

Research on the Impact of Two-Chain Integration on the High-Quality Development of China's Manufacturing Industry

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Abstract: China has a sizable manufacturing industry, but it is "big but not strong" and occupies the middle and lower levels of the global value chain, it is imperative to explore new models of manufacturing development and to cultivate new energies for development. In order to accomplish the high-quality development of China's manufacturing industry (Hereinafter abbreviated as HQD-MI), it requires efforts to promote the integration of the industrial chain and innovation chain(IOTC), and activation of the supporting financial chain, service chain, and talent chain. By scouring the pertinent domestic and foreign literature, the article thoroughly examines the workings of the IOTC as well as the driving forces behind the HQD-MI with the aim of establishing a connection between the two as well as providing a fresh line of inquiry for future researchers.

Keywords: Industrial chain, Innovation chain, High-quality development of manufacturing industry (HQD-MI).

1. Research on the Integration of Two Chains.

The thought of the integrated development of industrial chain and innovation chain first appeared in 2014, When Xi Jinping, the Chinese President made clear that the innovation chain ought to be placed surrounding the industrial chain. Since then, President Xi Jinping has since made numerous significant remarks on the IOTC in public. At present, the study on IOTC in the academic community mainly focuses on the analysis of its connotation and integration path.

1.1. Research on Industrial Chain

As early as 1958, HIRSCHMAN in his book "The Theory of Economic Development" regarded the industrial chain as a series of related industries with input-output links [3]. Adam Smith (1776) analyzed the division of labor within a single enterprise in *The Wealth of Nations*, and considered the industrial chain as the distribution process of resources within the enterprise [4]. The industrial chain is a form of intermediate organization between the market and enterprise, which is a cooperative and competitive quasi-market organization with the dual attributes of "organized market" and "organization with market" [5]. The concept of industrial chain transcends the transaction relationship between market subjects and reflects a wider range of non-market subjects and non-economic transactional interactions [6].

Collaborative innovation activities in the industry chain promote the sharing of knowledge among enterprises and improve innovation performance [7]. Relevant works mainly concentrate on the formation mechanism, integration theory, and modernization level of the industry chain. Domestic scholars have defined the connotation of the industrial chain modernization from various perspectives, such as the value chain (Huang Qunhui, 2020) [8], industrial autonomy and control (Liu Zhibiao, 2021) [9], and the industrial system [10], respectively. Currently, compared with developed countries, China's industrial foundation is still weak, the control ability of key links is not strong, the industrial chain security and

toughness is insufficient, and it is unable to keep pace with the development of the digital economy (Zhang, Qizai, 2022; Song, H. and Yang, Yudong, 2022) [11-12].

1.2. Research on Innovation Chain

The existing research on innovation chain is more focused on conceptual and functional perspectives. The concept of innovation chain was first proposed by Marshall and Vredenburg (1992), who believed that an innovation chain is a process or structure of integrated innovation activities that contains multiple innovation participants interconnected and undergoing multiple stages to generate value [13]. TURKENBURG (2002) believes that there are two models: forward linear innovation chain and reverse feedback innovation chain [14]. Innovation is by no means an easy linear change process; on the contrary, it is a complex nonlinear change process in which multiple innovation players interact with each other through multiple resources to realize the co-evolution of technology and market demand [15-17]. Nowadays, innovation activities are becoming more and more frequent and complex, based on which the innovation chain patterns show an evolution from linear to non-linear, from unidirectional communication to interactive operation [18]. Lin Runhui, Lu Yanhong, Li Yalin, et al. (2022) constructed a three-level global innovation chain measurement system of "link-connection-chain" to measure and evaluate the innovation status of countries, regions, enterprises and other entities in the global innovation chain of a certain innovation field [19].

1.3. Research on the development of "integration of two chains"

The level of IOTC has become a vital indicator of a nation's economic strength and modernization level. The innovation chain relies on the industrial chain and at the same time enhances the capabilities of it. The two chains are like the DNA double helix structure, they are mutually supportive, interdependent, integrated, and interactive. which is the organic unity of innovation subject and production subject,

innovation process and industrial development, innovation achievements and product production.

Rothwell (1992) believes that innovation chain is born from two aspects, one is the promotion of technology, and the other is the pull of the market, both of which couple the industrial chain and the innovation chain [20]. Porter's theory of competitive advantage holds that the achievement of a country's competitive advantage is not only related to factors of production such as labor and capital, but also to the integration ability of factors of production [21]. Both industrial chain and innovation chain are a kind of chain organization structure, which are formed in the process of industrial development and technological innovation respectively, these two chains can integrate the elements needed for production and innovation according to the market demand, to increase production effectiveness and innovative abilities [22]. Li Xuesong and Gong Xiaoqian (2017) believe that the IOTC can be divided into two modes, one is innovation chain develops first and then drives industrial chain to achieve integration, and the other is industrial chain develops first and then drives innovation chain to achieve integration [23]. The innovation chain pushing industry chain integration mode is generally applicable to countries or regions with strong R&D capabilities, while the industry chain pulling innovation chain integration mode is generally applicable to countries or regions with weak R&D capabilities [19]. According to Liu Jingyue and Wu Weixu (2022), the two chains are integrated in two ways through one-way extension and two-way promotion, one-way extension includes the extension of the innovation chain to the industrial chain and the extension of the industrial chain to the innovation chain, and two-way integration requires to construct a "bridge" for the IOTC. It is very necessary to build a "bridge" connecting the industrial chain and the innovation chain, to realize the matching of technology supply and technology demand, to realize the interaction and interoperability of innovation resources, and ultimately to realize the IOTC [24]. Most of the existing literature uses entropy method [25], principal component analysis [26], hierarchical analysis [27], composite system synergy model [28-29], coupling coordination model [30], gray correlation model [31], and evolutionary game model [32] and other methods to evaluate the level of "two-chain integration".

2. Research on High-quality Development of Manufacturing Industry

2.1. Connotation of high-quality development of manufacturing industry

The current studies have drawn on the theory of high-quality development (Hereinafter abbreviated as HQD), then linked to the features of the manufacturing industry, and finally generalized and sorted out the connotation of HQD-MI. Regarding the connotation of HQD, the existing research mainly evaluates China's HQD from three perspectives: economic growth quality, new development philosophy, and macro, meso and micro perspectives. The first type of research mainly conceptualizes the connotation of HQD as economic growth quality, but essentially they are different, with the former having a richer and more diversified connotation. (Barro, 2002; Zheng Yu-Xin, 2007) [33-34]. Montfort Mlachila et al. (2017) argued that, for

developing countries, high-quality growth refers to a growth rate that is higher and more sustainable social friendly growth [35]. HQD encompasses economic elements, such as industrial layout and resource availability, as well as non-economic elements, such as politics, culture and education [36-37]. High-quality development is manifested at the macro level as stable economic growth, balanced regional and urban-rural development, innovative green development, ecological development, and the fruits of economic development benefit all the people in a more and more equitable way; at the meso-industry level as growing scale, optimizing structure, innovation-driven transformation and upgrading, and continuous improvement of quality and efficiency; and at the micro-enterprise level as improved competitiveness, reliable product quality, and advanced quality management concepts, etc. [38].

HQD has a rich connotation, the connotation of HQD-MI is not completely equivalent to the HQD of the economy. HQD-MI is the concrete manifestation of HQD at the meso level, the substructure for realizing HQD of the economy at the macro-level, and the superstructure for product and service quality at the micro level. According to Liu Guoxin et al. (2020), HQD-MI is a multidimensional development model centered on economic construction, driven by innovation, guided by openness, constrained by ecology, and aimed at industrial upgrading. [39]. Yu Donghua (2020) believes that the HQD-MI is characterized by sustainable and high level, which is defined as a high level of development throughout every step of the production, manufacturing, and sales process to achieve lower production material input, higher resource utilization efficiency, stronger quality strength, superior ecological and environmental quality, and positive economic and social outcomes [40]. Qu Li, Wang Lu, Ji Huanyong (2021) [41] combined with the research of Zhang Tao (2020) [42] and the traits of the manufacturing sector, and concluded that the connotation of HQD-MI can be understood from these aspects-innovation, green, opening up, sharing, efficiency and risk control.

2.2. Measurement of high-quality level of manufacturing industry

At present, the literature on the construction of evaluation indexes for HQD-MI is increasing day by day, but basically it is the situation of "a hundred schools of thought", without forming a unified consensus. The evaluation methods for HQM-DI can be broadly categorized into three types. The first type of research uses the proportion of manufacturing industry, value-added rate [43] and other singular index, to represent the level of HQD-MI. For example, Feenstra (2014), measured the unit value and demand information of Chinese manufacturing items to assess their quality [44]. The second type uses total factor productivity to characterize the degree of HQD-MI. For example, Shangguan Xuming (2021) [45], Chen Zhao and Liu Yingman (2021) [46]. Levinsohn & Petrin (2003) [47] constructed a HQD index for manufacturing firms and industries by measuring their total factor productivity. The third type constructs a multidimensional indicator framework to measure the level of HQD-MI. Most often, academics construct their assessment frameworks from perspectives that involve resource environment, openness, social sharing, innovation efficiency, as well as synchronized development. For instance, Wang Fang and Shi Xin (2022) [48] draw on the compensatory summing function proposed by Tarabusi et al. (2004) [49] to

comprehensively measure the index of HQD level of 27 segments of the manufacturing sector via the viewpoints of green development efficiency and export technological structure. Jiang Xiaoguo, He Jianbo, Fang Lei, et al. (2019) constructed a comprehensive assessment frameworks covering six aspects: innovation inputs and outputs, economic efficiency, resources and environment, quality and branding and structural adjustment [50]. The measurement of each index's weight, which can be done in a variety of ways—including subjectively and objectively—is the key to using the comprehensive assessment index framework to gauge the manufacturing sector's HQD index. The most commonly used subjective assignment method is Delphi hierarchical analysis [41], while the most frequently used objective assignment methods consist of the coefficient of variation method [51], entropy weighting method [52], and the principal component analysis method [53].

2.3. Influencing factors of high-quality development of manufacturing industry

Manufacturing is a core component of the real economy, a significant driver of economic growth, and an influential determinant of a country's comprehensive strength. Due to a variety of reasons, the manufacturing sector's development quality is always evolving and changing, which include external environment and internal reasons. The external environment mainly includes policy and institutional environment, economic environment, natural environment and technological environment, while the internal factors include developmental basic conditions, factor endowment, industrial structure and openness [54]. For example, Tian Hui, Cheng Qian, and Li Wenyu (2021) conclude that competition from imported products and services as a whole inhibits the HQD-MI of China, and innovation has a mediating effect in this process[55]. Meng Maoyuan and Zhang Guangsheng (2021) found that rising labor costs can enable companies to strengthen their R&D efforts and invest more capital in R&D, which can optimize human capital and internal control, thus optimizing companies' operational efficiency and profitability.

2.4. The path of high-quality development of manufacturing industry

From the basic theories of economics and empirical facts, in order to fundamentally realize high-quality economic development, it is essential to make a radical transformation in terms of quality, efficiency and motivation. The fundamental power source of HQD-MI is the innovation of science and technology and the improvement and reform of the system [57]. Yu Donghua (2020) believes that the power mechanism to promote the HQD-MI is divided into six aspects, such as innovation power, reform power, open power, factor support, demand pulling power and talent support, and the endogenous power mechanism of HQD-MI will finally come down to the old and new kinetic energy conversion and transformation and upgrading of the manufacturing industry, and high-quality development will be realized through the conversion and transformation and upgrading of kinetic energy [40]. Jiang Xiaoguo, He Jianbo, Fang Lei, et al. (2019) pointed out that to realize the HQD-MI, it is necessary to raise the quality of the supply system as the main direction of attack, take technological innovation as the core power, take high-end manufacturing, intelligent manufacturing, high-quality manufacturing and green manufacturing as the main grips,

adher to the new development philosophy and the principle of prioritizing quality and efficiency, and ultimately realizing the triple transformation of the quality, efficiency and dynamics of the manufacturing industry[50]. Lu Yongxiang (2018) proposed that the continuous optimization of the business environment and the construction of a high-level open, cooperative and win-win investment and trade environment can help accelerate the process of HQD-MI[58]. Cao Zhengyong (2018) pointed out that under the conditions of the digital economy, the focus of improving the quality of the development of a particular industry lies in collaborative manufacturing, personalization, and service manufacturing [59].

3. Literature Review

In summary, there are currently abundant research results in the domestic and foreign academic circles on the IOTC, as well as the HQD-MI. However, most of the related studies only explore the concepts, integration paths and mechanisms of industrial chain and innovation chain at the theoretical level, and few scholars have quantitatively measured the degree of synergistic development of these two chains. Scholars have studied the driving factors of HQD-MI from various perspectives, however, the linkage between "two-chain integration" and HQD-MI has been less frequently analyzed. If researchers can incorporate the IOTC and HQD-MI into one analytical framework, and analyze the ways in which two-chain convergence affects the HQD-MI and what impact it has had on the HQD-MI, this will help facilitate the in-depth integration of the industrial chain and the innovation chain, improve the integration efficiency of production factors and innovation factors, and further drive manufacturing to a higher level.

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