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Article

Occupational diversity in Chinese cities: Facts, evolution and policy implications

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Abstract: Measuring the occupational diversity and trend of Chinese cities from the perspective of the distribution of urban occupational types, and discussing the impact of urban characteristics on urban occupational diversity can provide reference for guiding urban full and high-quality employment. By using the improved Herfindahl index, panel data fixed effect model and Oaxaca blinder decomposition, it is found that the occupational diversity in Chinese cities showed a trend of first decreasing and then increasing from 2002 to 2016, which was due to the adjustment of urban industrial structure and the emergence of new economy after the financial crisis; at the same time, the larger the city, the higher the administrative level and the more developed the economy, the higher the degree of occupational diversity. The conclusion of the study is helpful to intuitively understand the occupational distribution, industrial structure and division of labor in different cities, evaluate the human resource structure and economic development potential of cities, and then provide policy suggestions for different cities to formulate industrial development and human resource planning.

Keywords: agglomeration economy; urbanization economy; occupational diversity; urban diversity; full and high-quality employment

1. Introduction

The rapid urbanization in the past 40 years has been the “structural change” of China’s economic growth. With the change of labor flow and industrial structure, the trend of urban diversification is inevitable; from a global perspective, the growing diversity within cities is a remarkable feature of contemporary migration and urban development. Diversity, as one of the important characteristics of urbanization, has attracted extensive attention of scholars at home and abroad. Existing studies have involved the diversity and impact of cities in terms of functional form, industrial structure, immigrant origin and dialect culture, such as Jacobs [1], Duranton and Puga [2], Kemeny and Cooke [3], Xu and Zhang [4]. However, there is little literature on the occupational diversity of cities [5].

Since the reform and opening up, with the rapid advancement of urbanization and industrialization, China’s urbanization rate has increased from 17.92% in 1978 to 60.6% in 2019, and the urban resident population has also increased from 172million to 848million. Cities have gradually become the main carrier of China’s modern economic and social development. Michael Spencer, the Nobel Laureate in economics, once pointed out that urbanization is a “structural change” in China’s economic growth. On the one hand, the labor productivity of employees in urban manufacturing or service industries is three to five times that of employees in agriculture and other industries. The transfer of population from rural to urban areas has increased labor

productivity; on the other hand, the economies of scale generated by population agglomeration have further improved the labor productivity of cities [6]. Generally speaking, the economies of scale of cities can be divided into intra industry economies of scale (usually referred to as specialization or local economic effects) and inter industry economies of scale (usually referred to as diversification or urbanization economic effects). Urban specialization and diversification often coexist. Urban specialization forms the liberalization of urban economic interaction to a certain extent, and urban diversification is driven by the economic interaction between various departments. After the reform and opening up, China has experienced more than 40 years of rapid industrialization and urbanization. 2 The proportion of employment in the tertiary industry has reached as high as 73.9%. With the rapid increase of urban permanent population, the trend of diversification is inevitable; in addition, from a global perspective, the growing diversity within cities is a significant feature of contemporary migration and urban development. Therefore, compared with the attention to urban professionalism, the study of urban diversity is also of great significance.

Firstly, diversity is an inherent feature of cities. For example, cities often show diversity in economy, culture and race, and even there are many differences in lifestyle, residents' attitudes and individual behaviors. Secondly, diversity is also considered to be a key factor for sustainable urban development. Even some urban planning scholars regard promoting diversity as an important part of urban economic development planning [7]. Diversity mainly comes from the externality of urban agglomeration economy, and its micro mechanisms include sharing, matching and learning mechanisms [8]. From the perspective of research focus, the previous literature on diversity is mainly reflected in the industrial level. It is generally believed that diversity depends on the number and distribution of activities in different economies. At first, scholars defined diversity as the degree of distribution of a large number of different types of industries or regional economic activities in a region [9]. Since then, a large number of studies have continuously expanded the meaning and scope of diversification. For example, Malizia and Ke [10] have proposed that diversity can be used to reflect the structural differences in economic activities.

With the national "fourteenth five years plan" putting forward the goal of achieving more full and high-quality employment, measuring the current situation of urban occupational diversity has become an important basis for understanding the distribution of urban occupations, improving the level of human resources, and guiding urban full and high-quality employment. In theory, some literatures interpret the connotation of urban diversity from the perspective of labor allocation or employment, and believe that urban diversity helps to balance the employment market and may provide more employment opportunities, so diversity acts as a redistribution effect similar to some external distribution; the diversity of labor force will produce obvious externalities of human capital and help to improve the economic welfare of cities, such as Ottaviano et al. [11], Trax et al. [12, 13].

This paper aims to interpret the characteristics of urban diversity and its economic implications from the perspective of occupational diversity. On the one hand, the popularity of the Internet has had a positive impact on job creation. Driven by digital technology, more new jobs have been created. The digital economy plays a positive

role in the adjustment of employment structure and the creation of new jobs. In the context of economic globalization, the span of jobs in cities will be significantly expanded [14]. On the other hand, the development of occupational diversity has further promoted the urban diversity and the upgrading of urban industrial structure. The digital and intelligent new economy has promoted the transformation and upgrading of urban industries, impacted the urban labor market, reshaped the labor employment structure, and promoted the upgrading of the industrial employment structure. The improvement of labor skills and the optimization of labor occupational structure are very important to promote the high-quality development of urban economy and high-quality employment [15]. In addition, occupational diversity plays a positive role in reducing poverty and economic vulnerability, and occupational mobility is an important factor in raising the income level [16]. Therefore, the measurement of the current situation of urban occupational diversity can be used as an important indicator to dynamically monitor the industrial diversification and the diversity of labor employment forms in a city, and can also reflect the employment absorption capacity of the city.

The practical significance of the study is that with the national "fourteenth five-year plan" putting forward the goal of "implementing the priority employment strategy", promoting fuller and higher quality employment has become a key path. The measurement of the current situation of urban occupational diversity in this paper can be used as an important indicator to dynamically monitor the industrial diversification and the diversity of labor employment forms in a city, and can also reflect the employment absorption capacity of the city. Therefore, urban occupational diversity starts with the occupational types of labor force, which more objectively reflects the diversity characteristics within the city, helps to intuitively understand the current situation of occupational distribution in different cities, then analyzes the current situation of industrial structure and division of labor in cities, evaluates the human resource structure and economic development potential of cities, and then provides reference for different cities to formulate industrial development and human resource policies.

Based on the above analysis, the possible contributions of this paper are mainly reflected in the following aspects: first, it creatively calculates the current situation and evolution trend of China's occupational diversity, visually depicts the characteristics of occupational diversity in Chinese cities, and enriches the research literature on urbanization economy; secondly, it reveals the basic facts of career diversity in different types of cities in China from the aspects of city size, industrial structure and economic development level, which is helpful to understand the current situation and trend of China's urbanization economic development; the third is to try to explain the causes of the differences in occupational diversity among different cities in China. The relevant conclusions can provide a scientific basis for different cities to formulate policies on industrial development and human resources.

The structure of the rest of the article is as follows: the second part is literature review and research hypothesis; the third part is the introduction and data source of the measurement methods of occupational diversity; the fourth part is the calculation, basic facts and causes of occupational diversity in Chinese cities; the fifth part is a series of robustness tests; the last part is the research conclusion and policy

enlightenment.

2. Literature review and research hypothesis

Diversity mainly comes from the externality of urban agglomeration economy, but there is still a lack of research on career diversity in domestic and foreign literature. Scholars gradually measure industrial diversity from the perspective of employment, and believe that industrial diversity is a more equal distribution of employment or a distribution similar to some external distribution [17]. With the popularization of population migration, the deepening of intra industry division of labor and the rapid development of emerging technologies such as the Internet, urban occupational forms have become flexible and diverse, occupational diversity is widespread, and the trend of occupational diversity has become more and more obvious with the intensification of occupational mobility [18]. The theoretical analysis of urban occupational diversity in this paper [19] mainly refers to the discussion of Quigley, Duranton and Puga and other scholars on urban diversity [20], that is, three types of micro mechanisms based on the economic effect of Urban Agglomeration - sharing, matching and learning mechanisms, and analyzes their impact on urban diversity from the level of urban scale, industry (enterprise) and individual labor force.

2.1. City size and diversity

Economies of scale are the historical basis for the initial existence of cities. Without economies of scale, cities cannot give full play to their advantages. Economies of scale make up for the transportation costs of enterprises, so that the economic activities in the city show a U shape within a certain spatial range, and the average cost curve is reduced [21]. Similarly, many public facilities in the city or collective consumer goods provided to urban residents have reduced the average enjoyment cost of individuals due to the wide use of more residents (of course, the crowding effect with the excessive population expansion may also increase the average enjoyment cost of residents again, resulting in negative externalities). Therefore, heterogeneity or diversity encourages cities of a certain size to make better use of economies of scale to increase the output of cities and the utility of their residents [22]. Combes et al. Pointed out that the higher productivity of enterprises in big cities is due to the company selection effect (larger cities intensify enterprise competition and only allow the most productive enterprises to survive) and the agglomeration economy (larger cities are conducive to promoting enterprise exchanges to improve productivity) [23]. Based on the data of Industrial Enterprises above Designated Size from 1998 to 2007, Chen et al. [24] also tested the productivity advantage of China's major cities. The productivity premium of urban enterprises is the result of the combined action of agglomeration effect, selection effect, classification effect and competition effect, and the premium contributions of these four effects are different in different industries, and agglomeration effect improves the productivity premium of enterprises in most industries.

At the same time, there is a significant and positive relationship between industrial diversification and city size [25]. As time goes on, most cities will show more diversification due to the expansion of the scale, that is, the industrial

diversification will increase with the increase of the city scale, and the degree of benefit of enterprises from the diversity will also increase [26]. Glaeser et al. Used the database of large-scale industrial growth in 170 U.S. cities from 1956 to 1987, and found that local competition and urban diversity (rather than professionalism) significantly promoted the employment growth of urban industry. The reason is that people in large cities communicate more widely and knowledge spillovers are more effective. This discovery is different from the previous endogenous economic growth theory, which emphasizes the role of technology spillovers in promoting growth [27]. In addition, important knowledge spillovers may occur between industries rather than within industries, which is basically consistent with Jacobs' view [28]. Duncan and Vernon verified that there is a significant positive relationship between urban size and diversity in the United States [29]. In view of the relationship between industrial diversity and city size, this paper puts forward research hypothesis 1: the larger the city size, the higher the corresponding degree of occupational diversity.

2.2. Industrial structure and urban diversity

From the perspective of industry or enterprise, diversity is conducive to reducing the shared input cost in production and consumption. The more representative research is the shared cost theory proposed by Krugman [30]. On the one hand, urban diversity is first reflected in the more professional division of labor in accounting, law, advertising and other technical fields, which can reduce the operating costs of enterprises; on the other hand, big cities can use shared inputs to produce more differentiated consumer goods in various ways, cultures and styles, and then rearrange them to produce completely different products to obtain diversified benefits.

For different industrial categories, Combes [31] found that the service industry and the more innovative manufacturing industry benefited from diversity based on the data of France from 1984 to 1993. Emerging industries are booming in diversified metropolitan areas. Diversity plays a positive role in different stages of the product life cycle, which is not only conducive to understanding the city's own industrial system, but also of great significance to enterprise process innovation, enterprise location and relocation mode [32]. Similar to the competitive effect, diversity also has a positive impact on the production of enterprises. For example, Henderson et al. [33] Pointed out that diversity may promote the development of the most innovative sectors in the city, and new industries can develop rapidly in large and diversified metropolitan areas, thus making the economic development potential of this region greater.

Therefore, this paper puts forward the second hypothesis: the more diverse the industrial structure and rich in emerging industries, the more obvious the corresponding occupational diversity.

2.3. Labor income and urban diversity

From the perspective of individual labor, urban diversity improves the possibility of better matching between labor skills and job demands, and reduces the search cost between labor with different skills and employers with different job demands. Helsley and strange comparatively analyzed the impact of labor market search cost on the balanced city size; Acemoglu [34] pointed out that there is complementarity between

physical capital and human capital in cities. With the increase of human capital stock in cities, the return on human capital of urban labor will also increase, and the return on physical capital investment of investors will increase with the increase of human capital stock in cities [35].

Urban diversity also helps to ensure the stability of labor employment, improve employment and reduce urban unemployment [36]. Malizia and Ke found that regions with a higher degree of diversification can achieve more stable economic growth and lower unemployment rate; At the same time, diversity will lead to knowledge spillovers, new ideas, and provide the resources needed to stimulate innovation [37]. The increasing diversity has promoted the emergence of creative ideas and new designs. In addition, countries implementing industrial diversification policies may not face too much downward pressure on personal income, and different types of diversity play an important role in urban economic performance. More extensive job opportunities, convenient access to information and innovative ideas make people more inclined to migrate to big cities. Therefore, the more diverse urban areas are, the easier it is to attract the inflow of labor [38]. Although the diversity of immigrants may generate additional management costs, it is more conducive to improve the productivity of enterprises and labor returns, with significant spillover effects [39].

Therefore, the third hypothesis of this paper is put forward: the higher the labor income and the wider the employment opportunities, the higher the degree of occupational diversity.

3. Measurement methods and data sources of urban occupational diversity

3.1. Calculation method

Different indexes can be used to measure urban diversity according to different definitions, such as entropy index, Herfindal-Hirschman index, ogive index, durable goods percentage index, portfolio variance, etc. Among them, the entropy index is an effective method to measure the industrial diversity within a region or between different regions. It can not only reflect the time change trend, but also analyze its change causes through feature decomposition (Entropy index: where X_i is the share of each economic sector. If the employment or income of a region is concentrated in a single sector, that is, X is equal to 1, then the entropy is equal to 0.). Entropy provides a natural way to measure diversity, and the Herfindal-Hirschman index is actually an approximation of entropy (Herfindahl-Hirschman index: the proportion $\sum_{i=1}^{I}\left(s_{i,t}\right)^2$ of the I industry in the total. The closer the index is to 1, the higher the degree of specialization or concentration. The smaller the value, the higher the level of diversity). In the early measurement methods, Herfindahl-Hirschman index is also common, and the reciprocal of the standardized Herfindahl index can also be used to measure diversity. Duranton and Puga [40] believe that the Herfindal-Hirschman index is a common indicator to measure diversity, that is, the sum of the squares of each city's share of local employment in all industries. As the economic activities of cities become more and more diversified, the index will rise; if the relationship between economic activities and commercial activities is completely concentrated in one field, the index

is 1, otherwise it is 0. Alesina et al. [41] constructed a new birthplace diversity index based on the Herfindahl index to measure the possibility that two people randomly selected from the entire population were born in two different countries ($\mathrm{Div_{pop}} = 1 - \sum_{i=1}^{I} (s_i)^2$, where, $s_i (i = 1 \ldots i)$ refers to the proportion of individuals born in country I in the total population. In particular, $I = 1$ refers to those who were not born abroad, i.e., natives.). Using this method for reference, Kemeny and Cooke [42] measured the diversity of immigrants and found that the diversity of urban immigrants has brought positive and important spillover effects to the labor market in the United States ($\mathrm{Fractionalization}_j = 1 - \sum_{r=1}^{R} s_{rj}^2$ Where, s is the proportion of residents of city J born in country R, and R is the maximum number of countries captured in the population.). Tress proposed ogive index to measure economic diversity. The benchmark $\left[\left(\sum_{i=1}^{N} \frac{(X_i - 1/N)^2}{1/N}\right)\right]$ is 1/n, where n is the number of sectors [43]. The uniform distribution of sectoral economic activities means that x is equal to 1/n, which is the ideal share of each sector. At this time, the index is equal to 0, indicating complete diversity; when the distribution of sectoral economic activities is more unbalanced, the index value is larger, which indicates that the diversity level is lower. At the same time, the proportion of income or employment in the durable goods industry is often used to measure economic diversity [44]. In addition, portfolio variance can be used as another indicator to measure regional economic diversity, that is, when investing in an industry in the region, people expect to obtain a series of income or employment returns, which can be regarded as random variables with relevant probability distribution.

For the measurement of urban occupational diversity, scholars' calculations are mostly based on the above methods of measuring diversity. The term "occupation" has been broadly used to describe a specific form of human capital [45]. Career diversity can be regarded as the possibility that two people randomly selected have different occupations. Malizia and Ke [46] pointed out that the Theil entropy index is the most suitable method to measure career diversity, and used this method to construct an entropy index to measure career diversity. As the urban economy becomes more diversified, the index will rise significantly ($ENTR_i = \sum_{j=1}^{k} \left(\frac{E_{ij}}{E_i}\right) log \left(\frac{E_i}{E_{ij}}\right)$ Where I represents the ith region, J represents the jth industry, K represents the total number of industries in the ith region, eij represents the employment of the jth industry in the ith region, and EI represents the total employment of the ith region.). Alesina et al. [47] calculated the probability that two types of individuals randomly selected from a population belong to different groups $\mathrm{FRACT}_j = 1 - \sum_{i=1}^{N} S_{ij}^2$ (where, is the $S_{ij} (i = 1 \ldots n)$ share $i (i = 1 \ldots n)$ of the group in country j), and calculated a new classification standard of race, language and religion by subtracting the Herfindahl index of ethnic groups from 1. Domestically, Li has defined the index for measuring diversity (Occupational diversity index, where, is the $= 1 - \sum_i^n x_i^2 \ (\sum_{i=1}^n x_i)^2$ number of $X_i (i = 1 \ldots n)$ I occupations) to reflect the situation of occupational diversity in the region. It can be seen from the definition of the index that when all the labor force is concentrated in one occupation, the occupational diversity index is 0; when all the

people are evenly dispersed in n occupations, the occupational diversity index is (n − 1)/n. According to the census data, he divided the occupations into seven categories, and the maximum value of the occupational diversity index is 0.857; from the perspective of gender, men's occupations are more evenly distributed, while women are concentrated in service industries and other occupations [48].

Based on the above analysis, this paper mainly refers to Alesina et al.'s calculation method for the probability of different groups, and constructs the following indicators to measure urban occupational diversity

$$\text{Occupation}_i = 1 - \sum_{k=1}^{N} S_{ki}^2 \quad (1)$$

In Equation (1), $S_{ki}(k = 1 \ldots n)$ is the share of occupation k in city i.

3.2. Data source

The main data sources used in the article are two types: the data of China Urban Household Survey (UHS) from 2002 to 2009 and the data of China labor force dynamic survey (CLDs) from 2012, 2014 and 2016.

Among them, the urban household survey data (UHS) takes the urban non-agricultural households as the survey object, and the content mainly involves the family population and economic status, education background, consumption structure, etc. The valid urban household survey (UHS) sample used in this paper involves 155 prefecture level cities in 16 provinces (or municipalities directly under the central government). The industry distribution of the sample cities is shown in **Figure 1**. It can be seen that the industrial distribution of the sample cities selected in this paper is mainly concentrated in manufacturing, wholesale and retail trade, catering industry, state organs, party and government organs and social organizations. In general, the industrial distribution is relatively rich and basically consistent with the actual situation.

In terms of occupational distribution in the city, the urban household survey data (UHS) codes the occupations according to the specific work of the respondents, and divides them into the following eight categories: various professional and technical personnel, party and mass organizations of state organs, heads of enterprises and institutions, clerks and managers, commercial workers, service workers, agricultural, forestry, animal husbandry and fishery workers, production workers, transportation workers and related personnel, as well as other workers. Among them, in 2007, UHS slightly adjusted the classification standard of occupations, merged commercial workers and service workers into commercial and service workers, and added the occupation category of military personnel, but the occupation category is still 8 (Various professional and technical personnel include: scientific researchers, engineering technicians, agricultural and forestry technicians, scientific and technical management personnel and auxiliary personnel, aircraft and ship technicians, health technicians, economic and business personnel, legal staff, teaching personnel, literature and art, sports staff, cultural staff, and religious professionals; Person in charge of Party mass organizations, enterprises and institutions of state organs: refers to the person in charge of administration. If you have both technical title and

administrative position, fill in the administrative position; Administrative personnel and management personnel: including administrative personnel, political and security personnel, post and Telecommunications personnel, other administrative personnel and related personnel, and economic management professionals without professional titles or university or technical secondary school education; Commercial staff: including sales, procurement, supply and marketing, purchase and other commercial staff; Service staff: including waiters, ticket sellers, child care workers, chefs, tour guides, daily necessities maintenance personnel, and other service staff (such as cleaners, barbers, washing, dyeing and darning personnel, etc.); Agricultural, forestry, animal husbandry and fishery workers refer to those engaged in agriculture, forestry, animal husbandry and fishery production, agricultural machinery operation and hunting; Production workers, transportation workers and relevant personnel: section chief and various production workers, equipment operators, drivers, crew members, other production and transportation workers and relevant personnel; Other workers inconvenient to be classified: refer to the personnel other than the above 7 categories.).

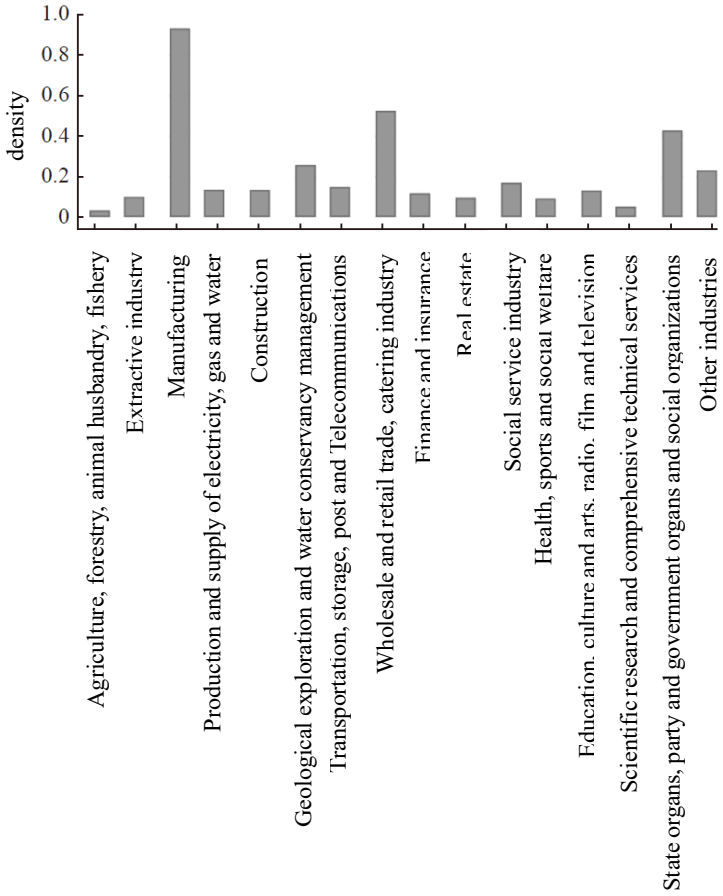


Figure 1. Urban industry distribution in UHS.

In order to better highlight the practical value of the article, the time span of this study is extended based on the China labor force dynamic survey data (CLDs) in 2012, 2014 and 2016. The feasibility lies in that the occupation code of CLDs has not been substantially changed compared with the occupation classification of UHS. Therefore, it is comparable to select this data for extended measurement (According to CLDs data in 2012, the occupational system is divided into 9 categories, namely: heads of Party

organs, state organs, mass organizations and social organizations, enterprises and institutions; Professionals and technicians; Administrative staff and related personnel; Commercial and service personnel; Agricultural, forestry, animal husbandry, fishery and water conservancy production personnel; Production and transportation equipment operators and relevant personnel; Military personnel; Types of informal employment (nanny, hospital nurse); Classification of persons without occupation. In 2014, it was divided into 8 categories: heads of Party organs, state organs, mass organizations and social organizations, enterprises and institutions; Professional technicians; Administrative staff and related personnel; Business and service personnel; Agricultural, forestry, animal husbandry, fishery and water conservancy production personnel; Production and transportation equipment operators and relevant personnel; Military personnel; Other employees who are inconvenient to be classified. In 2016, it was divided into 8 categories: heads of Party organs, state organs, mass organizations and social organizations, enterprises and institutions; Professional technicians; Administrative staff and related personnel; Social production service and life service personnel; Agriculture, forestry, animal husbandry and fishery production and auxiliary personnel; Manufacturing and related personnel; Military personnel; Other employees who are inconvenient to be classified.). Among them, the number of city samples covered by CLDs data in each year is: 267 prefecture level cities in 2012, 288 prefecture level cities in 2014 and 140 prefecture level cities in 2016.

Finally, after matching the two databases according to the same city, there were 145 prefecture level cities in 2012, 153 prefecture level cities in 2014 and 79 prefecture level cities in 2016. Based on this data, this paper further calculates the occupational diversity indicators of Chinese cities in 2012, 2014 and 2016.

4. Measurement results and trend analysis of occupational diversity in Chinese cities

4.1. Overall occupational diversity and its trend in Chinese cities

Figure 2 shows the trend of urban occupational diversity in China. It can be seen that from 2002 to 2009, the occupational diversity in Chinese cities showed a slight downward trend. Among them, the decline was obvious in 2007 and 2008, which may be due to the impact of the global financial crisis in 2008, and the impact of the financial crisis on the secondary industry led industries; after 2009, it showed an upward trend, which may be due to the economic stimulus policy after the financial crisis and the rapid development of emerging economies (such as online economy), which bred new jobs and career types.

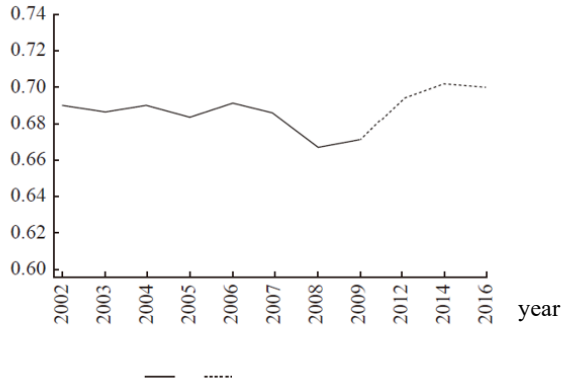


Figure 2. Trend of occupational diversity in Chinese cities (2002–2016) (—— Occupational diversity in Megacities; ------ Occupational diversity in big cities.).

Note: the solid line in the above figure represents the urban diversity index from 2002 To 2009 Calculated by UHS, and the dotted line represents the urban diversity index from 2012 To 2016 Calculated by CLDs.

4.2. Occupational diversity and its trends in different types of cities

Based on the above theoretical analysis, in order to fully reveal the basic facts of China's urban occupational diversity, this paper analyzes the occupational diversity and its trend of different types of cities in China from the three dimensions of city size, industrial structure and economic level (As CLDs data covers a small number of urban samples, UHS data are mainly used in this part of the study to ensure the accuracy of measuring the trend of occupational diversity in different types of cities.).

1. According to different city sizes.

According to the difference of urban population size, the sample cities are divided into small cities (27 in total), medium-sized cities (61 in total), large cities (60 in total) and megacities (7 in total) (The notice on adjusting the criteria for the division of city size issued by the State Council clearly defines the new criteria for the division of city size: cities with a permanent urban population of less than 500,000 are small cities; Cities with a permanent urban population of more than 500,000 but less than 1million are medium-sized cities; Cities with a permanent urban population of more than 1million and less than 5million are big cities; Cities with a permanent urban population of more than 5million and less than 10million are megacities.). **Figure 3** shows the trend of occupational diversity in cities of different sizes. On the whole, the occupational diversity in cities of different sizes shows a slight downward trend; relatively speaking, the occupational diversity of megacities is high. This finding is consistent with the hypothesis 1 of this paper: that is, the larger the city size, the stronger the occupational diversity of the city.

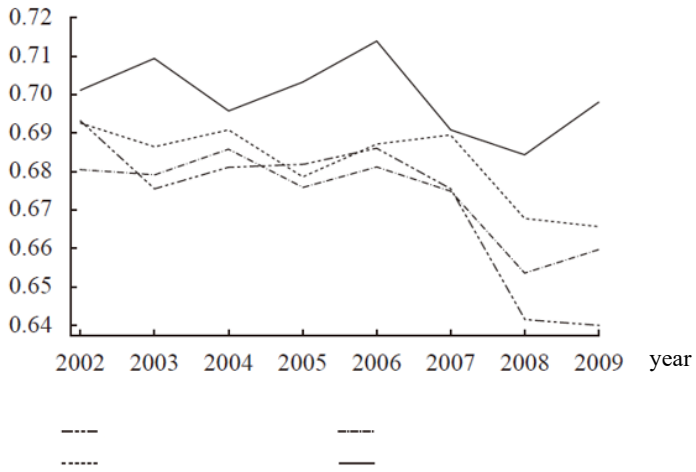


Figure 3. Occupational diversity trends in cities of different sizes (‾‾‾ Occupational diversity in small cities; -·-·- Occupational diversity in medium-sized cities; ------ Occupational diversity in big cities; —— Occupational diversity in Megacities).

Since the size of cities in China is more determined by the administrative levels of cities, the sample cities are divided into sub provincial and municipalities directly under the central government (13 in total) and other cities (142 in total) according to different administrative levels. **Figure 4** shows the trend of urban occupational diversity at different administrative levels. It can be seen that the urban occupational diversity of sub provinces and municipalities directly under the central government has always been higher than that of other cities.

2. According to different industrial structures.

According to the differences of industrial structure within cities, the sample cities are divided into 45 cities dominated by the tertiary industry and 110 cities dominated by the secondary industry. It can be seen from **Figure 5** that there is little difference between the occupational diversity of cities dominated by the tertiary industry and that of cities dominated by the secondary industry, and the occupational diversity corresponding to the industrial structure within different cities is not significant. It is worth noting that after 2008, affected by the global financial crisis, the advantages of occupational diversity in cities dominated by the tertiary industry began to appear, which can roughly explain the overall downward trend of occupational diversity in Chinese cities after 2007.

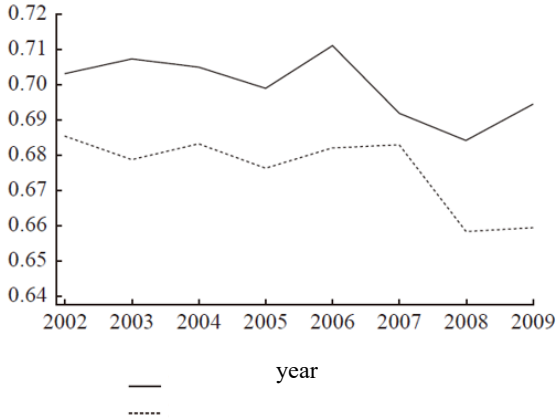


Figure 4. Trend of occupational diversity in cities of different administrative levels (—— Occupational diversity in sub provincial and municipalities directly under the central government; ------ Occupational diversity in other cities).

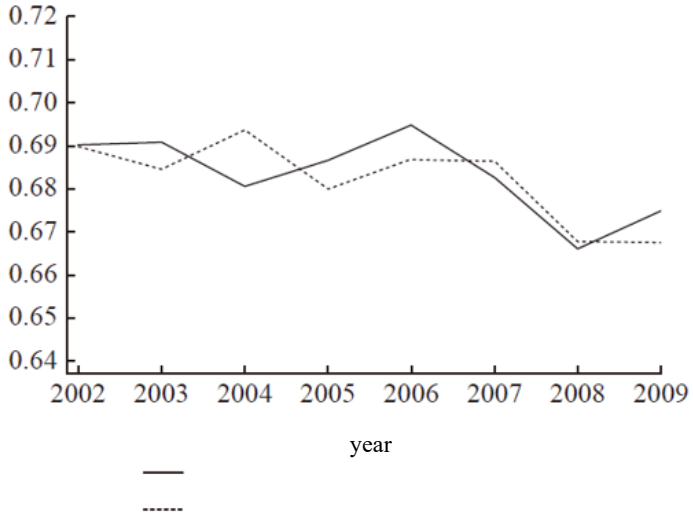


Figure 5. Occupational diversity trends in cities with different industrial structures (—— Urban occupational diversity dominated by the tertiary industry; ------ Urban occupational diversity dominated by the secondary industry).

Next, this paper analyzes the correlation between urban occupational diversity and urban industrial structure (the ratio of the output value of the tertiary industry to the output value of the secondary industry in each year) and urban digital economic development (measured by the urban digital inclusive financial development index [49]) (**Table 1**). It is also found that there is a positive correlation between urban occupational diversity and the upgrading of urban industrial structure and the development of urban digital economy, that is, the higher the proportion of the tertiary industry, the better the development of urban digital economy, the higher the degree of urban occupational diversity. This verifies the previous research hypothesis 2. Theoretically, both the increase in the proportion of the tertiary industry in the city and the development of the urban digital economy will be conducive to the generation of various emerging jobs. In the short term, it will create new types of jobs and increase the diversity of jobs in the city [50]. Therefore, the urban occupational diversity can

be used as an important window to peep into the upgrading of urban industrial structure and the development of emerging industries.

Table 1. Urban industrial structure, digital economy development and urban occupational diversity.

	Urban occupational diversity
Upgrading of urban industrial structure	0.1549*** (p = 0.0000)
Development of Urban Digital Economy	0.2331*** (p = 0.0000)

3. According to different income levels.

First, according to the geographical distribution of cities, the sample cities are divided into cities in the eastern region (56 in total), cities in the central region (71 in total) and cities in the western region (28 in total). **Figure 6** shows the trend of urban occupational diversity . It can be seen from the figure that occupational diversity is positively correlated with the level of economic development in different regions. The level of urban occupational diversity in the eastern region is always higher than that in the central and western regions, and the level of urban occupational diversity in the western region is the lowest.

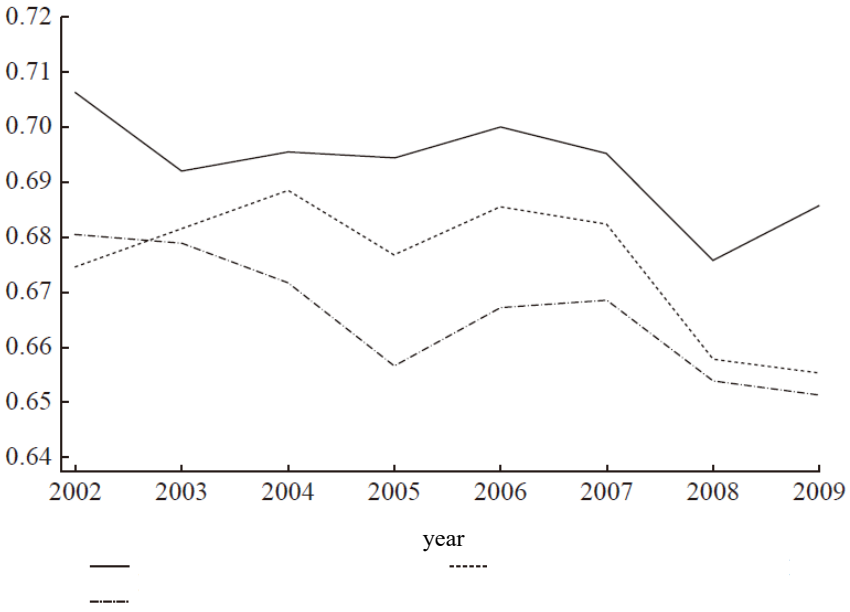


Figure 6. Trend of urban occupational diversity in different regions (—— Urban occupational diversity in eastern China; ------ Urban occupational diversity in Central China; -·-·-· Urban occupational diversity in Western China).

According to the difference of urban per capita GDP, the sample cities are divided into cities lower than the median per capita GDP (53 in total) and cities higher than the median per capita GDP (102 in total). **Figure 7** shows the trend of urban occupational diversity divided by the difference in per capita GDP. The above findings all verify the research hypothesis 3 proposed above.

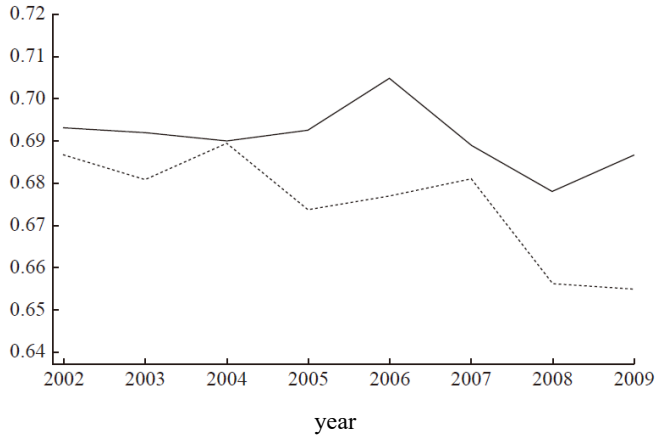


Figure 7. Trend of urban occupational diversity at different per capita GDP levels (—— Urban occupational diversity with per capita GDP higher than the median; ------ Urban occupational diversity with per capita GDP lower than the median; Urban occupational diversity; Particular year).

4.3. Regression analysis of urban characteristics and occupational diversity

The above provides a visual description of the basic facts and trends of urban occupational diversity in China, but it is impossible to infer the impact of urban characteristics on urban occupational diversity. Therefore, this paper further makes regression analysis on the basic characteristics of the city (including city size, administrative level, industrial structure, different regions and economic level) and the urban occupational diversity index. Among them, the corresponding variables are defined as: the city size is the logarithm of the population of the city at the end of the year. For different administrative levels, the cities of sub provinces and municipalities directly under the central government are assigned as 1, and the rest are 0; for different industrial structure division, the value of cities with the tertiary industry as the main industry is assigned as 1, and the value of cities with the secondary industry as the main industry is assigned as 0; for the division of different geographical locations, the cities in the eastern region are assigned as 1, and the cities in the central and western regions are assigned as 0; for the division of cities with different economic levels (per capita GDP), the cities greater than the median per capita GDP are assigned as 1, otherwise it is 0. The above data source is China urban statistical yearbook of each year. In order to overcome the heterogeneity effect of different urban characteristics, the main measurement method is the fixed effect model of panel data.

$$lnwork_rate_{ct} = \rho_0 + \rho_1 city_{ct} + \rho_2 X_{ct} + \rho_3 \gamma_{cti} + \varphi_c + \delta_t + \mu_{cti} \quad (2)$$

where, is $lnwork_rate_{ct}$ the occupational diversity index of City C in year t, $city_{ct}$ is the dummy variable of city category, X_{ct} is other urban characteristic variables of City C in year t, γ_{cti} is the family and personal characteristic factors of labor force I in City C φ_c in year t, represents the urban δ_t fixed effect, represents the year fixed μ_{cti} effect, and is the residual term.

It can be seen from **Table 2** that the higher the city size and administrative level,

the higher the degree of occupational diversity; the occupational diversity of cities in the eastern region is higher than that in the central and western regions, and the occupational diversity of cities with high economic level is higher than that of cities with low economic level. These findings are basically consistent with the theoretical combing and basic fact judgment of this paper. Specifically, from the results of model 1, it can be seen that under other conditions unchanged, the occupational diversity of cities with higher economic level is 0.4% higher than that of cities with lower economic level. The results of model 2 show that the larger the city size is, the higher the occupational diversity is under other conditions unchanged. From the results of model 3, it can be seen that under other conditions unchanged, the occupational diversity of cities in the eastern region is 0.6% higher than that of cities in the central and western regions. From the results of model 4, it can be seen that under other conditions unchanged, the occupational diversity of sub provincial and directly administered cities is about 1% higher than that of cities in other regions. The results of model 5 show that the occupational diversity of cities dominated by the secondary industry is higher than that of cities dominated by the tertiary industry. This may be related to the selection of the sample period. In combination with the above index calculation results, the advantage of occupational diversity in cities dominated by the tertiary industry in China gradually emerged after 2008. In addition, since the focus of this paper is not to focus on the causal effect of a key variable on the impact of urban occupational diversity, there is no endogenous discussion; at the same time, the urban fixed effect can eliminate the endogenous problems such as institutional differences between cities to a certain extent.

Table 2. Regression Analysis of occupational diversity in different types of cities.

	Dependent variable: lnwork_rate				
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Economic level	0.004***				
	(0.000)				
Different regions			0.006***		
			(0.001)		
Industrial structure					−0.004***
					(0.000)
Administrative grade				0.010***	
				(0.001)	
City size	0.005***	0.002***	0.002***	0.002***	0.003***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Regional GDP	0.009***	0.012***	0.012***	0.012***	0.011***
(lngdp)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Average wage of employees	−0.006***	−0.006***	−0.006***	−0.006***	−0.006***
(lnwage)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Proportion of tertiary industry output value	−0.000***	−0.000***	−0.000***	−0.000***	0.000***
(third_share)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Number of colleges and universities in provinces	−0.043***	−0.043***	−0.043***	−0.043***	−0.042***

(lnpro_uni)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Disposable income	0.001***	0.001***	0.001***	0.001***	0.001***
(lnincome_dis)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Account type (hukou)	0.000**	0.000**	0.000**	0.000**	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Education level	−0.000	−0.000	−0.000	−0.000	−0.000
(education)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Employment situation	−0.000***	−0.000***	−0.000***	−0.000***	−0.000***
(employment)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Occupation type	−0.000***	−0.000***	−0.000***	−0.000***	−0.000***
(work_type)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant term	0.760***	0.735***	0.735***	0.735***	0.725***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Year fixed effect	YES	YES	YES	YES	YES
Urban fixed effect	YES	YES	YES	YES	YES
Observed value	604748	604748	604748	604748	604748
Number of cities	142	142	142	142	142
R^2	0.706	0.706	0.706	0.706	0.706

Note: The values in parentheses are robust standard errors; *, **, *** represent significance at the 10%, 5%, and 1% levels, respectively; after matching with urban characteristic variables, the final urban sample used in the regression The number is 142.

4.4. Factor decomposition

In order to further verify the conclusion of this paper, this paper attempts to analyze the influencing factors of occupational diversity in cities of different sizes. The ob (Oaxaca blinder) decomposition method is mainly used here. It can be seen from **Table 3** that interpretable factors account for 32.73% of the total difference, and unexplainable factors account for 67.27% of the total difference. For the explicable part, the regional GDP has the greatest impact on occupational diversity, accounting for 39.64%, that is, the more developed the economy, the greater the occupational diversity gap between cities; then there is the total population factor at the end of the year, accounting for 37.81%, that is, the greater the population, the greater the occupational diversity gap between different city sizes; secondly, the average wage of employees and the urban industrial structure are also one of the factors that affect the occupational diversity of different urban sizes. This result is basically consistent with the conclusion of the above classification and regression analysis of urban occupational diversity.

Table 3. Oaxaca blinder decomposition results.

		Interpretable part	Proportion	Unexplainable part	Proportion
Total variance	0.0192*** (0.000175)				
Interpretable differences	−0.0181*** (0.000693)	32.73%			
Unexplainable difference	0.0372*** (0.000712)	67.27%			
Regional gross domestic product (lngdp)		0.0457*** (0.000751)	39.64%	−0.197*** (0.00657)	22.33%
Year end population (lnpop)		−0.0436*** (0.000864)	37.81%	0.263*** (0.00345)	29.81%
Average wage of employees (lnwave)		−0.0231*** (0.000206)	20.03%	0.380*** (0.00650)	43.06%
Third_share		0.00290*** (0.000129)	2.52%	−0.0424*** (0.000898)	4.81%
Constant term				−0.367*** (0.00464)	
Observed value	604757	604757		604757	

Note: The values in parentheses are robust standard errors; *, **, *** represent significance at the 10%, 5%, and 1% levels, respectively.

5. Robustness test

In order to further verify the accuracy of the above basic facts of occupational diversity, this paper also adopts the following robustness test method, and the corresponding analysis is as follows.

5.1. Replacement of measurement indicators

Based on the calculation method of Malizia and Ke, this paper reconstructs the measurement indicators of urban occupational diversity [51]:

$$Occupation_i = \sum_{j=1}^{n} \left(\frac{E_{ij}}{E_i} \right) \log \left(\frac{E_i}{E_{ij}} \right) \tag{3}$$

In Equation (3), i represents the i-th City, j represents the j-th occupation, n represents the total number of occupations in the ith E_{ij} City, represents the employment of the j-th occupation in the ith City, and EI represents the total employment of the ith city. Calculate with this formula to verify whether the above trend is reasonable. The results show that although different formulas for calculating occupational diversity are adopted, the changing trend of urban occupational diversity is still consistent under different urban classification methods, which verifies the robustness of this conclusion.

5.2. Comparison with other diversity indicators

Next, this paper compares and analyzes the relationship between the occupational diversity index calculated in this paper and other urban diversity indicators. First, using the dialect diversity index of 2010 calculated by Xu et al. [52] and others for reference, matching with the cities covered by the UHS data of 2009 used in the article, 139 effective city samples are obtained, and used to analyze the correlation between the occupational diversity index and the dialect diversity index; then, referring to the calculation method of occupational diversity, this paper calculates the industry diversity index of the city, and analyzes the relationship between the industry diversity

index and the first two diversity indexes. The results are shown in **Table 4**.

Table 4. Correlation between occupational diversity index and dialect diversity index.

	Work_rate	**Industry_rate**
Dialect diversity index	−0.0794***	−0.1062***
	(p = 0.0000)	(p = 0.0000)
Industry_rate	0.5367***	/
	(p = 0.0000)	

It can be found that the occupational diversity index has a significant positive correlation with the industry diversity index (the correlation coefficient is 0.537), but a significant negative correlation with the dialect diversity index (−0.079), while the industry diversity index also has a significant negative correlation with the dialect diversity index (−0.1062). That is, the industrial diversity of cities breeds more professional diversity, but the diversity of dialects is not conducive to the improvement of the degree of professional diversity. The possible explanation is that the diversity of dialects inhibits the construction of the social network of foreign labor, which is not conducive to the entry of labor into some industries and the increase of income [53].

5.3. Consider the impact of floating population

Due to the limitations of urban household survey data (UHS) survey objects, the occupational diversity index calculated in this paper is difficult to cover the occupational distribution of the floating population. In order to solve this problem, referring to Combes et al., this paper selects the proportion of the population classified by occupation from the 2005 National 1% population sampling survey data to the occupation classification from the UHS data for weighted processing, so as to make the indicator calculation of occupational diversity more general [54].

The population sampling survey in 2005 counted the number of employed people divided by major categories of occupations. The survey divided occupations into seven categories: heads of state organs, party and mass organizations, enterprises and institutions; professional technicians; administrative staff and related personnel; business and service personnel; production personnel of agriculture, forestry, animal husbandry, fishery and water conservancy; the operators of production and transportation equipment, relevant personnel and other employees who are inconvenient to be classified are consistent with the occupational classification of UHS (Compared with the occupational classification in UHS, the 1% population sampling survey in 2005 only lacked the special classification of "military personnel". Therefore, this occupational classification in UHS is also excluded here.). Therefore, based on this data, the article calculates the population weights of different occupational categories and weights them into the UHS data of corresponding occupations, so as to make the measurement of occupational diversity indicators more general. By comparing the trends of urban occupational diversity using UHS data and weighted by floating population, it is found that the two trends are basically the same, and the weighted trend of urban occupational diversity is relatively stable.

5.4. Adjusting industry classification

Considering that agriculture, forestry, animal husbandry and fishery cannot reflect the characteristics of urban economy, which may cause deviation to the calculation results, this paper also calculates the trend of urban occupational diversity after removing such occupations. The results show that after removing the categories of agriculture, forestry, animal husbandry and fishery, the change trend of urban occupational diversity is basically consistent with the previous results, which also verifies the robustness of this conclusion.

6. Conclusions and policy implications

Occupational diversity affects the economic growth, innovation and employment stability of cities. A correct understanding of the current situation of occupational diversity in Chinese cities is particularly important to guide the healthy development of urban economy. In recent years, with the rise of the Internet economy and other new economies, more and more attention has been paid to career diversity. As basic research, this paper takes urban household survey data (UHS) and China labor force dynamic survey (CLDs) data as samples, calculates the change trend of urban occupational diversity in China from 2002 to 2016, and gives explanations from the three dimensions of urban size, industrial structure and individual labor force. Overall, from 2002 to 2009, China's urban occupational diversity showed a slight downward trend, but it began to rise again after 2009; from the perspective of city size, the larger the city size, the stronger the degree of urban occupational diversity; from the administrative level, compared with the general cities, the sub provincial and directly administered cities have higher occupational diversity; from the perspective of industrial structure, the difference of industrial structure within the city has not caused a significant change in the trend of occupational diversity, but the advantage of occupational diversity in cities dominated by the tertiary industry has begun to appear since 2008; from a regional perspective, the eastern region has the highest urban occupational diversity, that is, the higher the level of economic development, the higher the urban occupational diversity; in terms of economic level, cities with higher per capita GDP have higher occupational diversity. At the same time, the above conclusions are further verified by regression analysis and factor decomposition.

In the context of promoting high-quality employment, urban occupational diversity starts from the occupational types of labor force, more objectively reflects the diversity characteristics within the city, helps to intuitively understand the current situation of occupational distribution in different cities, then analyzes the current situation of industrial structure and division of labor in cities, evaluates the human resource structure and economic development potential of cities, and then provides reference for different cities to formulate industrial development and human resource policies. Based on the research conclusions of this paper, the following policy recommendations can be provided:

(1) From the perspective of urban industrial division of labor, urban occupational diversity is an important factor affecting urban industrial transformation. Occupational diversity helps to give play to the spillover effect and complementary effect between different occupations, enrich people's social life, and promote the diversified

development of urban social economy. The adjustment of occupational scale and structure is an important factor affecting the evolution of industrial structure. The discussion on the distribution and development trend of occupational diversity within the city is an important window to peek at the adjustment of urban industrial structure and industrial division. Understanding its current situation and development trend is very important for the city to formulate specific industrial development policies.

(2) From the perspective of urban innovation and development, cities with rich occupational diversity have more labor forces with different skills, which provides a solid human capital foundation for urban innovation and development. The diversity of human capital contained in occupational diversity has a significant role in promoting the improvement of urban innovation ability, and is an important driving force for urban sustainable development. The improvement of human capital will further give play to the externality of urban agglomeration economy. Understanding the occupational distribution and diversity of urban labor force is an important factor to examine the diversity and innovative development of cities, and provides more space for innovative development for cities.

(3) From the perspective of urban human resources, the diversity of occupational distribution can not only reflect the current situation of occupational supply and demand in the city, but also help to provide accurate human resources services, so as to improve the human capital level of the city. At the same time, the distribution of labor industries affects the speed and depth of industrial evolution. The inflow of labor population will produce or respond to the labor market demand of the place of immigration. Understanding the occupational diversity of labor is conducive to better understanding the development stages and structural distribution of various industries in the city, so as to take more accurate measures to promote the matching of labor supply and demand.

(4) From the perspective of urban institutional security policy, the government should actively improve the employment environment, promote the program to promote talent cultivation, encourage the generation and development of diversity, continuously improve the diversity of labor force, and then promote the transformation and development of social economy. Career diversity is crucial to urban economic growth. The increasing diversity promotes the emergence of novelty, creative ideas, creative concepts and new designs. With the emergence of digital economy and other new economies, the types of occupations in most cities will become more diversified. The government should implement more targeted policies on talent introduction and public service guarantee according to the current distribution of the occupational structure of the urban labor force and in combination with the advantageous resources and industrial development of the city.

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