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Spatiotemporal Differences and Dynamic Evolution of Labour Factor Adaptability to the Upgrading of Industrial Structure: A Case Study of Guangdong Province, China

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Abstract: *Based on panel data of various manufacturing industry segments in Guangdong Province from 2000 to 2020, the spatiotemporal differences and evolution trends of labour factors adaptability to the advanced manufacturing structure are empirically analysed through the adaptation measurement function, Dagum Gini decomposition coefficient and Gaussian kernel density function. The results show that the trend of the advanced manufacturing industry structure in various regions of Guangdong Province is obvious, the degree of adaptability of labour factors to the advanced industrial structure is lower, and the spatial differences in adaptability within and between regions show a dominant trend and are the main contributors to the spatiotemporal differences. In addition to the decrease in the spatiotemporal difference and the enhancement of regional convergence of the adaptation values in West Kwongtung, the spatiotemporal difference of the adaptation values in other regions is expanding, which is not conducive to the high-quality collaborative development of the manufacturing industry. Therefore, we should pay attention to the connection between the supply and demand of skilled labour training, improve the adaptation level of labour force elements and industrial structure, and promote the advanced and collaborative development of the manufacturing industry in Guangdong Province.*

Keywords: *Labour factors; Adaptabilities; Upgrading of industrial structure; Spatiotemporal differences; Dagum Gini coefficient*

1. Introduction

Throughout the history of modern economic development in the world, industrialization has been the only mode for a country to develop economically, and manufacturing has played a pivotal role in the industrial process of many countries. Advanced industrial structure is the development goal of the manufacturing industry. Since the reform and opening up in 1978, China's manufacturing industry has deeply participated in the division of labour in the global manufacturing value chain by virtue of the cost advantage of primary resources. China is the only country with manufacturing capabilities in all industrial categories, and its low labour cost has been an important driver for its economic growth for a long time. However, in the process of participating in the global value chain, driven by the international manufacturing division system, local Chinese manufacturing enterprises have been "captured" by the long-term lock-in low-cost model, and many subsectors of China's manufacturing industry have been anchored in low-value fields. Therefore, the upgrading and advancement of the manufacturing industry is facing severe difficulties, and China needs to urgently transform from high-speed manufacturing to high-end manufacturing. However, the internal upgrading of the manufacturing industry needs to be matched with a series of important production factors, such as natural resources, labour, capital, and R&D investment. Even in the case of the gradual disappearance of the "demographic dividend", China is still in a situation where the surplus of labour factors far exceeds that of capital. In a country with a large population and R&D investment, which is in the process of manufacturing upgrading from the labour factor to the capital factor and then transitioning to the knowledge factor, the labour factor is still the primary factor affecting the upgrading of China's manufacturing industry [1]. From the perspective of industrial development, China’s manufacturing industry still has comparative advantages compared with various Southeast Asian countries due to the increase in manufacturing employment volume and labour productivity, although China's labour-intensive manufacturing industry has no obvious unit labour cost

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advantage [2]. Therefore, making the labour factor a source of comparative advantage for the manufacturing industry in terms of participation in international competition and leading the labour factor to adapt to the advanced structure of the manufacturing industry are issues that need urgent discussion.

2. Literature review

Upgrading of the industrial structure is driven by the advanced production factors [1]. The advanced industrial structure based on labour factor endowment can be expressed as the transfer of labour factors from low-productivity and low-skilled sectors to high-productivity and high-skilled sectors, thereby increasing the output share of high-productivity sectors [3]. The connotation of the labour factor affecting the advanced industrial structure is reflected in two aspects: the first aspect is the change in the proportion of the industry; the second aspect is the improvement of productivity. In an economy, the greater the proportion of industries with high labour productivity, the more advanced the industrial structure is. Scholars have mainly carried out research on labour factors and the upgrading of the industrial structure.

First, the labour force structure will have a direct impact on the advancement of the industrial structure. The structuralist school believes that changes in the industrial structure in the economic system have a great impact on economic activities, and the optimal industrial structure is determined by the factor endowment structure [4]. Among the various production factors, namely, natural resources, capital, and labour, labour, especially high-quality labour, is the forerunner factor of economic growth and it plays an important role in technology-intensive industries [5]. Usually, in the case of free flow of factors, labour factors will gather in places with higher wage levels, and this change in the factor endowment structure can meet the demand for labour quality in industrial upgrading. From a country perspective, some scholars believe that when a country's economy and income level develop to a certain level, industrial upgrading will be affected by whether the labour factor structure matches the industrial structure [6]. Middle-income countries not only face competition from low-income countries with large numbers of inexpensive labour and mature industries but they also face competition from high-income countries with large numbers of innovative labour and high-tech industries [7]. An important reason why middle-income countries have developed slowly over a long period of time is that the industrial structure does not match the labour factor structure [8]. From an industrial point of view, industrial development needs to match the structure of human capital; moreover, the distribution of labour with different education and skill levels among different groups has different effects on industrial upgrading [6]. According to the general law of industrial development, the advanced manufacturing industry follows the sequential evolution from labour-intensive industries to capital-intensive industries and technology-intensive industries [9], and low-skilled labour has a greater impact on labour-intensive industries; medium-tech manufacturing needs to match the labour force with specific professional skills; the high-skilled labour force has a greater impact on the technology-intensive industry, and the manufacturing industry can be advanced only when the labour force factors are effectively allocated and when these factors match the structure of the manufacturing industry.

Second, the labour factor indirectly affects the advanced industrial structure by improving production efficiency. Advanced labour factor is reflected in the improvement of labour factor efficiency and marginal output level, which is usually measured by the education level of workers. The effective ways for the labour factor to improve production efficiency are the "learning by doing" effect and the "technical innovation" effect. Arrow (1962)[12] proposed that the "learning by doing" effect can effectively improve the productivity level in the process of labour knowledge accumulation. Based on mastering the existing technology, technological transformation and innovation are carried out to promote the continuous advancement of the manufacturing structure [13]. However, when the manufacturing industry lacks a certain amount of human capital accumulation, the "learning by doing" effect will be exhausted as the productive potential of new technologies is exhausted [14], thus, the main obstacle to technological innovation further restricts the improvement of productivity [15]. Therefore, for developing countries, solving the adaptation of labour factors and industrial structure issues will become particularly important.

Third, the consideration of the degree of adaptation between labour factors and the advanced industrial structure. The work of scholars is mostly based on the theory of "synergy" and they construct the index system of human capital structure and industrial structure upgrading from different perspectives [16-26]. Some scholars use the structural deviation coefficient [27-28], the structural standard deviation [28], and the structural coordination adaptation degree coefficient [28] to investigate the adaptation degree of labour force factors and the industrial structure upgrading in China's provinces and cities. Some scholars have investigated the transformation of human capital and industrial structure at different income stages by establishing a regression model of advanced human capital and industrial structure [8].

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Table 1: Relevant research on the adaptation of labour factors to the advanced industrial structure

Author	Industry	Region	Measurement	Periods	Conclusion
Yang Shuang	Overall industry	30 provinces of China	Fit index evaluation system	2008	The degree of adaptation of human capital in China is relatively low, and workers do not have the labour capacity and adaptability required for economic growth. The regional differences in adaptation degree are significant. The adaptability of Shanghai, Beijing, Guangdong and other eastern regions is higher, and the adaptability of the central and western regions is lower.
Zhang Yanping & Li Mingsheng	Overall industry	30 provinces of China	The talent structure adapts to the index system of the industrial structure upgrading	1999-2008	During this period, the coordination and adaptation level of 30 provinces and cities has not been high, and the coordination and adaptation level in Beijing, Shanghai, Guangdong, Fujian and other places has increased slightly; other provinces and cities are stagnant and in a state of weak imbalance.
Futao	Overall industry	Whole China	Evaluation index system for the suitability of industrial structure transformation and upgrading and human resources development	2000-2015	From 2000 to 2008, the adaptability increased slowly, and from 2008 to 2015, the adaptability of industrial structure upgrading and human resource development rose rapidly.
Huoying, etc.	High-tech industry	Whole China	Build an evaluation index system for the suitability of high-skilled personnel training input and high-tech industry output	2010	The coordination and adaptability between the accumulation of high-skilled talents and the development of high-tech industries in China is 0.478, and the degree of adaptation is relatively low.
Wang Zhihua & Dong Cuntian	Manufacturing	Whole China	The proportion of labour force and industrial output value in subdivided industries	2007-2011	The consistency between the quality structure of the labour force and the industrial structure in the eastern and western regions has improved.
Fu Tao, etc.	Manufacturing	Whole China	The matching degree model of human capital and manufacturing industry upgrading	2000-2017	The matching degree between manufacturing human capital and manufacturing industry upgrading in China is on the rise, but the matching degree is not high overall.
Huo Ying, etc.	Overall industry	Northeast China	Structural standard deviation, structural absolute deviation, structural synergy adaptation	2011	There is a surplus of engineering talents in Heilongjiang, Jilin and Liaoning, and there is a large imbalance between supply and demand based on the attributes of landed talents.
Tao Feiyang	Overall industry	Yangtze River Delta - Jiangsu, Zhejiang and Shanghai	The efficacy function and adaptability function of the two subsystems of talent structure and industrial structure	2002-2017	The suitability of labour structure and industrial structure in Jiangsu, Zhejiang, Shanghai and Anhui has increased. Shanghai has weakly adapted, Zhejiang and Jiangsu have been weakly out of balance,

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					and Anhui has low imbalance.
Shen Yingchun & Jia Yujie	Overall industry	Beijing-Tianjin-Hebei region	Evaluation index system for the suitability of industrial structure transformation and upgrading and human resources development	2012-2016	Beijing has the highest fitness, followed by Tianjin, and Hebei is the weakest. The fitness of Beijing is on the rise and belongs to moderate coordination, the fitness of Tianjin is low coordination, and the fitness of Hebei is weak misalignment.
Fu Tao	Overall industry	Guangdong Province	Evaluation index system for the suitability of human resource development and industrial transformation and upgrading	2000-2013	The dual-transfer strategy in the Pearl River Delta region is faced with the problems of low transfer efficiency, lagging support facilities in the transfer area, and competition between emerging industries and neighbouring provinces.
Chen Xiumei, etc.tc	Overall industry	Guangdong Province	Structural deviation factor	2015-2018	The secondary and tertiary industries in Guangdong Province are in the basic coordination state of employment and industry, while the primary industry has hidden unemployment.

Source: Organized by the author according to relevant literature

For ease of comparison, Table 1 summarizes scholars' research on labour force factors and the advanced industrial structure based on different regions and different time periods. The degree of adaptation of capital and industrial structure upgrading is analysed, and it is believed that the level of adaptation of human capital in China to industrial structure upgrading is low, the growth rate of the adaptation degree is slow, and there are obvious differences in time and space. Among them, before 2008, Beijing, Shanghai, Guangdong, Fujian and other places had a slow growth rate of coordination and adaptation levels, other provinces and cities were basically stagnant, in a state of weak imbalance, and workers did not have the ability and adaptability to promote the advanced industrial structure. After 2008, based on a series of policies such as increasing the investment and development of human capital, the increase in the degree of adaptation in the eastern and other economically developed regions has accelerated, but there is still a "high in the east and low in the west, and high in the south and low in the north" regional differences. Based on the division of three industries, some scholars [22-24, 27] studied the regional differences in talent structure and industrial structure upgrading adaptability in the three northeastern provinces, Yangtze River Delta, Beijing-Tianjin-Hebei, Pearl River Delta and in other places. However, the sophistication of the industrial structure is reflected not only in the sophistication of the economic growth model which is dominated by the service industry but also in the increase of the high-end added value of the industry's internal value chain, which is crucial to China's industrial transformation. Subsequently, based on the evaluation index system of the adaptation degree of human capital and industrial structure upgrading, some scholars [19-20] conducted research on the matching degree of high-tech industry and manufacturing industry and concluded that the matching degree of human capital and manufacturing upgrading in China is not ideal.

In summary, there are three main deficiencies in the existing research results. First, the existing research has well explained that the labour force factors promote the upgrading of industrial structure, but the manufacturing capacity is an important indicator to measure the long-term growth prospects of a country's economy, and the research on the matching relationship between labour factors and the advanced manufacturing structure from the perspective of manufacturing is slightly insufficient. In the process of developing high-end manufacturing, the accumulation of experience and knowledge will affect labour productivity. The impact of labour factors on high-end manufacturing and low-end manufacturing is different. Relevant research on the degree of adaptation between advanced labour factors and the advanced industrial structure is also worthy of attention, but related research on this aspect is relatively lacking. Finally, there is a dynamic adaptation relationship between labour factors and the advanced industrial structure. The existing research lacks an analysis of the spatial and temporal differences in the adaptation level and does not effectively reveal the differences between regions and subregions in China. Even if we pay attention to the evolution of labour and industrial restructuring, the analysis is often superficial.

Against this background, this paper attempts to raise three practical questions: (1) From the

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perspective of factor endowment, how well does the current labour factor fit with the advanced manufacturing structure? (2) In the presence of heterogeneity in regional manufacturing, are there spatiotemporal differences in the fit degree, and what is the dynamic evolution? (3) Can the differences in the fit degree reasonably explain the differences in regional industrial development? To this end, from the perspective of factor endowment, this paper examines the degree to which labour factors adapt to the advanced structure of the manufacturing industry. While enriching theories related to the fit degree, this paper clarifies that China's manufacturing industry has changed from a "large manufacturing country" to a "manufacturing power". The path of transformation will provide certain support for the government to formulate labour policies and industrial development policies.

3. Data sources and measurement of related indicators

3.1 Data Sources

Research on the advanced manufacturing structure of the labour factor adaptation degree should be based on a reasonable measurement of the advanced labour factor and the advanced industrial structure of the manufacturing industry. As a major industrial province, Guangdong Province accounts for 12.4% and 14.8% of the country's industrial added value and profits of industrial enterprises above a designated size in 2020, respectively; this clearly represents the advanced development level of China's manufacturing industry structure. To this end, Guangdong Province is selected as the research object, and by collecting data from the 2001-2021 "Guangdong Industrial Statistical Yearbook", "Guangdong Provincial Statistical Yearbook" and the statistical yearbooks of various cities over the years, we obtain the labour force and industrial added value of Guangdong's manufacturing subsector data to investigate the level of labour force factor upgrading and industrial structure upgrading of the Guangdong manufacturing industry. To eliminate the influence of price factors, relevant data such as industrial added value were standardized.

3.2 Measurement of relevant indicators

Among the theories related to the advanced industrial structure for the division of manufacturing subsectors, the more classic theory is the element substitution theory. In 1932, Hick mentioned in the wage theory that rising labour costs will lead to the substitution of production factors such as capital and technology with labour factors and the substitution of advanced production factors with general production factors, which is the driving force for the advanced industrial structure. For this reason, the discussion of industrial structure upgrading around the upgrading of production factors will lead the related research of industrial structure upgrading to be more scientific because it is free from generalities. Judging from the general law of manufacturing development, when the technical level is difficult to change in a short period of time, industrial development will follow the development law of labour-intensive to capital-intensive and technology-intensive, and the industry will advance step by step. The gradual rise of industry will inevitably cause some factors of production to aggregate. Some scholars use the intensity of production factors such as the number of workers and their remuneration, capital stock and R&D input to measure the influence of production factors on the upgrading of industrial structure. Yang Ligao [29] considered the intensity of production factors and classified 31 subsectors of the manufacturing industry into three types of labour-, capital- and technology-intensive manufacturing according to the classification standards of the National Bureau of Statistics. This paper draws on this method, as detailed in Table 2.

Table 2: Classification of manufacturing by factor intensity

Industry	Detail industry
Labour-intensive industries	1 Agricultural and side-line food processing industry 2 Food manufacturing industry 3 Textile industry 4 Textile and garment, shoes, hat manufacturing 5 Leather, fur, feather (velvet) and its products industry 6 Wood processing and bamboo, rattan, palm, grass Product Industry 7 Furniture Manufacturing 8 Printing and Recording Media Reproduction 9 Cultural, Educational, Industrial, Sports and Recreational Products Manufacturing 10 Rubber and Plastic Products Industry 11 Non-metallic Mineral Products Industry 12 Machinery and Equipment Repair Industry 13 Other Manufacturing 14 Metal Products , Machinery and Equipment Repair Industry
Capital-intensive	15 Wine, Beverage and Refined Tea Manufacturing Industry 16 Tobacco Products Industry 17

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industries	Paper and Paper Products Industry 18 Petroleum Processing, Coking and Nuclear Fuel Processing Industry 19 Chemical Raw Materials and Chemical Products Manufacturing 20 Chemical Fibre Manufacturing Industry 21 Ferrous metal smelting and rolling processing industry 22 Nonferrous metal smelting and rolling processing industry 23 General equipment manufacturing industry 24 Special equipment manufacturing industry 25 Automobile manufacturing industry 26 Electrical machinery and equipment manufacturing industry 27 Waste resources and waste material recycling and processing industry
Technology-intensive industries	28 Pharmaceutical manufacturing 29 Railway, ship, aerospace and other transportation equipment manufacturing 30 Computer, communication and other electronic equipment manufacturing 31 Instrumentation and culture, office machinery manufacturing

3.2.1 Measurement of the advanced manufacturing structure

For measurement of the advanced industrial structure, scholars use the industrial structure hierarchy coefficient method [11], the industrial output value proportion method [30], the Moore structural variation index method [31] and the angle cosine method [32]. The advanced industrial structure is a process in which the flow of production factors drives the increase in the proportion of industries. The measurement of the advanced industrial structure should consider the dual effects of the industrial proportion and labour productivity. Yuan Hang and Zhu Chengliang (2018) [33] divide the advanced industrial structure (OMS) of the manufacturing industry into two aspects: the evolution of industrial structure and the improvement of labour productivity. The specific formula is:

$$OMS = \sum_{i=1}^{n} S_{it} * L_{it} \tag{1}$$

where i =1,2,3 represent labour-intensive, capital-intensive, and technology-intensive manufacturing, S_{it} represents the proportion of the output value of industry i to the total output value in time, and L_{it} represents the labour productivity of industry i in time t. It can be assumed that when the proportion of industries with high labour productivity is relatively high, the higher the value of the indicator OMS, the higher the level of advanced industrial structure.

3.2.2 Measurement of the matching degree

The main methods to measure the matching degree between labour factors and the advanced industrial structure are the structural conformity coefficient, the structural deviation degree coefficient and the structural deviation coefficient. These three coefficients describe the adaptability of labour factors to the advanced industrial structure through different functional forms. However, the structural conformity coefficient and structural deviation degree coefficient ignore the impact of productivity improvement on labour demand impact, and thus has certain limitations. The structural deviation coefficient has been improved, and based on the assumption that the marginal output of labour production factors between industries is the same, it is believed that the industrial structure achieves Pareto optimization of production efficiency, and that the degree of adaptation of labour factors to industrial structure is the highest. The structural deviation coefficient has the advantages of being intuitive and easy to calculate when measuring the matching degree of the two structures, but the measurement results of the index are all positive, ignoring the situation that there may be inverse changes between labour changes and industrial changes. To solve this problem, drawing on the idea of the Tapio decoupling model, the adaptation degree of labour factors and industrial structure is analysed by the mapping principle of functions at special points, and the adaptability measurement function of labour factors and industrial structure is constructed in formula (2):

$$e_t^{ij} = \frac{(\triangle(W_i/W_j))/(W_i/W_j)}{(\triangle(G_i/G_j))/(G_i/G_j)} \quad (i \neq j) \tag{2}$$

In equation (2), e_t^{ij} indicates the elastic calculation index of the adaptation degree of the two variables; W_i and W_j represent the number of workers employed in labour-intensive and technology-intensive industries; G_i and G_j represent the industrial added value of labour-intensive and technology-intensive industries; $\triangle(W_i/W_j)$ and $\triangle(G_i/G_j)$ indicates the degree of change in the ratio of the number of employees in labour-intensive and technology-intensive industries and the ratio of industrial added value over a certain period. According to the OECD decoupling and division criteria, combined with the

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difference in adaptation degree, we construct a one-to-one matching function $f(z_i)$ as shown in equation (3) below:

$$f\left(\begin{bmatrix} sign\Delta(W_i/W_j) & sign(\Delta W_i) & sign(\Delta W_j) \\ sign\Delta(G_i/G_j) & sign(\Delta G_i) & sign(\Delta G_j) \end{bmatrix}\right) \to \{INT[-32,32] \neq 0\} \quad (3)$$

In Equation (3), $f(z_i)$ contains 6 symbolic functions and satisfies $sign(x) = \begin{cases} 1, x \geq 0 \\ -1, x < 0 \end{cases}, i = 1,2,...,64$ 。When the value of $\triangle(W_i/W_j)$ and $\triangle(G_i/G_j)$ is 0 or invalid, that is, the ratio of added value or labour in technology-intensive industries and labour-intensive industries remains unchanged, then $f(z_i) = 0$, which means that the labour structure and industrial structure are in a disorderly adaptation state. Considering the degree and direction of changes in the labour structure and industrial structure, the mapping principle of labour structure and industrial structure advancement is shown in Table 3:

Table 3: Mapping principle of the fit measurement function at special points

Function	Adaptation level	Change in the labour structure $\Delta(W_i/W_j)$	Changes of employees in technology-intensive industries ΔW_i	Changes of employees in labour-intensive industries ΔW_j	level of advanced industrial structure $\Delta(G_i/G_j)$	Changes in the output value of technology-intensive industries ΔG_i	Changes in the output value of labour-intensive industries ΔG_j
$f(-z_i)$=32	Strong Positive adaptation	>0 Increase	>0 Decrease	<0 Decrease	>0 Increase	>0 Increase	>0 Increase
	Level I	$sign\ \Delta(W_i/W_j) =$	$sign\ \Delta W_i =$	$sign\ \Delta W_j =$	$sign\ \Delta(G_i/$	$sign\ \Delta G_i =$	$sign\ \Delta G_j = 1$
$f(-z_i)$=-32	Strong negative adaptation	<0 Decrease	<0 Increase	>0 Increase	<0 Decrease	<0 Decrease	<0 Decrease
	Level I	$sign\ \Delta(W_i/W_j) =$	$sign\ \Delta W_i =$	$sign\ \Delta W_j =$	$sign\ \Delta(G_i/$	$sign\ \Delta G_i = -$	$sign\ \Delta G_j = -1$

Furthermore, the fit function at 32 special points in the adaptation state is as follows:

$$f(z_i) = f\begin{bmatrix} \begin{bmatrix}1&1&-1\\1&1&1\end{bmatrix}\begin{bmatrix}1&1&-1\\-1&1&1\end{bmatrix}\begin{bmatrix}-1&1&-1\\1&1&1\end{bmatrix}\begin{bmatrix}-1&1&-1\\-1&1&1\end{bmatrix}\begin{bmatrix}1&-1&-1\\1&1&1\end{bmatrix}\begin{bmatrix}1&-1&-1\\-1&1&1\end{bmatrix}\begin{bmatrix}-1&-1&-1\\1&1&1\end{bmatrix}\begin{bmatrix}-1&-1&-1\\-1&1&1\end{bmatrix} \\ \begin{bmatrix}1&1&1\\1&1&1\end{bmatrix}\begin{bmatrix}1&1&1\\-1&1&1\end{bmatrix}\begin{bmatrix}-1&1&1\\1&1&1\end{bmatrix}\begin{bmatrix}-1&1&1\\-1&1&1\end{bmatrix}\begin{bmatrix}1&1&-1\\1&-1&-1\end{bmatrix}\begin{bmatrix}1&1&-1\\-1&-1&-1\end{bmatrix}\begin{bmatrix}-1&1&-1\\1&-1&-1\end{bmatrix}\begin{bmatrix}-1&1&-1\\-1&-1&-1\end{bmatrix} \\ \begin{bmatrix}1&1&-1\\1&1&-1\end{bmatrix}\begin{bmatrix}1&1&-1\\-1&1&-1\end{bmatrix}\begin{bmatrix}-1&1&-1\\1&1&-1\end{bmatrix}\begin{bmatrix}-1&1&-1\\-1&1&-1\end{bmatrix}\begin{bmatrix}1&1&-1\\1&-1&1\end{bmatrix}\begin{bmatrix}1&1&-1\\-1&-1&1\end{bmatrix}\begin{bmatrix}-1&1&-1\\1&-1&1\end{bmatrix}\begin{bmatrix}-1&1&-1\\-1&-1&1\end{bmatrix} \\ \begin{bmatrix}1&-1&-1\\1&1&-1\end{bmatrix}\begin{bmatrix}1&-1&-1\\-1&1&-1\end{bmatrix}\begin{bmatrix}-1&-1&-1\\1&1&-1\end{bmatrix}\begin{bmatrix}-1&-1&-1\\-1&1&-1\end{bmatrix}\begin{bmatrix}1&1&1\\1&-1&1\end{bmatrix}\begin{bmatrix}1&1&1\\-1&-1&1\end{bmatrix}\begin{bmatrix}-1&1&1\\1&-1&1\end{bmatrix}\begin{bmatrix}-1&1&1\\-1&1&-1\end{bmatrix} \end{bmatrix}$$

$$= \begin{bmatrix} I & I & II & II & III & III & IV & IV \\ 32 & 31 & 30 & 29 & 28 & 27 & 26 & 25 \\ 24 & 23 & 22 & 21 & 20 & 19 & 18 & 17 \\ 16 & 15 & 14 & 13 & 12 & 11 & 10 & 9 \\ 8 & 7 & 6 & 5 & 4 & 3 & 2 & 1 \end{bmatrix}$$

Strong adaptation
Weak adaptation
Decenuative positive connection
Decenuative negative connection

Furthermore, since $f(-z_i) = -f(z_i)$, $f(z_i)$ is an odd function, the adaptation state of $f(z_i)$ can be expressed as:

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$$f(-\varepsilon_i)=\begin{bmatrix} \text{I} & \text{I} & \text{II} & \text{II} & \text{III} & \text{III} & \text{IV} & \text{IV} \\ -32 & -31 & -30 & -29 & -28 & -27 & -26 & -25 \\ -24 & -23 & -22 & -21 & -20 & -19 & -18 & -17 \\ -16 & -15 & -14 & -13 & -12 & -11 & -10 & -9 \\ -8 & -7 & -6 & -5 & -4 & -3 & -2 & -1 \end{bmatrix}$$

Strong negative adaptation
Weak negative adaptation
Half-growth negative connection
Half-growth positive connection

4. Empirical Analysis

4.1 Analysis of the adaptation results

The measurement of the adaptation needs is based on a reasonable analysis of the advanced industrial structure. According to the regional division of the Pearl River Delta, East Kwongtung, West Kwongtung and North Kwongtung, the values of the advanced manufacturing industry structure in various regions of Guangdong Province are calculated according to formula (1), and the evolution trend in time and space is shown in Figure 1:

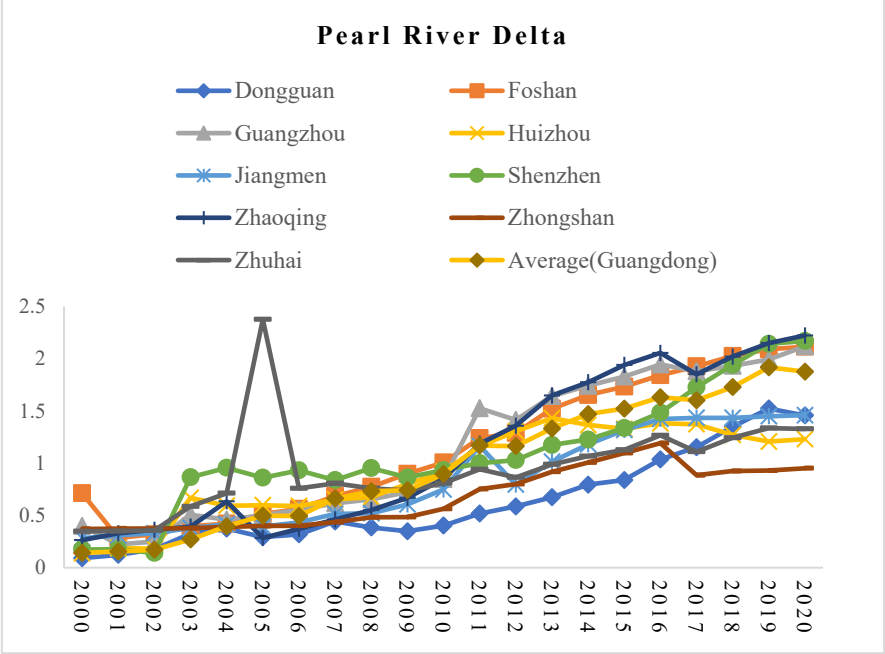

Figure 1(a): The temporal and spatial evolution of industrial structure upgrading in the Pearl River Delta

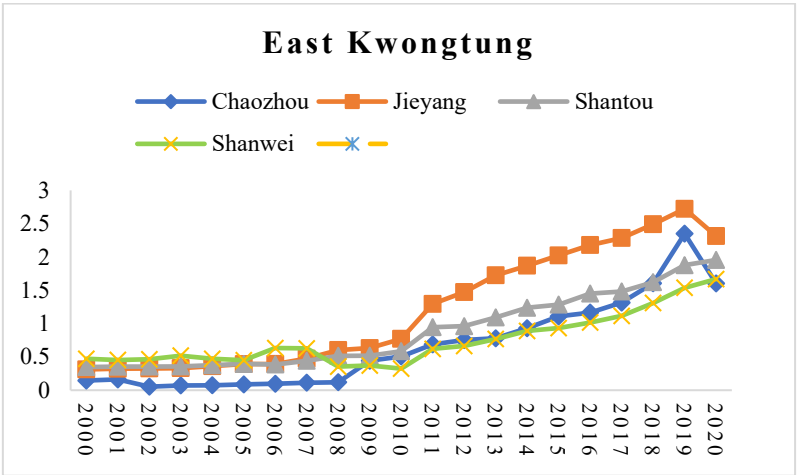

Figure 1(b): The temporal and spatial evolution of industrial structure upgrading in East Guangdong

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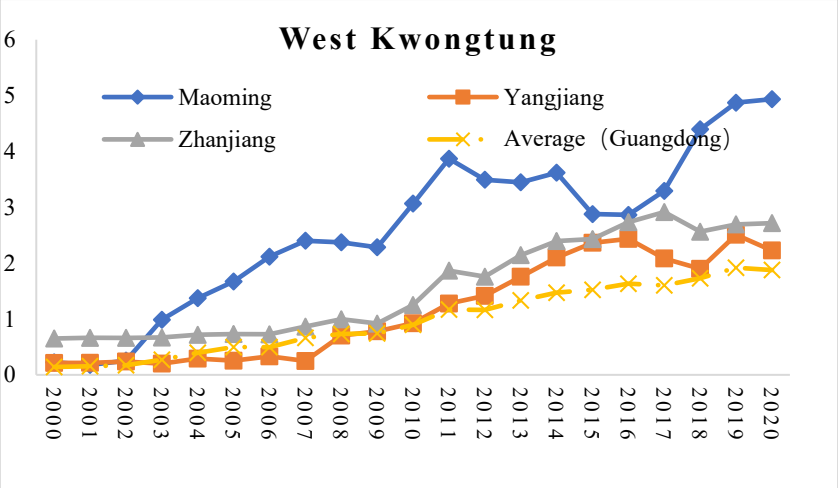

Figure 1(c): The temporal and spatial evolution of industrial structure upgrading in West Guangdong

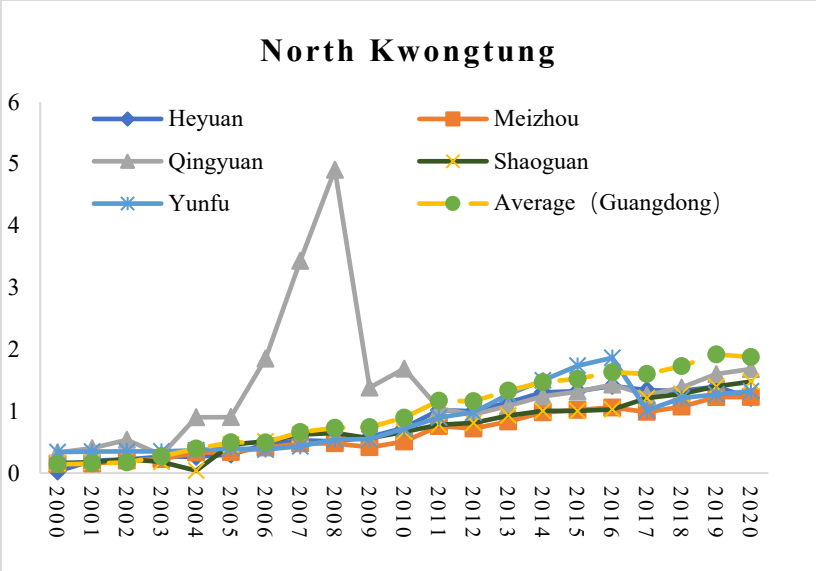

Figure 1(d): The temporal and spatial evolution of industrial structure upgrading in northern Guangdong

From the perspective of the temporal and spatial changes in the advanced industrial structure, it can be seen from Figure 1 that from 2000 to 2020, the OMS values in various regions of Guangdong Province showed a steady upwards trend except for fluctuations in individual years, and the industrial structure of the manufacturing industry has had a clear trend of advanced industrial structure. From the perspective of the trend of temporal and spatial evolution, the process of advanced industrial structure in various regions was slow from 2000 to 2009, the process of advanced industrial structure in various regions intensified after 2010, and some regions had a downwards trend after reaching a peak in 2020. According to the relevant research of China's Industrialization Progress Report, China's industrialization level is still in the middle stage of industrialization during the "10th Five-Year Plan" and "11th Five-Year Plan" periods [34], and export-oriented labour-intensive industries are still the main feature of this period. With the continuous advancement of the new industrialization process, the industrial structure gradually transformed from a capital-intensive heavy chemical industry during the "Twelfth Five-Year Plan" period to a technology-intensive industry during the "Thirteenth Five-Year Plan" period, and the process of industrial structure advancement intensified. There are obvious differences in the advanced industrial structure between different regions. Due to the difference in regional industrial division, the degree of advanced industrial structure in the Pearl River Delta region and the Western Kwongtung region is significantly higher than that in the East Kwongtung and Western Kwongtung, and the temporal and spatial evolution trend of the advanced industrial structure is obvious. The high-tech industrial belt represented by Shenzhen, Guangzhou, Zhuhai, Huizhou and Foshan has accelerated the development of the electronic information industry with an open technological innovation system, and its industrial

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structure has reached an advanced level that is higher than the average. Shenzhen's industrial structure advanced level is significantly higher than that of other cities, and is becoming a gathering place and diffusion source for the development of the manufacturing industry in the Easte Kwongtung, West Kwongtung and northern Kwongtung areas.

Based on this, using the mapping principle of the adaptation function at special points, the adaptation value of labour factors to the advanced industrial structure of Guangdong and its subordinate cities is calculated and listed in Table 4.

Table 4: The fit value of the labour force structure adapting to the advanced industrial structure in various regions of Guangdong Province from 2000 to 2020

Time/Period (Year)	HY	MZ	QY	SG	YF	**NG**	DG	FS	GZ	HZ	JM	SZ	ZQ	ZS	ZH	**PRD**	CZ	JY	ST	SW	**EG**	MM	YJ	ZJ	**WG**	**GD**
2000-2001	25	-32	-28	6	-24	**-11**	24	-11	22	-26	11	22	32	-24	-19	**3**	23	27	28	-6	**18**	-19	21	16	**6**	**3**
2001-2002	-24	11	-23	24	-6	**-4**	-25	23	-6	22	24	-25	23	23	16	**8**	21	22	22	25	**23**	-6	25	-16	**1**	**7**
2002-2003	24	-19	22	-19	26	**7**	24	-19	-19	24	-19	24	6	26	32	**9**	24	28	28	-6	**19**	-19	21	31	**11**	**10**
2003-2004	-16	24	25	23	24	**16**	24	24	24	23	24	24	27	24	24	**24**	-20	24	22	26	**13**	16	26	-20	**7**	**18**
2004-2005	23	21	24	25	16	**22**	21	21	32	21	-26	23	-27	26	-20	**8**	23	-22	27	24	**13**	-24	24	31	**10**	**13**
2005-2006	24	32	-20	24	24	**17**	24	23	23	23	21	24	-20	24	24	**18**	24	23	1	-19	**7**	24	26	-20	**10**	**15**
2006-2007	24	22	22	21	23	**22**	25	23	31	23	23	23	21	-24	23	**19**	25	27	-2	23	**18**	-19	23	32	**12**	**19**
2007-2008	24	32	25	-16	22	**17**	23	22	21	21	24	27	21	23	11	**21**	21	23	21	-6	**15**	-19	26	-11	**-1**	**16**
2008-2009	24	22	23	-24	28	**15**	-31	11	28	28	25	4	25	26	-22	**10**	28	27	27	-20	**16**	-20	24	16	**7**	**12**
2009-2010	24	24	24	-6	23	**18**	24	23	32	23	21	22	21	24	24	**24**	23	24	23	21	**23**	32	24	23	**26**	**23**
2010-2011	27	27	-32	27	-2	**9**	27	-2	32	31	32	31	23	27	-2	**22**	32	31	-2	31	**23**	32	32	32	**32**	**21**
2011-2012	16	20	-23	21	21	**11**	32	32	-22	24	-21	31	32	8	-2	**13**	26	21	-20	21	**12**	23	21	-26	**6**	**11**
2012-2013	32	23	25	-20	-20	**8**	22	23	-20	23	31	-20	21	8	23	**12**	-16	21	-20	24	**2**	24	21	24	**23**	**11**
2013-2014	24	32	22	-19	21	**16**	26	-20	8	23	32	32	21	32	27	**20**	28	-20	-20	31	**5**	22	32	-20	**11**	**15**
2014-2015	24	24	32	11	32	**25**	31	24	26	23	31	8	-16	32	16	**19**	25	22	1	-24	**6**	22	25	-24	**8**	**16**
2015-2016	31	6	32	4	-20	**11**	16	22	-22	-6	31	8	-21	28	11	**7**	24	24	23	26	**24**	23	-24	-24	**-8**	**9**
2016-2017	8	-24	16	20	-23	**-1**	24	-24	-21	16	-21	24	-24	-21	-24	**-8**	16	-24	22	-24	**-3**	-16	-24	20	**-7**	**-5**
2017-2018	-2	8	21	26	8	**12**	-19	-24	-22	-21	20	8	-23	20	25	**-4**	-23	-21	16	-24	**-13**	-22	-22	16	**-9**	**-3**
2018-2019	16	25	25	-24	-19	**5**	25	-19	-20	1	32	25	31	-24	-2	**5**	-24	-2	-21	32	**-4**	8	-16	-21	**-10**	**1**
2019-2020	19	16	24	32	-6	**17**	11	-21	16	-19	16	16	23	-24	-19	**0**	16	-32	16	16	**4**	20	22	20	**21**	**8**
2000-2020	17	15	12	7	7	**11.6**	16	7	7	14	16	17	10	12	7	**11.7**	15	11	10	9	**11.0**	4	15	4	**7.8**	**9.8**

Mark: Due to space limitations, city names are replaced by the first letter.
Heyuan=HY; Meizhou=MZ; Qingyuan=QY; Shaoguan=SG; YunFu=YF; Dongguan=DG; FoShan=FS; Guangzhou=GZ;Huizhou=HZ; Jiangmen=JM; Shenzhen=SZ; Zhaoqing=ZQ; Zhongshan=ZS; Zhuhai=ZH; Chaozhou=CZ; Jieyang=JY; Shanto=ST;Shanwei=SW; Maoming=MM; Yangjiang=YJ; Zhanjiang=ZJ; North of GuangDong=NG; East of Guangdong=EG;West of Guangdong=WG; Pearl River Delta=PRD

Table 4 shows that the average degree of adaptation in Guangdong Province from 2000 to 2020 was 9.8, indicating a relatively low degree of adaptation. Among them, the highest adaptation value from 2009 to 2010 was 23, and the lowest from 2016 to 2017 was -5. The adaptation interval was between the half-growth positive connection and the weak adaptation. From a regional perspective, the ranking of the fitness values between the cities is in the order of: the Pearl River Delta, North Kwongtung, East Kwongtung and West Kwongtung, and there are obvious gradient differences in the fitness values between cities. Among them, Shenzhen and Heyuan have the highest fitness value of 17, which is in a weak adaptation level IV, Maoming and Zhanjiang have the lowest adaptation value of 4, and the adaptation interval is in a declining negative connection level III. Combined with the advanced level of industrial structure, Shenzhen's high suitability level is due to the high proportion of technology-intensive industrial output and high-skilled labour in Shenzhen's manufacturing industry output and overall labour force. Unlike Shenzhen, Heyuan's higher suitability level is caused by the matching changing direction of its labour structure and advanced level of industrial structure and does not represent the advanced development of its manufacturing industry. Similarly, although the industrial structure of Maoming and

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Zhanjiang is higher than the provincial average, the growth rate of the labour force in technology-intensive industries has lagged that in labour-intensive industries for a long time. The low adaptation value is caused by the fact that the low efficiency of the labour force can hardly meet the demand for the labour force in technology-intensive industries.

4.2 Analysis of the fluctuation characteristics of fitness values

To describe the fluctuation characteristics of the adaptation value of Guangdong Province from 2000 to 2020, the fitness value is divided into a certain time interval. From the perspective of industrial policies for promoting China's economic development, the 18th National Congress of the Communist Party clearly stated that the adjustment of industrial structure is the main direction of accelerating the transformation of the economic growth mode. With the formulation of strategic emerging industries and advanced manufacturing industry development strategies, China's manufacturing industry structure has taken a new step forward. For this reason, the research interval is divided into 2000-2011 and 2012-2020 and is presented in accordance with the four five-year planning intervals of China's economic development, which will help in understanding the spatiotemporal evolution of the regional labour factors adapting to the upgrading of industrial structure.

Table 5: The fluctuating characteristics of the adaptation degree in various regions of Guangdong Province

Periods	HY	MZ	QY	SG	YF	**NG**	DG	FS	GZ	HZ	JM	SZ	ZQ	ZS	ZH	**PRD**	CZ	JY	ST	SW	**EG**	MM	YJ	ZJ	**WG**	**GD**
2000-2011	16	15	3	9	15	**12**	16	14	17	20	12	19	15	15	7	**15**	21	21	15	10	**17**	0	24	7	**11**	**14**
2012-2020	19	14	25	4	-3	**12**	17	-5	-7	5	22	13	2	6	7	**7**	6	-4	2	7	**3**	10	2	-1	**4**	**7**
“Tenth Five Year”	6	1	4	12	7	**6**	14	8	11	13	3	14	12	15	7	**11**	14	16	25	13	**17**	-10	23	8	**7**	**10**
“Eleventh Five-Year”	24	26	15	0	24	**18**	13	20	27	24	23	20	14	15	12	**19**	24	25	14	0	**16**	0	25	8	**11**	**17**
“Twelfth Five-Year Plan”	25	25	5	4	10	**14**	28	11	5	25	21	16	16	21	12	**17**	19	15	-12	17	**10**	25	26	-3	**16**	**15**
“Thirteenth five-year”	14	6	24	12	-12	**9**	11	-13	-14	-6	16	16	-3	-4	-2	**0**	2	-11	11	5	**2**	3	-13	2	**-3**	**2**

As showed in the table 5, from 2000 to 2011, upon joining the World Trade Organization, Chinese industry gradually participated in the international division of labour and integrated into the global industrial system. While introducing foreign resources and technologies, the proportion of capital and technology-intensive products increased significantly, but labour-intensive industries are still the focus of China's industrial development at this stage. Before and after the 18th National Congress of the Communist Party, Guangdong's adaptation level of labour structure and industrial structure has been generally in a weak state due to the constraints of workers' education level and labour resources, although the level of industrial structure in various regions of Guangdong has made significant progress, It is worth noting that in 2004, China experienced “skilled labour shortage” for the first time in the coastal areas, which triggered debate among scholars on the "Lewis turning point" and "demographic dividend disappearing". Combined with the research in this paper, the manufacturing industry of the Pearl River Delta region experienced rapid development in 2004-2005, but the adaptation is only 8 in value. The lack of skilled labour makes it difficult to adapt to the advanced industrial structure of the manufacturing industry, and the degree of adaptation is low. Point values of cities, except for Guangzhou and Zhongshan, whose adaptation values at this stage are 32 and 26, respectively, and are in a strong adaptation range, the adaptation values of Shenzhen, Dongguan, Foshan and Huizhou are 23, 21, 21 and 21, respectively, which are all in the weak fit range. The adaptation values of Zhuhai, Jiangmen and Zhaoqing are -20, -26 and -27, which are in the strong and weak negative fit ranges, respectively.

From 2012 to 2020, China's manufacturing industry developed in a high-quality direction driven by innovation. Cantered on the continuous promotion of the "manufacturing power" strategy, the state emphasizes the compatibility between factor support ability and industrial development and has introduced relevant policies to solve the structural shortage of technical talent. However, the adaptation of the skilled labour force between supply and demand during industrial transformation has become a

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long-term systemic project. Acemoglu (2002) [35] believes that, with the transformation of labour-intensive industries to technology-intensive industries, the structure of human capital needs requires to be adjusted accordingly. This will change with the change in the industrial structure and then it will adapt to the upgrading of the industrial structure. According to a survey report on migrant workers in 2021, 70% of the new generation of migrant workers in China have a junior high school education or below, despite the improved education level of the current skilled labour force[1]. Although the new generation of migrant workers does not represent the entire skilled labour force, it reflects the quality and level of the skilled labour supply to a certain extent because based on the survey report on migrant worker monitoring, approximately 27% of migrant workers work in manufacturing industries.

Given the trend of advanced industrial structure and the fact that there are certain gradient differences in the advanced level of manufacturing industry structure in various regions of Guangdong, a steady upwards trend from 2012 to 2020 is shown in Figure 1. However, it is worth noting that the current structural shortage of high-skilled manufacturing labour has hindered the high-end transformation of the manufacturing industry to a certain extent. By analysing the adaptation trend of the manufacturing labour structure and industrial structure in Guangdong from 2012 to 2020 compared with 2000-2011, the adaptability of the labour force and industrial structure in the Pearl River Delta, eastern Kwongtung and western Kwongtung decreased to varying degrees, the average adaptability in the Pearl River Delta region decreased from 15 to 7, and the average adaptability in eastern Kwongtung and western Kwongtung decreased from 17 and 14 to 3 and 7, respectively, due to the relative shortage of high-skilled labour, except for the adaptation value of northern Kwongtung which remained unchanged. The adaptation range has decreased from a recessionary positive interval to a recessionary negative interval, and promoting the collaborative optimization of the labour structure and industrial structure is still a challenge in the process of industrial transformation and upgrading.

To further explore the path of adapting labour factors to the advanced industrial structure, it is necessary to select key cities to analyse the fluctuation characteristics of adaptability. In view of Shenzhen's obvious advantages in the advanced manufacturing industry structure and adaptability, Shenzhen is selected as an example to compare and analyse the suitability and change trend and to summarize its advanced experience, along with the Pearl River Delta and Guangdong Province; moreover, the adaptability value is divided according to the four five-year planning processes of China's economic development, which are shown in Table 6.

Table 6: Index values of suitability and advanced industrial structure in Shenzhen, Pearl River Delta and Guangdong Province

Periods	Fitness				Advanced industrial structure		
	Shenzhen	Pearl River Delta	Guangdong		Shenzhen	Pearl River Delta	Guangdong
“Tenth Five Year”	14	11	10		0.6	0.6	0.5
“Eleventh Five-Year”	20	19	17		0.9	0.6	0.8
“Twelfth Five-Year Plan”	16.4	17	15		1.2	1.2	1.4
“Thirteenth five-year”	16.2	0	2		1.9	1.4	1.9

To easily describe the comparative change trend of adaptability and industrial structure advancement in various regions, the comparison chart of the adjustment value and the advanced industrial structure in Shenzhen, Pearl River Delta and Guangdong Province is displayed in Figure 2:

As shown in Figure 2, from the perspective of the trend of industrial structure premiumization, the level of industrial structure upgrading in Shenzhen, the Pearl River Delta and Guangdong Province showed an upwards trend during the "10th Five-Year Plan" to "13th Five-Year Plan" period. Given the degree of adaptability, the constraints of labour quality, and the condition that the growth rate of labour in technology-intensive industries cannot adapt to the growth rate of the output value of technology-intensive industries, the level of advanced industrial structure of labour adaptation declines. During this period, the average adaptation degree range of the industrial structure of labour factors in Shenzhen was [14,20], and the typically high-quality labour forces gathered in economically developed areas, which was an important reason why Shenzhen's overall adaptation state was better than that of the Pearl River Delta and other parts of Guangdong Province. From the perspective of different regions, the average adaptation degree of Shenzhen increased from 14 to 20 from the "Tenth Five-Year Plan" to the "Eleventh Five-Year Plan" period, and the adaptation state increased from a semi-growth negative succession to a weak

[1] The National Bureau of Statistics of the People's Republic of China website: http://www.gov.cn/xinwen/2022-04/29/content_5688043.htm

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adaptation level. During the "Twelfth Five-Year Plan" and "Thirteenth Five-Year Plan" periods, the average suitability was 16.4 and 16.2, respectively, the adaptability degree was reduced, and the degree of advanced industrial structure improved.

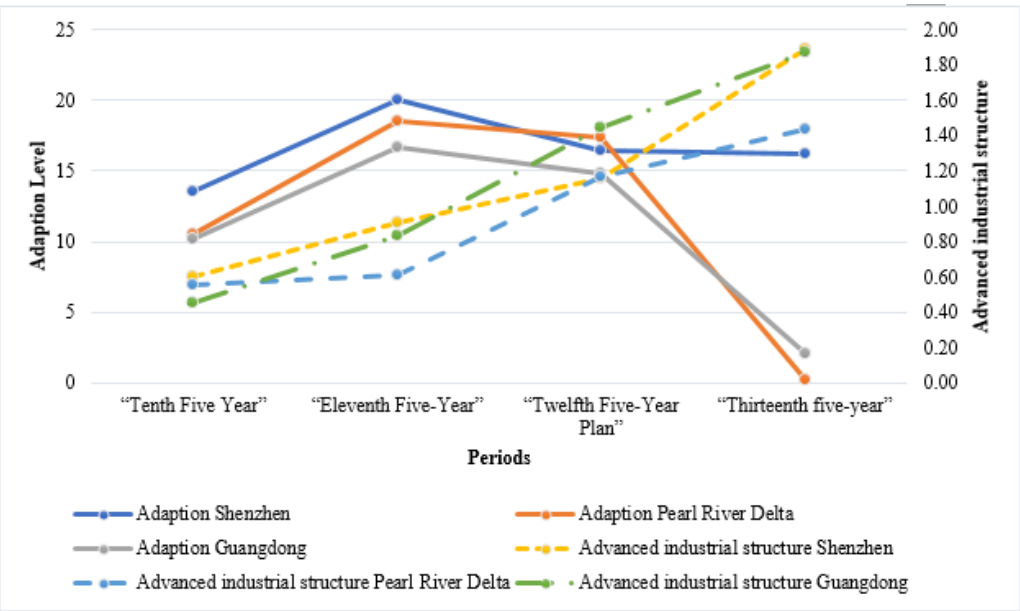

Figure 2: Comparison of the adaptability value and the fluctuation characteristics of the advanced industrial structure

4.3 The characteristics of spatiotemporal differences and dynamic changes in adaptation

The Dagum Gini decomposition coefficient was originally used to measure the characteristics of income inequality between regions and their subregions and it was gradually extended to the measurement of regional economic differences; the coefficient has the advantage of solving the grouping and cross-overlapping of sample data compared with the traditional Gini coefficient. Kernel density estimation can effectively reveal the dynamic evolution process of adaptation differences between regions and their subregions and can overcome the defects of α convergence and β convergence due to the interaction between the separation.

To facilitate the description of the spatiotemporal difference characteristics and dynamic evolution process of the adaptation value, based on measuring the advanced industrial structure of labour factor adaptation, the "first year" of the five-year plan was selected as the observation period. The Dagum Gini decomposition coefficient was used to analyse the spatiotemporal difference of the adaptation, the subregional differences and the residual of the Dagum Gini coefficient of the subregion adaptation level cross influence of the manufacturing industry in Guangdong Province. The contribution rates to regional differences were calculated, and the kernel density was estimated. The calculation results are shown in Table 7.

Table 7: Dagum Gini decomposition of the adaptation values in Guangdong Province from 2000 to 2020

Periods	G	Gw					Gnb	Gt	Contribution rate/%		
		Whole province	North Kwongtung,	Pearl River Delta	East Kwongtung	West Kwongtung			Gw	Gnb	Gt
2000-2001	0.34	0.09	0.53	0.33	0.13	0.23	0.13	0.12	27.04%	36.95%	36.00%
2005-2006	0.17	0.06	0.17	0.09	0.23	0.24	0.05	0.06	35.40%	27.86%	36.74%
2010-2011	0.15	0.04	0.28	0.12	0.11	0.00	0.07	0.04	26.13%	45.56%	28.31%
2015-2016	0.26	0.07	0.24	0.26	0.01	0.42	0.12	0.07	26.44%	47.70%	25.86%

As shown in Table 7, the decomposition coefficient G of Dagum's Gini coefficient changed from 0.34 in 2000-2001 to 0.26 in 2015-2016 and achieved a minimum value of 0.15 in 2010-2011, indicating that the spatial difference in the industrial structure of manufacturing labour adaptation in Guangdong

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Province decreased first and then increased. (1) The values of Gw in northern Kwongtung and eastern Kwongtung are larger and smaller, with value intervals of [0.17, 0.53] and [0.01, 0.23], respectively. The spatial difference in the adaptation degree value between cities in northern Kwongtung is large, it moved from 0.53 in 2000-2001 to 0.17 in 2005-2006 and then rose to 0.28 in 2010-2011, the spatial difference decreased first and then increased, and the suitability improved. The spatial difference in the Pearl River Delta region decreased from 0.33 in 2000-2001 to 0.09 in 2005-2006 and then increased to 0.26 in 2015-2016. The spatial difference decreased first and then increased, and it was obvious. The spatial difference in the suitability value of cities in eastern Kwongtung was small, moving from 0.13 in 2000-2001 to 0.01 in 2015-2016, the spatial difference increased first and then decreased, and the adaptability improved significantly. The spatial difference in western Kwongtung decreased from 0.23 in 2000-2001 to 0 in 2010-2011 and then increased to 0.42 in 2015-2016, and the spatial difference decreased first and then increased. (2) During the observation period, the spatial difference in the adaptation value in different regions decreased first and then increased, the Gnb value decreased from 0.13 in 2000-2001 to 0.12 in 2015-2016, and the minimum value was 0.05 in 2005-2006. The trend of the Gt value is consistent with that of the Gnb value. (3) In each time period, the contribution rates of Gw and Gnb to the spatial difference in adaptation degree were 64.00%, 63.26%, 71.69% and 74.14%, respectively, indicating that the spatial difference in adaptation degree within and between regions is the main contributor to the spatiotemporal difference in adaptation value in Guangdong Province, and it is a leading trend, which will not be conducive to the high-quality coordinated development of the manufacturing industry.

5. Conclusion

Based on panel data of the manufacturing industry in various regions of Guangdong Province from 2000 to 2020, this paper analyses the spatiotemporal differences and dynamic evolution of the advanced industrial structure of labour factors adapted to the industrial structure through the mapping function, Dagum Gini decomposition coefficient and Gaussian kernel density function, and the conclusions are as follows: (1) Except for individual years, the trend of manufacturing industry structure upgrading in various regions of Guangdong Province is obvious during the inspection period. From the perspective of spatiotemporal evolution, the upgrading process of the industrial structure in various regions was slow from 2000 to 2009 but intensified after 2010, and some regions had a downwards trend after reaching a peak in 2020. (2) From 2000 to 2020, the average adaptability value of the manufacturing industry in Guangdong Province was 9.8, and the adaptation degree was between semi-growth and weak adaptation. In terms of the subregions, there are obvious gradient differences. The order from the highest to lowest is the Pearl River Delta, northern Kwangtung, eastern Kwangtung and western Kwangtung, and the average adaptation values are 11.7, 11.6, 11 and 7.8, respectively. The adaptation values of Shenzhen are higher than those of other cities in the Pearl River Delta and Guangdong Province. (3) The spatial difference between the adaptation of the manufacturing labour force and industrial structure upgrading in Guangdong Province decreased first and then increased. The Dagum Gini coefficient changed from 0.34 in 2000-2001 to 0.26 in 2015-2016, with a minimum value of 0.15 in 2010-2011. The spatial difference in intraregional and interregional adaptation is the main contributor to the spatiotemporal difference in adaptation value in Guangdong Province, and it is the leading trend, which will be detrimental to the high-quality collaborative development of the manufacturing industry. (4) The kernel density curve of the adaptation degree has a "bimodal" pattern, and the adaptation difference between regions shrinks first and then expands.

From the perspective of the regions, in addition to the convergence of the spatiotemporal difference in the adaptation value in western Kwangtung, the spatiotemporal difference in the adaptation value of other cities is expanding. Based on the above research conclusions, the main insights obtained are as follows. First, the advanced industrial structure needs high-tech talent. Under the current situation in which the education level of workers is continuously improving, the level of labour factors adapting to the advanced industrial structure is still low. Only by connecting skilled talent training with the advanced industrial structure of the manufacturing industry can we effectively solve the structural inconsistency between the supply and demand of labour factors, which would support China's manufacturing industry in terms of climbing to the high end of the global industrial chain. Second, under the circumstance that the compatibility of labour factors and industrial structure is low, all cities should actively find bottlenecks that are suitable for restricting the development of labour adaptation industries and focus on key scientific and technological fields and key technology links in the development of the manufacturing industry, with corresponding support to institutions that can cultivate special talent for major technical research. Third, there are obvious intraregional and interregional differences in the degree of advanced industrial structure adapted to labour factors, and "improving the level of development and narrowing

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the absolute difference" is the core concept for the country to promote common prosperity, and the interaction, cooperation and exchange between the manufacturing industry in the Pearl River Delta region and other regions should be accelerated. Full support should be given to the aggregation and diffusion spillover effect of production factors in central cities to drive the collaborative innovation and development of manufacturing industries in surrounding cities from points to areas.

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