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The Impact of Global Value Chain Position on Emerging Industrial Cluster Innovation Efficiency in China

Yan Xu[1,2], Hanny Zurina Hamzah[1], and Law Siong Hook[1]

[1]School of Business and Management, University Putra Malaysia, Malaysia, [2]Institute of international Trade, Shanxi University of Finance and Economics, China

Corresponding Authorc Email: Hannyzurina@upm.edu.my

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Abstract

With the increasingly frequent international interaction, economic globalization has become the main trend of social development. The position of division of labor in global value chains greatly affects the income share of a country participating in international economic activities. Despite remarkably enhance in China's GVC position of its primary industries, manufacturing, and services, demonstrating a trend of "catching up," there remains a considerable gap in emerging industries. This paper studies the problems existing in the emerging industry cluster at this stage, such as the lack of technological innovation, the imbalance of regional industrial cluster layout, and the defects of financial policy system. We analyze the mechanism and impact of GVC position on the industrial cluster innovation efficiency. The conclusion is that higher GVC position can improve innovation efficiency, and the influence of upstream or downstream position on innovation efficiency is different. In addition, the influence is dynamic. Based on this analysis, we put forward suggestions for enhancing GVC position and targeted to provide a theoretical reference for the emerging industrial cluster innovation efficiency improvements.

Keywords: GVC position, Industrial Cluster, Emerging Industry, Innovation Efficiency.

Introduction

Industrial clusters have become an important organizational for the development of emerging industries. Developed countries, leveraging their technological leadership and diversified intermediate products, primarily engage in high-value-added innovation, design, and some segments of high-end manufacturing (Word Bank, 2020), while developing countries are relatively deficient in advanced factors, they are often compelled to participate in the lower-end segments of the GVC division of labor which is dominated by developed countries, and they are prone to falling into the development dilemma of being "locked in at the low end" (Schmitz, 2004). The current domestic industrial agglomeration mainly introduce foreign capital, technology imitation and activities focusing on low-end manufacturing (Hagemejer &

Ghodsi, 2017). The development of emerging industrial clusters require attention to several key elements in the new environment, the high-end autonomous value chain network stage and resource utilization network stage (Humphrey & Schmitz, 2000). There are some problems in domestic emerging industries, such as small number of enterprises, slow accumulation of resources, weak strength of parks and obvious agglomeration of industries with the same structure. Extending industrial chains, rationally planning parks, constructing innovative systems and exploring new models of internationalization are effective for technology upgrading through GVC (Kergroach, 2019).

Due to the low-cost advantage of production factors, China has integrated into the global value chain division system led by research and development. Its foreign trade has grown rapidly and its economic strength has been comprehensively enhanced. However, on account of constraints such as a weak industrial base and a lack of core technologies, China has not been able to escape the fate of being "locked in at the low end." Currently, China has grown into the largest goods trade country and its factor endowment structure has undergone fundamental changes. Given its vast economic size and changes in factor endowments, China urgently needs to accelerate its efforts to elevate its position in the GVC.

As the background of GVC division of labor becomes deeper, emerging industrial clusters are playing an increasingly important role in it. On the one hand, the development of new industrial clusters promotes the transformation and upgrading of its own industry, and meets the needs of innovation. On the other hand, the development of industrial clusters promotes the competitiveness of international industries, making the corresponding industries eligible for outward transfers in the context of GVC. It can be said that clarifying the positioning of new industrial clusters is an important condition for promoting the innovation efficiency of industries. Based on this, our paper conducts a comprehensive study of the GVC position and proposes specific suggestions which has important practical significance for the development of emerging industry clusters.

The impact of GVC position on innovation has been a subject of academic interest, with its impact channels mainly consisting of two aspects: international trade and foreign direct investment. On the export side, GVC position helps domestic firms produce according to international standards, expanding the consumption market for their products and achieving scale economies, thereby improving innovation (Eissa & Zaki, 2023; Hu et al., 2021). At the same time, GVC position forces export firms to increase their technological innovation input to cope with the pressure of international competition, thereby raising the technological complexity of their exports, which is conducive to overall productivity improvement (Yu et al., 2023). On the import side, GVC position usually brings about spillover effects of technology, with export firms improving their exports' complexity through technological introduction and intermediate goods exports, and spillover effects to other industries, at the same time, GVC position also diversify and improve the quality of intermediate goods imports, helping to save production costs and effectively promote steady innovation (Thakur & Sharma, 2024). The second impact channel is foreign direct investment. The main driver of global value chain division of labor is multinational corporations, which effectively promote technological innovation through foreign direct investment and its spillover effect. Among them, foreign direct investment accelerates the host country's innovation through competition effects, training effects, demonstration effects, and industrial linkage effects.

In recent years, with the deepening of economic globalization, the trend of GVC reconstruction has become increasingly apparent. The alteration of GVC position refers to the changes in participation within the upstream and downstream of the industry by regional comparative advantages through transnational direct investment and international trade. Moreover, China's current GVC position alterations are mainly concentrated in the eastern coastal areas. Although the GVC position has gradually improved, for a long time, the role of GVC position in innovation needs to be further enhanced.

Literature Review

GVC Theory

The concept of the GVC has emerged gradually with the development of economic and production globalization, as well as the increasing trend of vertical specialization among world economic organizations and nations. This theory has become a focal topic of discussion in the field of management studies. Scholars began to propose the theory of value chains in 1990s. Jelinek & Porter (1990), pointed out in his book that every enterprise is a collection of activities involved in designing, producing, selling, delivering, and supporting its products. These activities, both basic (such as internal logistics, production operations, external logistics, marketing and sales, and services) and supportive (including procurement, technology development, human resource management, and corporate infrastructure), constitute a dynamic process of value creation, known as the value chain. He also extended his perspective beyond individual enterprises to economic interactions between different enterprises, introducing the concept of a value system, which is foundational to the concept of the global value chain.

Krugman (1991), explored the ability of enterprises to configure internal value chain stages across different geographic spaces. The fragmentation of production processes and their reorganization across borders have become prominent features of the GVC. Research on the governance of the GVC focuses on its organizational structure, power distribution, and relationship coordination among economic entities within the chain. Governance structures and system efficiency are core elements of GVC analysis. Gereffi (1994), and others combined value chain analysis with industrial organization research to propose the concept of the Global Commodity Chain (GCC). Almeida & Kogut (1999), further developed the concept, introducing the value-added chain to analyze international strategic advantages. He viewed the value chain as a process where technology, raw materials, and labor are integrated to form various input stages, which are then assembled to create final products. These products ultimately complete the value cycle through market transactions and consumption. In the context of economic globalization, the production process of goods is decomposed into different stages, forming a transnational production system that organizes enterprises and institutions of various sizes worldwide into an integrated production network.

Sturgeon (2002), defined the GVC based on three dimensions: organizational scale, geographic distribution, and productive actors. The GVC includes all entities involved in productive activities for a particular product or service and must have a global scope. Participants include integrated enterprises, retailers, lead firms, turnkey suppliers, and component suppliers. The GVC focuses on the value-added stages of product life cycles and the interaction and profit distribution among enterprises within the value chain. Complex products involve more production processes and have longer vertical dimensions, while larger

industries are more likely to achieve economies of scale and more developed horizontal dimensions, potentially forming large and complex production networks. Fernandez-Stark & Gereffi, (2019) later refined the concept, proposing the Global Value Chain (GVC) as a method to study the global spatial distribution of production activities. This concept reveals the dynamic characteristics of the current world economy.

GVC Position (GVC pos)

As an organization and governance force, GVC siphons the firms of various countries into the "world process" through the space production network. The change of the position and participation mode of domestic firms in GVC may change the integration form of resource acquisition, the strategy of international layout of production and the network relations between global organizations. To profoundly influence the mode of action of domestic localization clusters involved in the production performance of firms (Humphrey & Schmitz, 2000).

Downward Participation (DOWN)

The major progress of GVC research mainly focuses on indicator measurement. A large number of scholars have conducted relatively perfect measurements of a country's participation in vertical specialization (VS) or domestic value added (DVA) contained in exports from the macro industry and micro-firm levels (Hummels et al., 2001). This study refers to the existing literature to construct the firm GVC downward participation index.

Upward Participation (UP)

Both VS and DVA can only reflect the degree of integration into the international division of labor from one direction, the participation of the downstream participation of GVC cannot be measured the participation of the upstream link of GVC. In this study, the real position of firms in GVC division of labor is measured by establishing the index of firm participation in the upward link of GVC.

Industrial Clusters Theory

Industrial clusters represent a geographical concentration phenomenon comprising numerous interconnected enterprises and institutions, playing a significant role in regional economic growth, innovation, and the enhancement of competitive advantages. Since Alfred Marshall first proposed the concept of industrial clusters, scholars have conducted in-depth research on them from various perspectives, forming a variety of theories and models.

The development of industrial cluster theory can be divided into several stages, each with its specific research methods and content. Classical location theory began in the early 19th century and ended in the mid-20th century which analyzed the relationship between factory location and factors such as raw material sources, market locations, and transportation methods from a cost perspective, developing a quantitative approach to factory location analysis, laying the quantitative foundation for industrial spatial analysis in economic geography. Industrial interconnection stage spanned from the 1950s to the 1980s. Comprehensive analysis of multiple cost factors replaced single-cost analysis, and the focus shifted from the location of individual enterprises to the synergistic relationships among multiple enterprises. Greater emphasis was placed on input-output analysis among enterprises and the backward and forward linkages between industries, highlighting the

polarization, radiation, return, and cumulative effects of factors in space. Research in social integration stage placed greater emphasis on cooperation and competition among enterprises, as well as resource integration and knowledge spillover effects within industrial clusters (Anokhin et al., 2019; Gordon & McCann, 2000; Hervás-Oliver & Albors-Garrigós, 2007). Network theory, competitive advantage theory, and others were further developed during this stage.

Although significant achievements have been made in the research on industrial cluster theory, there are still some problems and deficiencies. Existing research on industrial clusters primarily focuses on theoretical analysis, with relatively few empirical studies. This limits the explanatory and predictive power of industrial cluster phenomena. Despite some important achievements in industrial cluster theory, the transformation and application of these results in practical applications are still insufficient. This limits the guiding role of industrial cluster theory in actual economic activities. Existing research mainly focuses on developed countries and regions, with relatively few studies on industrial clusters in developing countries and regions (Borghi et al., 2010; Breschi & Malerba, 2005; Kim et al., 2023). This limits a comprehensive understanding of global industrial cluster phenomena.

Innovation Efficiency Theory

The initial innovation theory was put forward by economist Joseph A Schumpeter in his book *The Theory of Economic Progress* published in 1912, who investigated that innovation is the setting up of a new product in function and essentially an unbalanced process. He divided an economic system into two types: the circulation system and economic development system. The circulation system of resources is the performance of the conventionalization of economic life. The economic development system breaks the equilibrium state in the economy. He first used the concept of innovation to demonstrate the impact of technological revolution on unbalanced economic growth and unstable social development. Under the influence of Schumpeter, Solow (1956) proposed the neoclassical model of economic growth. Enos (1962) defined innovation as a comprehensive process of mental activity, capital input, plan formulation and implementation. Glynn (1996) illustrated that the key to innovation lies in the transformation of business results. In the report of Successful Industrial Innovation, Myers & Marquis (1969) defined innovation as a collection of technological changes. Freeman (1995) expanded innovation as the process of commercialization of technology, management, design, manufacturing, etc., which eventually leads to new products, new processes, and new equipment for commercial applications. On the basis of these studies of innovation, Romer (1986) advanced the endogenous economic growth theory. The study of innovation has gradually moved from a linear paradigm to a network paradigm. Asheim & Isaksen (2002) compared the characteristics of linear paradigms with network paradigms. The linear paradigm holds that innovation generally goes through a simple linear process of development, design, production, and sales, and is limited to the technical process within a single firm. Later studies have investigated that external information exchange and coordination play an important role in innovation. Since then, innovation research has shifted from within individual firms to the connection and interaction between firms and the external environment, which is the networking paradigm (Audretsch & Belitski, 2022; Zhang & Yu, 2024).

With the development of innovative research, some calculation methods have been gradually applied. Technical efficiency was proposed by Farrell (1957). He defined the concept from the perspective of input and thought that technical efficiency refers to the ratio between the ideal minimum possible input and the actual input of a production unit under the same output. From the perspective of output, Leibenstein (1966) measured the technical efficiency refers to the ratio between the actual output of a production unit and the ideal maximum possible output under the same input.

Essentially, innovation efficiency is a kind of technical efficiency which considered to be related to many factors. Pavitt (1987) observed that there was a "U-shaped" relationship between firm size and innovation capability. According to Scherer & Ross (1990), R&D efficiency will be impaired as the scale of firms increases. Government subsidies can make up for the lack of firm R&D and improve the firm innovation ability (Czarnitzki & Licht, 2006; Zafar et al., 2021)

The Impact of GVC Position on Industrial Cluster Innovation Efficiency

The position of a firm within the Global Value Chain (GVC) refers to its location and role in the global production and trade network, which often influences its access to resources, technologies, markets, and competitive advantages on the global stage. In contrast, cluster innovation efficiency pertains to the ability of an industrial cluster within a specific geographical area to enhance production efficiency and foster technological advancement through innovative activities.

The concept of industrial clusters has been explored by Marshall and Porter from the perspective of enterprise competition (Marshall & Marshall, 1920; Porter, 1996), with an emphasis on how industrial agglomeration affects international competitiveness. Both scholars highlighted the significant role that the innovative environment within clusters plays in fostering business success. Existing research on industrial clusters can be broadly classified into three main areas: 1) studies on the upgrading pathways of industrial agglomeration within the GVC framework, focusing on the international division of labor; 2) case studies exploring the relationship between industrial agglomeration and GVC upgrading; and 3) research examining how industrial agglomeration influences a country's position in the international division of labor within the GVC. These categories reflect the diverse approaches and focal points in understanding how industrial chain agglomeration impacts global economic integration and competitiveness (De Marchi et al., 2017; Kergroach, 2019).
However, a review of the literature reveals that relatively little attention has been given to the direct impact of a country's position in the international division of labor within the GVC on industrial clusters. While some studies have explored the broader relationship between the GVC and innovation, fewer have specifically analyzed how a firm's or a country's position in the GVC influences the innovation efficiency of industrial clusters.

Problems in GVC Position of Emerging Industries

Insufficient Technological Innovation Investment

Although relevant departments have increased investment in technological innovation and continuously issued supportive policies, there are still significant gaps in independent innovation capabilities when compared to developed countries. In particular, China has not yet mastered the latest integrated technologies, critical components, and materials related to key products. Some large-scale equipment relies on foreign imports and can only be

transferred within GVC. Additionally, core technology patents have not been registered overseas, leading to frequent issues during international transfer processes. Furthermore, the support system for technological innovation is clearly lacking, with insufficient reserves for scientific research, industrialization-related resources, and a shortage of innovative talent in science and technology. As shown in Table 1, China's investment in emerging industries in 2021 was notably lower than that of related developed countries.

Table1
Proportion of Emerging Industry Investment in Total Industrial Output Value of Countries in 2021

Country	United States	Sweden	Finland	Japan	Canada	Germany	Italy	China
Emerging industry investment	1105.45	931.30	875.14	933.67	787.51	802.34	681.40	795.99
Gross Industrial Output Value	6210.4	5713.5	5402.1	6102.4	4474.5	5210.0	4424.7	5303.6
proportion	17.8%	16.3%	16.2%	15.3%	17.6%	15.4%	15.4%	15%

(Unit: USD 100 million)

Unbalanced Regional Industrial Cluster Layout

The current layout of emerging industry clusters in China is influenced by factors rooted in Eastern management culture, with the primary consideration being the specific roles these clusters play for both the country and society. At the national level, the distribution of emerging industry clusters is largely shaped by government policies and directives. On the societal level, geo-social network factors also come into play. As a result, phenomena such as regional agglomeration protection and the convergence of industrial structures are observed. China is divided into three regions—eastern, central, and western—and the overall regional industrial agglomeration layout is presented in Table 2.

Table 2
Layout of Emerging Industries in Eastern, Central and Western Regions

Region	Agglomeration and distribution of emerging industries
East	Aerospace industry, new generation information technology industry, biological industry, energy conservation and environmental protection industry, new energy automobile industry, high-end equipment manufacturing industry, biomedicine industry, transportation equipment manufacturing industry, nuclear power related industry, marine high-tech industry, Internet of things industry.
Central	New energy equipment manufacturing industry, transportation equipment manufacturing industry, new material industry, electronic information industry, energy conservation and environmental protection industry, modern coal chemical industry, advanced equipment manufacturing industry, cultural and creative industry, energy conservation and environmental protection industry, new energy automobile industry, biomedical industry.
West	New energy equipment manufacturing industry, transportation equipment manufacturing industry, energy saving and environmental protection industry, modern coal chemical industry, new energy automobile industry, biomedicine industry, new materials industry, new energy automobile industry, biomedical industry, electronic information industry.

As shown in Table 2, the similarity in industrial agglomeration has directly contributed to an imbalance in the layout of emerging industries, resulting in repeated investments and incomplete infrastructure. Industrial clusters, such as those in the new energy equipment manufacturing, energy-saving and environmental protection, and new energy vehicle sectors—supported by government policies—are distributed across many regions. This imbalance in the layout of emerging industry clusters leads to irrational regional industrial structures, ultimately disrupting the supply and demand balance and hindering the achievement of steady economic growth.

Policy and Financial Resource Allocation Defects

At present, the country's fiscal and policy for the promotion of GVC position in emerging industrial clusters have shortcomings. The allocation of financial resources and the cultivation of scientific research personnel remain unreasonable, failing to meet the needs of emerging industrial cluster development. Furthermore, the state's taxation policies are inadequate, lacking customization and rationalization based on the unique development characteristics of these clusters. The development of emerging industry clusters varies significantly in terms of organizational form and enterprise scale. A one-size-fits-all tax preferential policy fails to provide meaningful incentives for agglomerated industries, which undermines the original intent of such policies. In terms of financial resource allocation, investment in the eastern regions is notably higher than in the western and central regions. This unequal distribution of resources impedes the effective development of emerging industries.

Weak Industrialization Capacity

The efficiency of industrial conversion in applied research is currently low, with frequent disconnects between research outcomes and industry application. In terms of technological

research and development, the interests of universities, research institutes, and enterprises are often misaligned, resulting in a failure to translate research results into tangible products. With the deepening of the GVC division of labor system, the value added of products is shared by more and more countries, and the subjects participating in the international division of labor are becoming more and more diversified. The ability of the emerging industry in value increment reflects the competitive advantage of the industry in the benefit distribution pattern of the value chain division. At this stage, the value adding ability of China's emerging industries is still weak.

The Mechanism of GVC Position's Impact on Industrial Clusters Innovation Efficiency

The impact mechanism of GVC position on cluster innovation efficiency mainly operates through the following aspects:

Firstly, the higher the position in the GVC, the greater the innovation efficiency of the cluster. This is because firms in the upstream of the GVC are more likely to access advanced technologies and resources, which are crucial for driving innovation. According to the Smile Curve theory, upstream firms enjoy broader market access and stronger competitiveness, allowing them to increase brand recognition and expand market share in international markets. Moreover, as firms move upstream in the GVC, the level of collaborative innovation among cluster members deepens. The cooperation between industry, academia, and research within the cluster facilitates technological progress and industrial upgrading, which fundamentally enhances the overall innovation efficiency of the cluster.

Secondly, different GVC positions have varying effects on cluster innovation efficiency. Firms in the upstream are typically engaged in the research, design, and production of core components, and they possess advanced technological capabilities and innovation drive. Therefore, they play a critical role in promoting innovation and improving cluster efficiency. However, it is important to note that if upstream firms overly rely on external technological inputs and neglect the development of their own innovation capabilities, the overall innovation efficiency of the cluster will not improve. On the other hand, firms in the midstream or downstream of the GVC are mainly involved in processing, assembly, and sales, and their technological and R&D capabilities are often insufficient. Only by strengthening cooperation with upstream firms and drawing on advanced technologies and management experiences from developed countries or regions can they enhance the innovation efficiency of the cluster.

Additionally, the impact of GVC position on cluster innovation efficiency is dynamic. Since GVC position is not fixed, this variability also has a dynamic effect on cluster innovation efficiency. When a firm moves up the GVC, it may face challenges such as technological barriers and limited market access. Conversely, a decline in GVC position may lead to a loss of market opportunities, inevitably resulting in a decrease in the cluster's innovation efficiency.

Discussion and Suggestion

Cultivating Innovative Enterprises

The cultivation of innovative enterprise must be continuously strengthened. On the basis of existing technological advantages, innovative enterprises should extend to areas such as R&D design, brand marketing, and after-sales service, enhancing the company's ability to

introduce, digest, absorb, and innovate. By improving the level of scientific and technological talent, this will drive technological upgrades.

On the other hand, according to the development direction of industrial innovation, adjustments and optimization should be made to the professional and hierarchical structure of higher education, expanding the scale of high-skilled labor supply to provide talent for enterprise-driven innovation. Once technical talent is trained, it is crucial to establish innovative enterprises. This requires a thorough understanding of market demand and leveraging technological innovation to unlock new opportunities. For example, Steve Jobs harnessed the power of the Internet to innovate in mobile terminal manufacturing, opening up the smartphone market, accelerating its growth, and driving GVC restructuring, which resulted in substantial economic gains.

Promoting Long-Term Growth

To foster the growth of domestic emerging industrial clusters, it is essential to address the current imbalances in industrial layout. This can be achieved by aligning industrial cluster locations with regional advantages, adhering to the natural laws of industrial development, and focusing on long-term strategic goals.

In the eastern region, many coastal cities benefit from favorable geographical conditions and robust economic foundations. These areas should leverage their advantages to develop industries such as next-generation information technology, aerospace, nuclear power, marine high-tech, and the Internet of Things, positioning themselves as hubs for emerging industrial clusters.

The central region, acting as a vital link between the eastern and western parts of the country, should build on its existing industrial base to prioritize the development of emerging industries. It can also serve as a conduit for industrial transfers from both regions. Key clusters in the central region could include transportation equipment manufacturing, new materials, electronic information, energy-saving and environmental protection, and advanced equipment manufacturing. Furthermore, the region should harness its historical strength in telecommunications to develop a next-generation information technology cluster while supporting industries with regional characteristics.

The western region, rich in mineral resources, wind energy, and solar energy, holds significant potential for industries such as modern coal chemicals, energy conservation, new energy, and new energy equipment manufacturing. By capitalizing on its natural resources, this region can drive the growth of these strategic industries, further strengthening its position in the emerging industrial landscape.

Optimizing Innovation Resources Allocation

To address the shortcomings in innovation policies and resource allocation, the government and relevant departments must implement targeted support measures and strengthen fiscal and tax frameworks. For example, environmental taxes should be increased for enterprises that discharge wastewater and dust, thereby reducing negative externalities and encouraging the growth of energy-saving and environmental protection industries.

Policies should promote the concentration of resources in emerging industrial clusters, accelerate the optimal allocation of innovation resources in science and technology, finance, data, etc., and innovate public services and financial services in emerging industries. The basic capabilities of emerging industries and the modernization of industrial chains are also encouraged by innovation policies.

Accelerating Industrialization of Technology R&D

The formulation and optimization of industry standards can promote the industrialization process of emerging industry cluster R&D technologies. By establishing comprehensive standards, technological innovation is supported, and consistency within and outside the industry is ensured. At the same time, the government needs to streamline market access and approval processes to enhance the commercialization capability of R&D outcomes.

For example, in high-tech industries like new energy vehicles and pharmaceuticals, the government should focus on promoting continuous technological innovation and improving the regulatory framework. These regulatory measures will ensure that innovative technologies in areas such as new energy vehicles and pharmaceuticals meet the required safety and quality standards, creating favorable conditions for commercialization.

In conclusion, through policies that cultivate innovative enterprises, promote long-term development, optimize resource allocation, and facilitate the industrialization of technological R&D, GVC position can be further enhanced and it is expected to have a positive impact on the innovation efficiency of emerging industrial clusters.

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