Research on how the digital economy has affected the improvement and modernization of the industrial structure in the Beijing-Tianjin-Hebei area

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Abstract. Due to the Internet's rapid technological advancement, the level of digital economy development has become a crucial metric for assessing the quality of economic development as well as a significant driver for the improvement and modernization of industrial structure. It is crucial to examine and research the effects of the digital economy's growth on the modernization and optimization of the industrial structure in Beijing, Tianjin, and Hebei from the standpoint of cooperative development. Based on collecting and organizing relevant literature, this essay explains and evaluates Beijing, Tianjin, and Hebei's current state of industrial structure modernization and the growth of the digital economy, and conducts an econometric analysis to conclude that the level of digital economy development and industrial structure upgrading in Beijing, Tianjin and Hebei is improving. Next, the degree of government intervention, the amount of direct investment by foreign businessmen and the level of innovation in technology are introduced as control variables to construct a regression model, and it is discovered that the upgrading of the industrial structure in Beijing, Tianjin, and Hebei is significantly benefited by the digital economy.

Keywords: Beijing, Tianjin and Hebei; digital economy; industrial structure upgrading; impact study.

1. Literature review

1.1. Research on upgrading and optimizing industrial structure

Firstly, about the necessity of industrial structure upgrading. Wu Aidong (2017) points out that from the perspective of advanced, the proportional relationship between the three industries affects the way of economic growth of a region [1]. Agricultural production is inefficient and countries or regions with predominantly agricultural economies have smaller economies and slower growth rates; Wang Maoxiang (2017) suggests that when the proportion of secondary and tertiary industries gradually increases their economic growth patterns also become more advanced, and as a result, economic development is more rapid [2]. Sun Jing(2012), meantime, emphasizes that proportionate industrial structure modification enhances the level of technical innovation, increase the added value of products, and make the value chain move to a higher level [3]. From the perspective of rationalisation, Xu Min (2015) and Wang Wei (2015) point out that the difference between production efficiency among industrial sectors will further promote the optimal allocation of resource factors, making labour resources flow into secondary and tertiary industries, thus adjusting income distribution and raising the income level of residents [4-5].

Secondly, studies on the path of factors for upgrading the industrial structure. In terms of advancement, Reeve (2006) argues that technological upgrading will lead to the flow of factor resources to more efficient production sectors, increasing the proportion of secondary and tertiary industries while enhancing the structure's quality [6]. According to Peters(2012),the majority of foreign investment flowing into China is targeted at the tertiary sector [7].This encourages the expansion of the service sector's output value and hastens the industrial structure's transformation and modernization. Zhang Cuiju and Zhang Zongyi (2015)argue that appropriate policy support can reorient the innovation development of industries, promote the level of technology as well as productivity, and thus achieve industrial structure upgrading [8].

1.2 A research on how the digital economy has affected industrial structure modernization and optimization

In terms of research methodology. Beck(2015) employed GMM estimate techniques to determine the driving force behind the upgrading of the industrial structure and found regional variations [9]. Utilizing spatial econometric techniques, Lin, Yu-Hao and Chen, Ying-Kui (2020) examined how the digital economy affected the degree of industrial structure in each region, and the existence of its driving effect was also found [10]. By using a fixed-effects model, Chen Xiaohui (2020) arrived at the empirical conclusion that the level of industrial structure is marginally and steadily improved by the digital economy [11]. By creating a complete index system for the growth stage of the digital economy using OLS regression. Empirically, the modernisation of the industrial structure may benefit greatly from the digital economy, as Zhang Yongqing and Chen Mianmian (2020) have shown. in terms of the influences and routes [12]. Henderson (2002) points out that an increase in the level of technology can drive the transformation of the industrial structure to an advanced direction and increase the proportion of high value-added industries.According to Zhang Yu Che, the digital economy has the potential to further alter the economic development business model(2018), spark a number of adjustments within each industrial sector, encourage the effective distribution of production resources, and encourage structural rationalization [13]. According to Li Yiming's research(2019), the digital economy will propel the growth of a number of new industries and encourage the modernization of industrial structures through technology innovation and integration [14].

2. Conceptual definition and theoretical foundations

2.1 Definition of concepts

2.1.1 Defining the digital economy

Don Tapscott first introduced the concept of the digital economy in 1996 and since then it has generated a great deal of interest and discussion . Carlsson B (2004) argues that the digital economy is a dynamic, more expressed through new products or activities, and is a product of information based on huge amounts of data [15]. Zimmerman (2015) looks at the development process on the economic system and the process of creating economic value, determining the fundamental traits of the digital economy. According to Chen (2018), the transformation and upgrading of industries can only be accomplished by the continual integration of new technologies with new industries, which can support a leapfrogging expansion of China's economy[7] . Xu Qingyuan and Shan Zhiguan et al. (2018) believe that the digital economy refers to a new type of industry that uses information technology as a platform root and the network system as a communication and interaction channel to create products or services through digital technology [16].

In summary, this paper argues that the digital economy is a series of actions undertaken to achieve efficient use of information technology and optimise economic structures, in which digital knowledge and information are central elements and various internet platforms are used to promote economic development with digital technology.

2.1.2 The connotation of industrial setting optimisation and upgrading

At present, the concept of industrial structure upgrading is mainly discussed from two aspects: advanced and rationalisation. Liu Zhibiao (2000) and Zhang Yaohui (2002) believe that the advanced industrial structure is mainly the process of substitution of high value-added industries for low value-added industries, i.e. shifting from lower to higher forms; particularly, the share of tertiary industry is still growing while the share of primary industry is continuously decreasing [17-18].According to Alfaro (2010), the effective distribution of limited resources is referred to as industrial structure rationalization. The effective use of scarce resources to promote coordinated development among diverse industrial sectors is referred to as "so as to achieve the rationalization of industrial structure."

2.2 Relevant theories

2.2.1 Theories related to the digital economy

Xie Kang (2019) specifically considers the performance characteristics of digital economy products in his study, explains the reasons for them from the perspective of demand and supply, and provides some theoretical references for the use of digital technology [19]. Chen Wanqin (2020) analyses the differences between the digital economy and the traditional business model. Firstly, producers and consumers can be connected and matched through online platforms to regulate changes in market demand and improve transaction efficiency. Second, it can significantly reduce the cost of economic operation and sustainably increase marginal returns. Thirdly, there are changes in the factors of production. Data information is beginning to become a new input resource and contains enormous economic value.

2.2.2 Theory of industrial structure evolution

The main theories in this area include the Allotment-Clark theorem, Kuznets theory and Hoffmann's theorem, which clearly point out the trends and influencing factors of industrial structure ratios in the process of socio-economic development.

2.2.2.1 Allotment of the Dee-Clark Theorem

The theory suggests that differences in industrial structure between countries are due to differences in the earning power of their domestic populations. This statement explains to a certain extent the pattern of transfer of labour resources among the three industries. The important argument is that as population income levels rise, secondary and tertiary businesses gradually gain labor from basic industries.

2.2.2.2 Kuznets theory

Kuznets' empirical study of changes in industrial structure in terms of GDP per capita shows that the share of agriculture in GDP decreases as the economy develops, while the share of industry and services in GDP increases. Similarly, the share of agricultural employment in total employment has been declining, while the share of employment in industry and services has been increasing.This theory suggests that as socio-economic development proceeds, industrial restructuring is mainly characterised by a gradual reduction in the share of employment and income in agriculture, which has a declining role in the national economy. The industrial manufacturing sector has seen its income levels rise and its contribution to GDP become more pronounced. The service sector has seen an overall rise in incomes and a continued increase in the proportion of the workforce.

2.2.2.3 Hoffman's Theorem

The theory, mainly developed in 1931, focuses on the changing trends in the structure of the industrial sector. Hoffmann mathematically analysed the changes in the ratio of output of consumer goods to capital goods in more than twenty countries and found a continuous downward trend. Technological upgrading has increased production efficiency, leading to a gradual shift towards a more advanced industrial structure.

3. Analysis of the impact path of digital economy on the study of industrial structure improvement and modernization in Beijing-Tianjin-Hebei region

3.1 The direction of the digital economy's effects on improving and optimizing agriculture

Utilizing digital technology can alter how agriculture is produced, encourage resource allocation that best serves all parts of production and distribution, increase production efficiency, and foster production intelligence. This is illustrated in Figure 1.

The digital economy has changed the original production methods of agriculture. The application of intelligent machinery and equipment further enhances the automation of the entire agricultural production process, improves labour productivity and enhances the quality of agricultural products. Digital technologies such as remote sensing technology and the Internet of Things are used to analyse information on water sources, land and other related resources, effectively reducing production costs and improving land productivity and resource utilisation.

Digital technology has changed the previous mode of distribution and sale of agricultural products, further enhancing the direct connection between buyers and sellers. The scope of transactions is expanding, transaction costs are gradually decreasing, and the speed and efficiency of agricultural products moving through the marketplace is being effectively increased.

The digital economy changes the agricultural management model. Digital technology allows precise access to effective information such as natural weather and market information, bringing advanced management techniques, improved management efficiency and a digital management model.

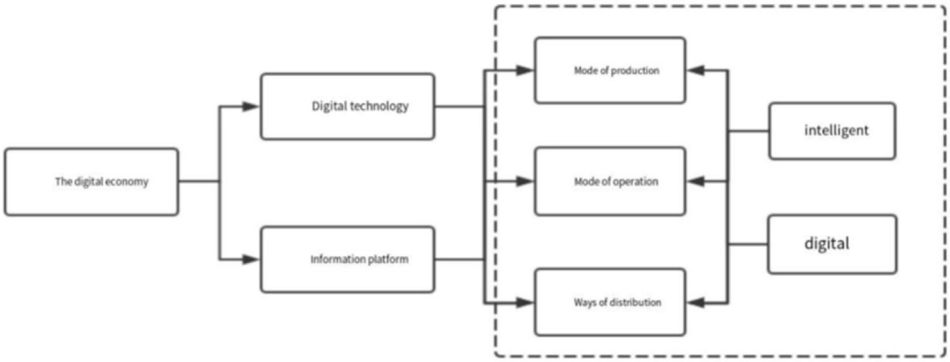


Figure 1 Map showing how the digital economy has improved and optimized agriculture.
Source of data: Plotted by the author based on relevant information.

3.2 Impacts of the digital economy on industry modernization and optimization

The impact of the digital economy on the secondary sector is mainly in the manufacturing sector, as shown in Figure 2.

The use of digital technology fosters the industrial sector's intelligent level of output. The extensive use of Industry 4.0 and Internet technology has changed traditional production methods, updated machinery and equipment, improved the level of equipment numerical control, saved investment in labour costs, greatly improved the efficiency of industrial operations and increased the added value of the industry.

Utilizing digital technology may result in the creation and updating of intelligent production technology, efficient manufacturing sector growth, reduction of associated energy consumption and prices, rational resource allocation, and compliance with green development laws.The emergence of personalization in manufacturing services is a result of the digital economy. Manufacturing industry sales and customer service are being innovated by the digital economy. Major e-commerce platform development in the digital economy has the potential to increase sales volume, decrease costs associated with sales, and increase sales channels. It can also effectively encourage timely and accurate feedback of consumer information so that businesses can quickly understand and react to shifts in consumer demand, significantly enhancing the degree of integration between the production and consumption segments.

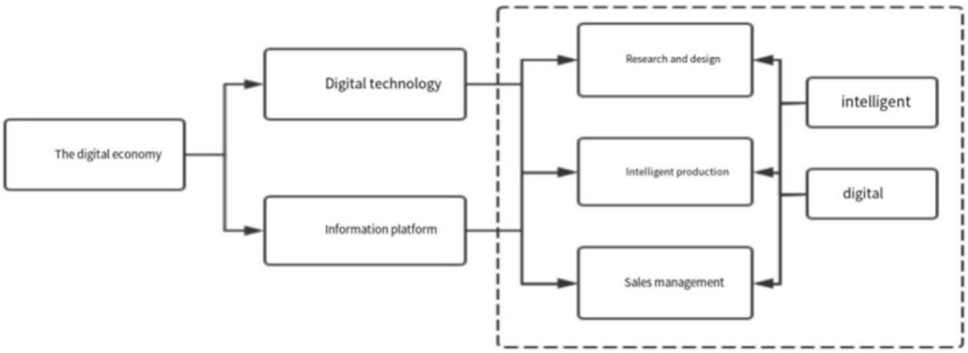


Figure 2 A diagram showing how the digital economy has affected the modernization and optimization of industry
Source of data: Plotted by the author based on relevant information.

3.3 The ways in which the digital economy has influenced the growth and modernisation of the service sector

The services industry is the industry sector most affected by the digital economy, and its digital transformation and high value-added conversion are important drivers for upgrading the industrial structure. Specific changes in both content and operating models are shown in Figure 3.

The significant use of information technology and the Internet of Things in the service sector has increased the level and quality of services while also increasing the efficiency of industrial processes. New goods and services have also emerged as a result of the digital economy, significantly strengthening the service supply side's capacity to adapt quickly to the market and satisfy more complex and changeable customer needs.

The emergence of the digital economy can give rise to new service systems, enrich the content of services and increase the level of intelligence of services. This is reflected in the continued inflow of new factors and resources into old industrial models, the continued emergence of a variety of new service models such as network distribution and sharing platforms, which have greatly stimulated the development of this sector and greatly improved service capacity, quality and efficiency.

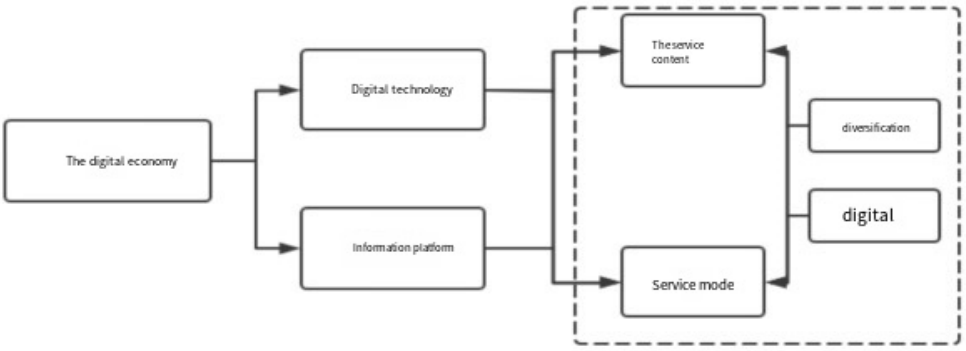


Figure 3 The improvement and modernization of the service industry as a result of the digital economy are depicted on a map.
Source of data: Plotted by the author based on relevant information.

4. Policy recommendations

4.1 Policy Recommendations

4.1.1 Upgrading industrial structures and improving infrastructure construction

The previous analysis has shown that there is still an imbalance in the development of network infrastructure in the Beijing-Tianjin-Hebei region. While Beijing is already at the forefront of network infrastructure development, Hebei Province is relatively backward, therefore lowering the whole economic system's degree of digital economy. The current traditional infrastructure development is no longer able to meet the further development of network information technology, which in turn also limits the stimulating effect of digital technology on the transformation of industrial structures. Based on this, Beijing, Tianjin and Hebei, especially Hebei, should continue to accelerate the promotion and use of 5G technology, further improve the coverage of fibre-optic cable lines and lay a strong foundation for efficient network operation; additionally, it's important to build more network cloud platforms, try to assemble the Internet of Everything, and recognize the quick exchange of data and information among diverse businesses.

4.1.2 Promote technological innovation and enhance technological support for industrial structure upgrading

The essence of contemporary economic competition is the competition of science and technology. Only by mastering advanced production technology can we quickly occupy the market and improve the level of economic development. The development of the tertiary industry is the key to promoting economic development, and scientific and technological innovation is the source of power for the development of the tertiary industry. Therefore, in the process of promoting the upgrading of the industrial structure and the development of the tertiary industry in Beijing, Tianjin and Hebei, full attention should be paid to science and technology. Scientific and technological innovation has changed the production methods of traditional industries, With the growth of numerous online platforms as well as a significant number of new service sectors has continually injected fresh life into society's development, leading the development of the tertiary industry and indicating the direction for the optimization and upgrading of the industrial structure.

4.1.3 Promote the improvement and modernization of industrial structures as well as the quickening of digital economy industries' penetration and integration with established industries.

Promoting positive transformational change in traditional industrial models is an important way to promote regional industrial restructuring, and the digital economy is an important entry point.

(1) Transforming traditional agriculture with the help of digital technology.

(2) Accelerate the in-depth use of the digital economy in industry.

(3) Accelerate the pace of digitisation of the service industry.

5.Conclusion

This essay's analysis and research are concentrated on how the expansion of the digital economy in the Beijing, Tianjin, and Hebei area has impacted the development and optimization of the regional industrial structure, focuses on the study of how the industrial structure and the digital economy are now developing, and conducts an empirical investigation of the correlation between the degree of industrial structure modernization and the growth of the digital economy in Beijing, Tianjin, and Hebei. The study's principal findings are listed below.

First, the Beijing-Tianjin-Hebei region's digital economy has been developing at an increasing rate, and the region's use of digital technology has been expanding. These developments have had a significant impact on the region's economic development. At the same time, there is an uncoordinated and unbalanced development among the three regions. Beijing, as the capital, has gathered a large number of highly skilled talents, and coupled with the government's policy support, The digital

economy sector has a high output scale, excellent digital infrastructure,the digital economy is developing rapidly, and the growth of the tertiary industry is very obvious; Tianjin's industrial structure and degree of digital economy growth are superior to those of Hebei but fall short of Beijing's. Tianjin's digital economy and industrial structure are not as good as Beijing's, but they are better than Hebei's. Hebei's digital economy is relatively slow, and the proportion of tertiary industries in GDP is much lower than that of Beijing and Tianjin, which lacks industrial competitive advantages.

The outcomes of an empirical research on the interaction between the growth of the digital economy and the modernization and optimization of the industrial structure are the second point.Firstly, using methods such as factor analysis models for measurement and evaluation, it was discovered that the Beijing-Tianjin-Hebei region's industrial structure and degree of digital economy growth have both been rising. The relationship between the two was then regression tested on this basis. The results show that the development of the digital economy has a significant contribution to the upgrading of the industrial structure in Beijing, Tianjin and Hebei. The extent of government participation, foreign direct investment, and technological advancement all contribute to the improvement of the industrial structure. The global economy's shift to a digital economy is bringing forth fresh industrial and technical developments. The Beijing-Tianjin-Hebei area, particularly Hebei, should make an effort to take advantage of the industry's growth in the digital economy and speed up the transformation of its own economic structure in order to support the advancement and development of the whole economic system.

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