities. Take InnoTech as a prime example. This company has successfully filled a significant domestic gap in the field of unmanned systems, revolutionizing the industry with its cutting - edge technology. Similarly, Contour Medical has achieved a major breakthrough in 3D printing implant technology. This achievement not only represents a huge leap forward in medical science but also demonstrates the high - end R & D strength of Xi'an's "specialized, refined, distinctive and innovative" enterprises. These technological feats not only enhance the competitiveness of individual enterprises but also contribute to the overall development of China's high - tech industries[6].

In the aspect of industrial connection, an impressive 78.4% of these enterprises are integrated into 17 provincial and municipal key industrial chains. The High - tech Zone and Economic Development Zone in Xi'an have emerged as important hubs, forming robust industrial clusters. In particular, the national "little giants" in the High - tech Zone account for 58.4% of the city's total, which showcases the strong agglomeration effect of the region[7]. Moreover, enterprises like Xindazhijian have actively and deeply participated in global satellite industrial chain collaboration. This not only expands the market scope of these enterprises but also promotes the exchange and cooperation between Xi'an's industries and the international community, helping Xi'an to integrate more deeply into the global industrial division of labor. Through such in - depth industrial chain collaboration, these enterprises can achieve resource sharing, complementary advantages, and jointly promote the upgrading and development of the entire industrial chain. Regarding quality and efficiency, the data in 2022 is highly encouraging. The average revenue per enterprise reached 190 million yuan, and the average net profit was 29.18 million yuan. This indicates that these enterprises not only have a large - scale business operation but also maintain a high level of profitability. Twelve A - share listed companies among them have demonstrated strong risk - resistance capabilities, which is of great significance in a complex and ever - changing economic environment. Meanwhile, enterprises like Ansen Intelligent have actively embraced digital transformation. By introducing advanced digital technologies and management systems, they have significantly improved production efficiency, reduced costs, and enhanced product quality. This digital transformation not only meets the development needs of the new era but also provides a new model for the transformation and upgrading of traditional industries in Xi'an[8].

In terms of brand service, many enterprises have made remarkable achievements in the international market. Products from enterprises such as Xifelong Valve and Huaweitek have successfully entered the markets of Europe, America, and the Asia - Pacific region, winning the recognition of international customers with their high - quality products and services. However, it should also be noted that some enterprises still face the problem of insufficient brand recognition. To address this issue, they need to strengthen international certification efforts, which can help them meet international quality and safety standards and enhance their brand credibility. At the same time,improving the service system is also crucial[9]. A complete and high - quality service system can not only improve customer satisfaction but also enhance brand loyalty, which is essential for enterprises to gain a firm foothold in the international market and achieve long - term development [10].

3.2. Analysis of Problems and Obstacles of Xi'an's "Specialized, Refined, Unique and Innovative" Enterprises from the Perspective of "Dual-Chain" Integration

In terms of specialization, the problem of "hollowing out" of core technologies is prominent. Although it focuses on aerospace, semiconductors and other fields, key materials and core components still rely on imports. The "low-end" supply quality is manifested in a high proportion of low-end products in the industrial chain and insufficient added value. The "marginalization" in the mainstream market is reflected in the difficulty of international market expansion due to technical certification barriers and insufficient brand recognition[11]. In terms of refinement, unreasonable industrial division of labor leads to homogenized competition among development zones, and the industrial chain support is weak. The weak quality management ability is due to the lack of internal driving force for digital transformation. Market service barriers are closely related to financing difficulties and fragmented policy implementation. In terms of distinctiveness, the weakening of comparative advantages is reflected in the insufficient regional cluster effect and the lagging operation mode behind the intelligent trend in the eastern region[12]. The low brand effect is due to the lack of leading enterprises and national consumer brands in the light industry field. In terms of novelty, the phenomenon of patent bubbles is obvious. The quality of some enterprises' patents is disconnected from industrial applications. The lack of technical standards leads to insufficient international discourse power. The conversion rate of only 30.5% highlights the shortcomings of the industry-university-research collaboration mechanism. In addition, systemic obstacles exacerbate the predicament: market segmentation and regional barriers hinder resource flow. The technology gap is due to the high cost of digital transformation for small and medium-sized enterprises and the loss of high-end talents. Innovation islands are caused by the low local implementation rate of university research and insufficient cross-regional technology collaboration[13]. These problems jointly restrict the "specialized, refined, distinctive and innovative" enterprises in Xi'an from climbing to the high end of the industrial chain and deeply integrating into the innovation chain.

4. The realization path of High-Quality development of "specialized, refined, Distinctive and Innovative" enterprises in Xi 'an driven by the integration of "dual chains"

Firstly, the "dual-chain" integration drives the specialized development of "specialized, refined, high-quality, and innovative" enterprises. In terms of core technology autonomy, enterprises in Xi'an enhance their independent R&D capabilities through the synergy of innovation chains and industrial chains. For instance, InnoTech has filled the domestic gap in unmanned systems for unmanned aerial vehicles through independent R&D, and Kangtuo Medical has broken through 3D printing implant technology, with its R&D investment accounting for 8.9% of its total revenue. On the path of high-end supply quality, enterprises rely on the QinChuangYuan platform to promote the intelligent upgrading of process equipment, such as Shaanxi Fuantai Standard Components Factory achieving production process visualization through IoT integration, with production efficiency increasing by 50%[14]. In terms of mainstream market dominance, the integration of industrial chains strengthens competitive advantages, such as Xingzhan Tescan participating in global satellite industry chain collaboration, Shaanxi Auto Group jointly building a cluster with over 400 suppliers to promote the international market share of products exceeding 10%[15]. Secondly, the "dual-chain" integration drives the refined development of "specialized, refined, high-quality, and innovative" enterprises. The key raw material refinement path focuses on the upstream collaboration of the industrial chain. Xi'an new materials enterprises have established carbon-based material research and development platforms through "chain leader-driven production" and universities, achieving domestic substitution of raw materials[16]. Quality management refinement involves introducing the Six Sigma management system, establishing a quality traceability system,

and enhancing product qualification rates through ISO certification. Market service refinement is enabled by big data, such as Rina Intelligent, which builds an "Internet + intelligent operation and maintenance" model through user profiling to achieve full life cycle management of power equipment and increase customer response efficiency by 40%. Thirdly, the "dual-chain" integration drives the distinctive development of "specialized, refined, high-quality, and innovative" enterprises. The product distinctive path emphasizes the integration of "digital - service - product package", such as Meilanxin New Materials launching customized solutions for photovoltaic thermal field carbon-based materials, which meet customers' differentiated needs through a digital design platform[17]. Mode distinctive path reconfigures production processes through "reverse customization + network collaborative manufacturing", such as a certain electronic equipment company relying on the C2M platform to directly connect customer demands with the production line, shortening the delivery cycle by 30%. Brand distinctive path focuses on precise promotion, such as Hefelong Valves entering the European and American markets through international exhibitions, and Lite Optoelectronics OLED materials shaping an industry benchmark with a domestic market share of 86.7%.

Fourthly, the "dual-chain" integration drives the innovative development of "specialized, refined, high-quality, and innovative" enterprises. Patent innovative path focuses on laying out high-value patents. Yuanjie Semiconductor has built a patent jungle around photonic chip technology, with a cumulative application of 322 patents and receiving a 300,000-yuan award for the China Patent Award. Technological standard innovative path involves leading the formulation of industry standards in semiconductor and new energy fields, such as Shaanxi Huawei Technology participating in the formulation of national standards for free forging parts, and Lite Optoelectronics leading the research and development of international standards for OLED materials. Transformation of achievements innovative path relies on the QinChuangYuan platform, with the "hard technology" pilot base of Xi'an Institute of Optics and Fine Mechanics promoting a patent conversion rate of 30.5% and achieving financing of 167 million yuan through intellectual property securitiesization.

5. The "dual-chain" integration drives the high-quality development mechanism of "specialized, refined, distinctive and innovative" enterprises in Xi 'an

First, market-driven mechanism. The "dual-chain" integration in Xi'an promotes the internal development mechanism through innovation-driven approach, enabling "specialized, innovative, and high-quality" enterprises to break through core technology barriers. For instance, InnoTech independently developed an unmanned system for unmanned aerial vehicles, filling the domestic gap. Kangtuo Medical's 3D printing implant technology achieved domestic substitution. The proportion of R&D investment by enterprises reached 8.9%. The mechanism for the emergence of new technologies, new models, and new business forms is reflected in digital transformation and scenario application. For example, Shaanxi Fuantai achieved full-process visualization of the production line through IOT technology, increasing production efficiency by 50%, while Xituo Electric's "Internet + intelligent operation and maintenance" model optimized the full life cycle management of equipment. In terms of the innovation classification-led cooperation mechanism of "state-owned enterprises + private enterprises", Shaanxi Automobile Industry Group, as the "chain leader", led 400+ upstream and downstream enterprises to develop collaboratively, forming a cluster effect, and promoting private enterprises to integrate into the high-end industrial chain through the "leader + supporting" model.

Second, platform support mechanism. The Qinchuangxiang Innovation-driven Platform accelerates the transformation of technological achievements through the resource coordination

mechanism, integrating resources from "government, industry, academia, research, and application". For instance, the "hard technology" pilot base of Xi'an Institute of Optics and Precision Mechanics promoted the patent conversion rate to 30.5% and achieved financing of 167 million yuan through intellectual property securitiesization. In terms of the collaborative innovation mechanism of "government, industry, academia, research, and application", Meilanxin New Materials jointly developed carbon-based materials with universities and broke through the bottleneck of photovoltaic thermal field technology. While Xi'an Thermal Power Research Institute and its industrial chain partners jointly tackled the technology of circuit breakers for 100,000-kilowatt generators and achieved a breakthrough in domestic production. The risk-sharing mechanism of "industry fund + VC + PE + credit + guarantee" reduces the innovation risks of enterprises through multi-level financial support. For instance, Shaanxi Equity Exchange established a "specialized and innovative" special board to provide a green channel for enterprises like Tailesong and supported them in digital transformation through the "industry fund + guarantee" model. The industrial fund-acquisition mechanism focuses on key fields. The Aerospace Base has set up a special team for 13 industrial chains to promote the development of satellite communication and new energy clusters. The risk compensation mechanism for the first unit (set) major equipment focuses on supporting enterprises with the highest support of 600,000 yuan through the "three hundred and sixty-six" policies of the Economic Development Zone for enterprises meeting the conditions.

Third, policy guarantee mechanism. The gradient cultivation mechanism for "specialized, innovative, and high-quality" small and medium-sized enterprises achieves precise support through classified database establishment and tagging management. Xi'an High-tech Zone established "small-scale enterprises to large-scale enterprises" and "small giants" cultivation databases, awarded 200,000 yuan to national-level "small giants" enterprises, and promoted enterprises like Qiwei Technology to receive nationalSpecial funds support. In terms of the "chain leader" and "chain leader" mutual communication mechanism, Xi'an City dynamically released supply and demand lists through the "chain leader service system", and 49 municipal "chain leaders" enterprises led the industrial chain to collaborate. For instance, Shaanxi Automobile Industry Group achieved clustering through the "one-chain-one-policy-one-fund" model. In terms of key core technology research and development, the "race horse" and "soliciting solutions" systems were relied on. Shaanxi Huawei Technology led the formulation of national standards for free forging parts, and Lite Optoelectronics led the research and development of international standards for OLED materials. The industrial chain acquisition mechanism focused on key fields. The Aerospace Base promoted the development of satellite communication and new energy clusters through 13 industrial chains special teams. The risk compensation mechanism for the first unit (set) major equipment provided support of up to 600,000 yuan to qualified enterprises through the "three hundred and sixty-six" policies of the Economic Development Zone.

6. Conclusions

The "dual-chain" integration promotes the high-quality development of "specialized, refined, distinctive and innovative" enterprises in Xi'an through three mechanisms: market-driven, platform-supported and policy-secured. The market-driven mechanism focuses on the internalized innovation-driven development as its core, relying on the "state-owned enterprise + private enterprise" collaboration model (such as Shaanxi Auto Group leading 400+ supporting enterprises) and the application of new technologies in scenarios (such as IoT enhancing production efficiency by 50%), to break through the predicament of core technology "hollowing out"; the platform-supported mechanism takes Qinchuangyuan as the core carrier, integrating resources from government, academia, industry and research (such as the patent conversion rate of Xi'an Institute

of Optics and Precision Mechanics reaching 30.5%), and accelerating technology industrialization through the risk-sharing model of "venture capital + guarantee" (such as financing support from the Economic and Technological Development Zone); the policy-secured mechanism takes the gradient cultivation, "chain leader system" and "challenge and solution" as the handles (such as a 200,000-yuan reward for national "little giants" in the High-tech Zone), to break through regional barriers and innovation islands, and promote enterprises to integrate into the high-end industrial chain. In the future, it is necessary to strengthen cross-regional technological collaboration, international standard alignment and full-chain penetration of digital technology, to elevate Xi'an's experience into the national "dual-chain" integration paradigm, and help achieve the dual goals of technological self-reliance and self-strengthening and industrial upgrading.

Acknowledgements

This work was supported by Research Project on Educational and Teaching Reform of Shaanxi Open University in 2025: Exploration and Practice of Digital Competency Evaluation for Finance and Accounting Teachers in Open Education(sxkd2025zd01); Research on the Path and Mechanism of "Dual-Chain" Integration Driving the High-Quality Development of "Specialized, Refined, Unique and Innovative" Enterprises in Xi 'an (25JX10); Research topic of Internet Ideological and Political Work in 2024: Research on the Path and Mechanism of Internet Course Ideological and Political Construction for Higher Vocational College Students Empowered by Digital Technology (2024WS-A03); Xi 'an Social Science Fund in 2025: Research project of Shaanxi Open University (Shaanxi Industrial and Commercial Vocational College) in 2024: Research on Promoting the deep integration of "Four chains" in Shaanxi (2024KY-B04); Xi 'an Social Science Fund in 2024: Research on Xi 'an's Promotion of the Deep Integration of Innovation Chain Industrial Chain Capital Chain Talent Chain (24GL04); Project of Shaanxi Institute of Education Science in 2024: Study on the Revolutionary Classroom Model of Core Curriculum for Finance and Accounting Majors in Higher Vocational Colleges (SGH24Y3130); Research project of Data Analysis Education and Training Committee of Chinese Adult Education Association in 2024: Construction of Digital Competency Evaluation Model and Coping Strategies for Open Education Teachers (2024-SJYB-074S); The 11th Accounting scientific research Project and research project of Xi 'an Accounting Society in 2024: Research on the implementation status, problems and optimization Strategies of budget Management integration in provincial universities in Xi 'an Area (1); Project of China Electronic Labor Society in 2024: Construction of Digital Competency Evaluation index System of higher education Teachers and research on Improvement Path (Ceal2024155); 2024 Chinese Educational Accounting Association Project: Research on Optimization Strategy of University Budget Performance Management (JYKJ2024-007MS); Scientific Research Program Funded by Shaanxi Provincial Education Department (Program No.22JZ017); 2023 National Open University Key Research Project: Open University Comprehensive Budget Performance Management Research (Z23B0017); 2023 Research project of Shaanxi Open University (Shaanxi Industrial and Commercial Vocational College) : Research on Digital Learning Achievement Certification of Higher Continuing Education (2023KY-A05); 2023 China Adult Education Association 14th Five-Year Educational Research Planning project: Research on Adult Continuing Education Learning Achievement Certification based on block-chain technology (2023-019Y); Research and Innovation Team of the Open University of Shaanxi" Study on financial Support for rural Revitalization and development in Shaanxi"(TD2021001).

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