

# Study on Guangzhou's Employment Subcentres and Polycentricity

L. Jiang

**Abstract**—Since the late 1980s, the new phenomena of 'employment subcentres' or 'polycentricity' has appeared in the metropolises of North American and Western Europe and it has been an interesting topic for academics and researchers. This paper specifically uses one case study-Guangzhou to explore the development and the mechanism of employment subcentres and polycentricity in Chinese metropolises by spatial analysis method on the basis of the first economic census data. In conclusion, the paper regards that the employment subcentres and polycentricity has existed in Chinese metropolises. And that, the mechanism of them is mainly from the secondary industry instead of the tertiary industry in North American and Western Europe.

**Keywords**—Employment Subcentre, Polycentricity, Guangzhou.

## I. INTRODUCTION

SINCE the late 1980s, the new phenomena of 'employment subcentres' or 'polycentricity' has come out. This means that the urban spatial structure has entered a new development period. The employment subcentres can not only lead to local rises in population density, land prices, and perhaps housing price, but also the cut-down of the long and time-consuming exchange, and the provision of agglomeration economies with lower wages and land prices comparing with the traditional central business district (CBD) [1],[2]. Meanwhile, polycentricity can combine a number of the benefits of big and small urban areas, where CBDs supply the companies with agglomeration economies and employment subcentres with reduced costs [1]. The employment decentralising urban spatial structure (employment subcentres and polycentricity) has been an interesting topic for academics and researchers in the metropolis of North American and Europe [3], [4]. Thus, academics and researchers in North America and Western Europe utilise a variety of methods and styles to identify the employment subcentres in different metropolis from the early 1990s such as those in Los Angeles[5]-[8], Atlanta [9],[10], Cleveland[11],San Francisco [12],[13], Chicago[14]-[16], Houston[17], Montreal[3],[18]-[20], Beilgium[21] and Randstad [22]. Furthermore, some evidences show that large metropolitan areas with high congestion levels have at least one subcentre in 62 American urban areas in 1990[1].

In China, there are tens of metropolises throughout the country according to the definition of metropolis with over 3,000,000 populations [23]. However, there is only Wu and Ma whose study is on the employment subcentres in Shanghai by

using the data of Jiedao population census and the method of population model[24], although McDonald 'advocates use of the employment density function rather than the population density function to identify employment subcenters' [17]. Therefore, more research studies should be on the employment subcentres, and polycentricity of urban spatial structure in Chinese cities (developing country). According to the literature of Guangzhou urban spatial structure, it seems that polycentricity and employment subcentres have existed in Guangzhou metropolis [25]. However, how do the employment subcentres exist and what kind of the polycentricity pattern is in Guangzhou metropolis is what still need to be researched. This research attempts to fill this gap in the literature by identifying the employment subcentres and polycentricity in Guangzhou metropolis, using employment-density thematic maps, the identification of employment subcentre, professional knowledge, land-use standard.

## II. DEFINING 'EMPLOYMENT SUBCENTRE' AND 'POLYCENTRICITY' IN PRACTICE

### A. Definition of 'Employment Subcentre' and 'Polycentricity'

Numerous studies have documented the definition of employment subcentre and polycentricity in metropolises. McMillen and Smith [1] regard an employment subcentre is 'an area with significantly higher employment densities than surrounding areas', which should be 'large enough to have a significant effort on the overall spatial structure of the urban area'. This definition imitates the conventional concept of an urban area, which has been used to identify various metropolises in the US [1]. Meanwhile, Shearmur and Coffey notes that an employment subcentre refers to locations with high totals of employment, which is different from the definition of industrial districts or milieu that specialises locations with high benefits from linkages [1]. McMillen argues that 'an employment subcentre is a concentration of firms large enough to have significant effects on the overall spatial distribution of population, employment and land prices' [26]. Moreover, he proposes that large employment subcentres can be similar to a traditional central business district [26]. However, employment subcentres are not as strong as the CBD, which are subsidiary to CBD. Some of them grow out of old towns, but others appear from nearly nothing. The latter can develop in 'edge-cities', which are regarded as a great mature form of polycentrism: 'a morphologically separated subcentre with city-level functions that can complete with the traditional

L. Jiang is with Guangzhou Academy of Social Sciences, Guangzhou, China, 510410 (phone: 0086-20-86486958; fax: 0086-20-864864123; e-mail: gzjiangli@hotmail.com).

CBD' [21]. Giulinano and Small define the employment subcentre comparing with the city centre [6]. McDonald uses the objective definitions on the basis of employment data for a great deal of zones in a metropolitan area [14].

Large employment subcentres and strong central business district are composed with a polycentricity [26]. In other words, 'a polycentric city has one or more employment subcentres beyond the traditional central business district (CBD)' [2]. However, Riguelle, et al. regard that 'the presence of several concentrations of employment is necessary but not sufficient criterion for an area to be polycentric' [21]. Musterd and Zelm [22] consider that 'a polycentricity refers to nothing more than the existence of more than one centre in a city, region or other geographical unit' from urban form aspect. Polycentricity can possess a large number of the benefits both of big and small urban areas [1], [26]. The CBDs supply the companies with agglomeration economies but should pay a high salary as well [1], [26]. However, employment subcentres can reduce the costs and to some extent offer some advantages of agglomeration at the same time [1], [26]. Meanwhile,

Generally speaking, an employment subcentre should have four meanings. Firstly, from the density aspect, it has remarkably higher employment densities than surrounding areas. This means there might be some distances from the CBDs to employment subcentres as well. Secondly, from the function aspect, it has multi-function such as retail, manufacturing and finance and can affect whole urban spatial structure by contributing to the population density, land or housing price. Thirdly, it should be subsidiary to a CBD as well. Last but not least, from the location aspect, it is the essential part of the polycentricity in a metropolitan area, which is mainly located in the periphery of a metropolis but some still grow up from old towns. Meanwhile, a polycentricity is composed of several employment subcentres and CBDs.

#### *B. Characters of Employment Subcentres and Polycentricity in Metropolises Figures*

Academics found out some characters in their researches of employment subcentres and polycentricities in North America and West Europe as follows. Firstly, the tertiary is the principal driving force for employment subcentres. For example, high-order services are the major components of employment subcentres such as finance, insurance and real estate services and business services in Montreal area of Canada[18]. Secondly, employment subcentres have several forms. For example, 20 employment subcentres can be classified into six categories in Chicago, which are '1) old satellite cities, 2) old industrial suburbs, 3) post World War II industrial suburbs, 4) newer industrial retail suburbs, 5) Edge Cities, and 6) service or retail centres [16]. Thirdly, polycentricities are still weak in Western Europe and North America. It is feeble although the employment subcentres have existed at the edge of medium-sized European cities and the developmental trends of decentralisation has continued and enlarged such as Brussels, Antwerp, Ghent and and Lie`ge of four largest Belgian cities[21]. As do those in Canada. Coffey and Shearmur present

the CBD is still strong so that it accumulates the principal employment in 1981-1996[18]. Fourthly, some evidence of empirical regularities presents that large cities have more employment subcentres than smaller cities such as Los Angeles, Chicago, and New York and employment subcentres are apt to arise near freeway intersections and in old satellite suburbs [26]. Last but not least, distance from the employment subcentres to traditional CBD is the most significant element to determine the employment densities in the large 62 American metropolises in 1990 [26].

#### *C. The Methods of Identifying, Analyzing and Presenting Employment Subcentres in Polycentricities*

It seems that the most important research approach is employment-density, which has been used the most widely in North America and Western Europe, although the methods of defining employment subcentres are various, including examining the effects of employment subcentres on population density and house prices. In total, the methods of identifying employment subcentres can be divided into three categories particularly. Firstly, an employment density means that its employment-density is higher than its surrounding area. It can affect the urban spatial structure and rise up the population density, the housing price, and land rent [2]. This method was utilised widely in the early period [21]. However, it has been more difficult to attain, as it is hard to the 'obvious higher employment-density' by a specific data [21]. Afterwards, some researchers use a visual review of density maps and discretionary definition based on professional knowledge, land-use standard and the research on commuter flows in the early days [21]. Secondly, the 'cut-off' method is a popular method currently. That is to formulate thresholds for employment subcentre consisting employment density and total employment above which the area is regarded as an employment subcentre [6], [7],[27],[29]. Meanwhile, many academics utilise an employment-to-population ratio criterion as a complement for this method [5], [19]. For example, Coffey and Shearmur consider that an employment subcentre should own over 5,000 jobs and the employment-to-population ratio should be higher than 1.0[18]. However, this method has some shortages [21]. The first one is how to choose the thresholds for employment subcentre [29]. The second one is that the area has its own thresholds for employment subcentre, which restricts the comparison of areas [21]. The third one is that it prevents the area to be an employment subcentre that it is not above the thresholds but with higher employment density than surrounding area [21]. Last but not least, it is to identify employment subcentres through studying employment density functions. For example, Craig and Ng to identify an employment subcentre as local peaks in the predictions from non-parametric regressions of the natural logarithm of employment density on distance from the CBD [21], which should be combined the local knowledge and employment statistics [2]. This method is more precise than the 'cut-off' method, but less sensitive [21]. However, it was mainly utilised in mono-centric cities rather than polycentricity with many

employment subcentres [21]. How to choose three methods depends on the available data.

### III. STUDY ON CHINESE EMPLOYMENT SUBCENTRE AND POLYCENTRICITY—GUANGZHOU CASE

#### A. Guangzhou Metropolis

Guangzhou is the third largest city in China, of which the urban land expanded to 7434 km<sup>2</sup> and the population was up to 7.6 million in 2008 [30]. It can be presented as Chinese metropolis. Guangzhou metropolis is composed of ten districts involving 122 Jiedao, 25 Towns. To describe easily, the Towns or Administration Zone are all called Jiedao. Thus, there are 147 Jiedaos in Guangzhou metropolis (Fig. 1). The Jiedaos is similar to the tracts in North America and West Europe, which are called sub-district as well. This means that the average area of one Jiedao is per 6.09 kilometers, which is similar to a tract per 8 square kilometers in Los Angeles area while it is totally different from a tract per 0.65 square kilometers in Chicago. Therefore, this research focus on Jiedao level is appropriate for employment subcentres analysis of Guangzhou metropolis.

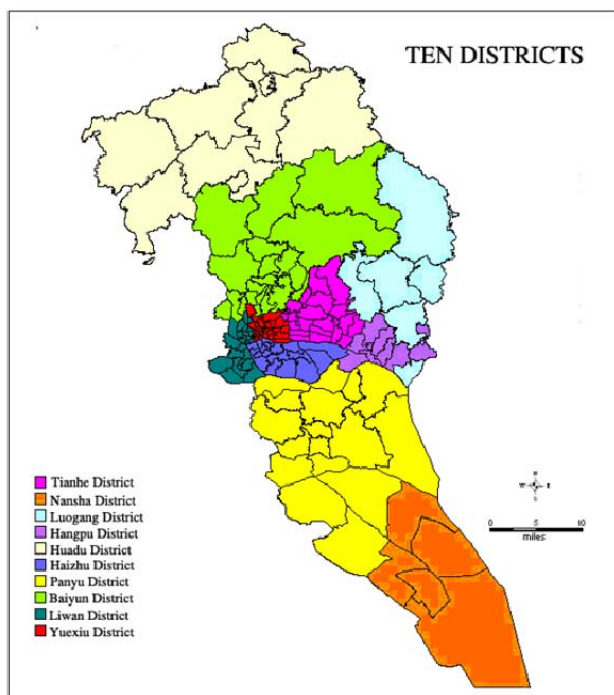


Fig. 1 Ten districts of Guangzhou

#### B. Data

Data of this study mainly involves employment data and area data at Jiedao level covering the ten urban districts. The employment data that is used in this analysis relies on Guangzhou Second National Economic Census at the end of 2008. They were made by Guangzhou Municipal First National Economic Census Leading Group Office. Thus, these employment data were from Guangzhou Municipal Second

National Economic Census Leading Group Office and Guangzhou Municipal Statistics Bureau and ten First National Economic Census Leading Group Office and ten Districts Statistics Bureau [31]-[40]. In addition, the area data at Jiedao level is available from Guangzhou Urban Planning, Design and Survey Institute in 2006[41].

The employment data can be divided into a three categories industry—the primary industry, the secondary industry and the tertiary industry, covering 20 economic sectors. It should be noted that these employment data only means the workers who work in the unit and get salary from legal entities [31]. They were set up by laws; have their own names, places and organisations; take civil responsibilities; own and use assets, liabilities, and commitments independently; have rights to sign contracts with other units; account independently [31].

#### C. Identification of Employment Subcentres and CBDs

Firstly, according to analysis the number of employment-density, the density of employment of 147 Jiedaos are available. Meanwhile, the Jiedaos are classified into four categories as follows according to the density of employment (Fig. 2, Table I). The first level is twenty Jiedaos with at least one square kilometer over 20,000 employees, which mainly distribute in Yuexiu District and Liwan District. The second level is seventeen Jiedaos with one square kilometer between 10,000 and 19,999 employees, which mainly distribute in Tianhe District. The third level is twenty Jiedaos with one square kilometer between 5,000 and 9,999 employees, which distribute in eight districts except Nansha District and Baiyun District. The last one are 81 Jiedaos with one square kilometer below 4,999 employees, which disperse in ten district.

TABLE I  
THE NUMBER AND SPATIAL DISTRIBUTION OF LEVELS OF EMPLOYMENT CENTRES

Levels of Jiedaos' employment-density (employees per square kilometer)	The Number of Jiedaos
the first-level (over 20,000)	21 Jiedaos
the second-level (between 10,000 and 19,999)	21 Jiedaos
the third-level (between 5,000 and 9,999)	24 Jiedaos
the fourth-level (below 4,999)	81 Jiedaos
Total	147 Jiedaos

Source: Fig. 2

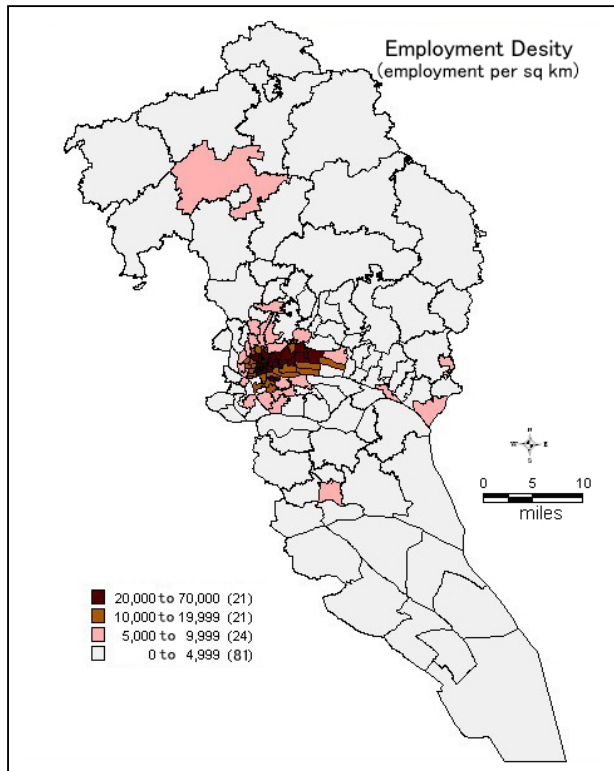


Fig. 2 The levels of Jiedaos' employment-density

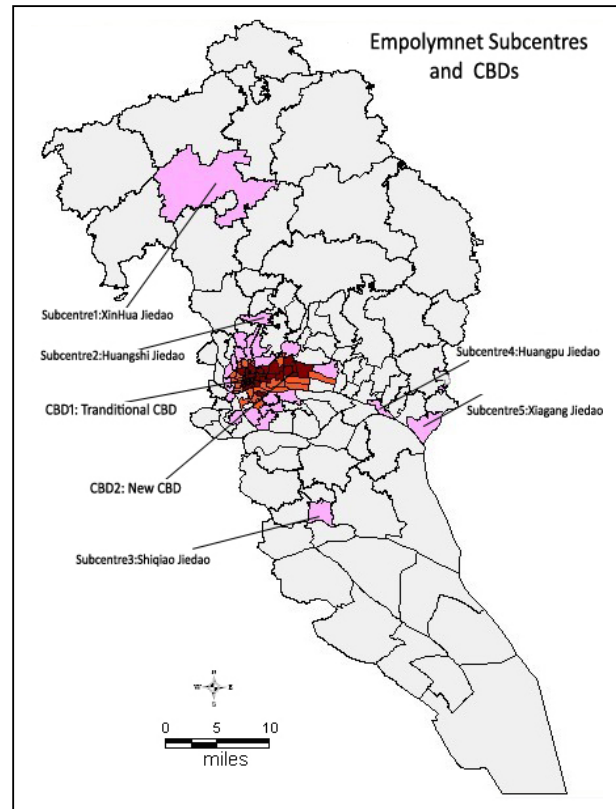


Fig. 3 Employment subcentres and CBDs

Secondly, according to the literature review, to identify employment subcentres requires four conditions in North American and Western Europe. In this research, the threshold of an employment subcentre should have at least an employment density of 5,000 employees per square kilometer. The first-level employment centre has become traditional CBD (mainly located in Yuexiu District and Liwan District) and New CBD (mainly located in Tianhe District). In the second-level and third-level employment centres, there are five employment subcentres have a threshold of employment densities, outstandingly higher employment densities than the surrounding areas, distance to employment subcentres to the CBDs, and multi-function. They are Huangshi Jiedao in Baiyun district, Huangpu Jiedao in Huangpu district, Xinhua Jiedao in Huadou district, Xiagang Jiedao in Luogang Jiedao and Shiqiao Jiedao. Huangshi Jiedao and Huangpu Jiedao. Huangshi Jiedao and Huangpu Jiedao grow out of the old town while Xinhua Jiedao and Xiagang Jiedao locate in the periphery of metropolis (Fig. 3).

It seems that this is one third of the employment density of 15,000 employees per square kilometer in Los Angeles area [2] and one sixth of the employment density of 15,000 employees per square kilometer in Chicago [16]. However, the employment data of Jiedaos only included the legal entities, and excluded the self-employment households as they were not separated by Jiedao level. For example, in Nansha District, the self-employment census were over one fifth of the total district employment data; and in Yuexiu District, they were just less than one fifth of the total district employment data. Thus, it cannot be concluded that the economic agglomeration and activities in Guangzhou is less than in the metropolises in USA.

Two CBDs and five employment subcentres composed of polycentricity. According to 《Guangzhou 2020: Urban overall development strategy planning consult》 [25], Guangzhou can be divided into four circle layers: Core Circle Layer, Inner Circle Layer, Outer Circle Layer and Outer Circle. The Outer Circle mainly means Conghua and Zengcheng edge cities. Thus, combining the research result of Guangzhou Urban Planning, Design and Survey Institute and the distribution of employment subcentres, Guangzhou can be divided into three circle layers due to excluding Conghua and Zengcheng edge cities in this research. The Core Circle Layer involves the two CBDs. The Inner Circle Layer includes four employment subcentres—Huangshi, Shiqiao, Huangpu and Xiagang employment subcentres. The Outer Circle Layer involves only

one employment subcentres—Xinhua employment subcentres (Fig. 4, Fig. 5).

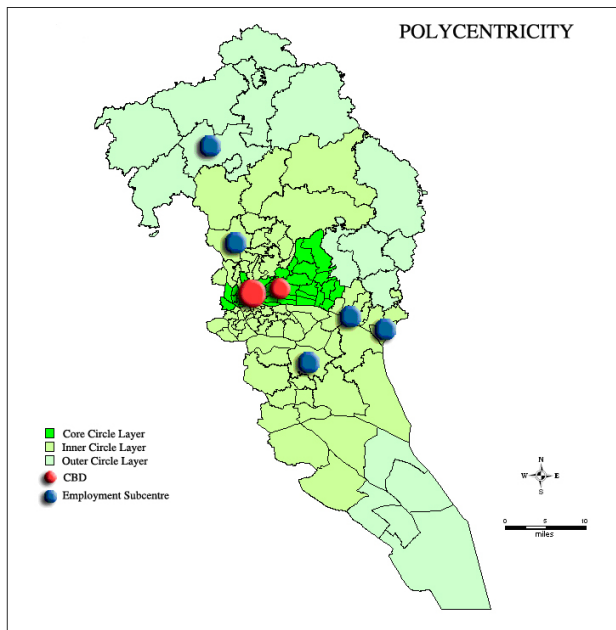


Fig. 4 Polycentricity

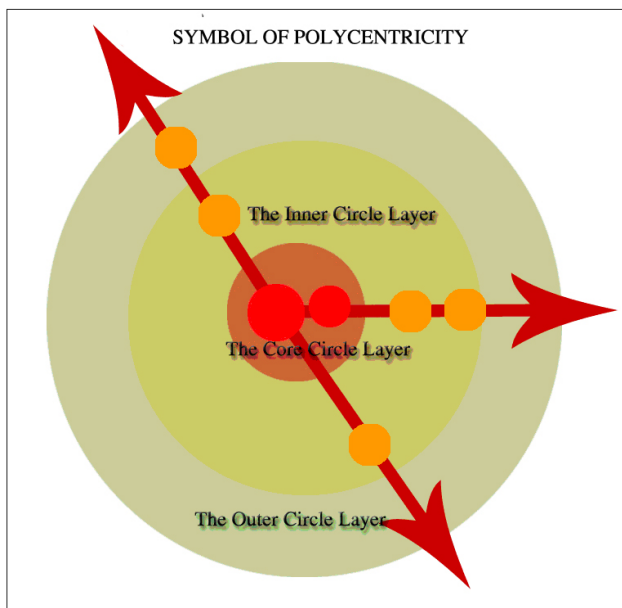


Fig. 5 Symbol of polycentricity

*D. The Cause of Employment Subcentres Shape*

According to researching based on analysis of four employment subcentres and CBDs of Guangzhou metropolis, it can be seen that the causes of four-employment subcentres form are various. There are the manufacturing economic sectors, the construction sectors, manufacturing economic sectors, and the transport storage and postal service sector.

The manufacturing economic sector is the main cause of

employment subcentres of Xinhua Jiedao and Xiagang Jiedao forming. In Xinhua Jiedao, the manufacturing sector ranks first with 55.11per cent of the eighteen sectors. This is as twenty-nine manufacturing categories have been gathering in Xinhua Jiedao. There are six manufacturing categories: Garments, shoes, hat manufacturing; textile manufacturing; leather, fur, feathers (cashmere) manufacturing; computer communications equipment and other electronic equipment manufacturing; handicrafts manufacturing; transportation equipment manufacturing. In Xiagang Jiedao, the manufacturing sector ranks first with 55.91 per cent of fifteen economic sectors. This is as twenty-nine manufacturing categories have been gathering in Xiagang Jiedao. There are four kinds of manufacturing: food manufacturing; computer communications manufacturing; raw chemical materials and chemical manufacturing; computer communications equipment and other electronic equipment manufacturing. However, although tens of industry parks clustered in Xinhua Jiedao, Xiagang Jiedao belongs to one industry park---Guangzhou Development District.

The Manufacturing and Construction are main elements of Employment Subcentre of Shiqiao Jiedao. This is as the manufacturing sector ranks first with 14.64 per cent of seventeen economic sectors and construction sector yielded 12.70 per cent. Many employment of construction sector in Shiqiao Jiedao are as it is the great building-muster of South China block, which has massive residential area. On the other hand, seventeen manufacturing categories have gathered in Shiqiao Jiedao, which are less than Xinhua Jiedao and Xiagang Jiedao. However, there are still tens of industries parks in Shiqiao Jiedao.

The transport storage and postal service sector is the primary ground of Huangpu employment subcentre. The transport storage and postal service sector ranks first with 48.90 per cent of fifteen economic sectors. This is because Huangpu port is the biggest port in the Southeast of China.

*E. The Features of Employment Subcentres*

Employment subcentres have seven features. The first one is that the majority of drive force is the secondary industry especially manufacturing industry. In four employment subcentres' drive force, three of them are manufacturing industry. Furthermore, percentage of two is very high. Only one is third industry--transport storage and postal service sector. Thus, Guangzhou employment subcentres can be divided into three categories: manufacture centre, manufacture and construction centre, transport storage and postal service centre. The second one is that categories of manufacturing are diversified. For example, twenty-nine manufacturing categories are in Xinhua Jiedao and Xiagang Jiedao, seventeen manufacturing categories are in Shiqiao Jiedao. The third one is that the majority of manufacturing are labour-intensive. For example, Garments, shoes, hat manufacturing runs the first in Xinhua Jiedao and Shiqiao Jiedao; raw chemical materials and chemical manufacturing runs the first in Xiagang Jiedao. The fourth one is that there are too many industry parks especially

in the manufacturing employment subcentres of Huadu Jiedao and Shiqiao Jiedao. They both had tens of industry parks as the local government had no plans and nearly every Urban Village established an industry park to develop its industry economy. The fifth one is that the manufacturing industry has not clustered in employment subcentres although their categories are various. As it is mentioned, the categories of manufacturing are various. However, the industry chain still requires being further strengthened and extended. It seems that the manufacturing is over-dispersed and has a lack of concentration. The sixth one is that multi-function has formed in every employment subcentre that there at least has been fifteen economic sectors. However, the multi-function is still weak. There are only three economic sectors over 5 per cent in Xinhua Jiedao and the ratio of manufacturing is 55.98 per cent. Meanwhile, only four economic sectors is over 5 per cent in Xianggang Jiedao, which is a manufacturing sector with 55.91 per cent. Furthermore, even though five economic sectors are over 5 per cent in Huangpu Jiedao, transport storage and postal service sector owns 50.90 per cent. Thus, three categories of employment subcentres can be classified in Guangzhou metropolis as follows: industrial suburbs including Xinhua Jiedao and Xiagang Jiedao, transport storage and postal service centers including Huangpu Jiedao, and industrial and construction suburbs including Shiqiao Jiedao. The last one is that the housing and office price is higher in the CBDs than in the employment subcentres. For example, the office price is 10-13 thousand Yuan per square metre in employment subcentres while it is 19-30 thousand Yuan per square metre; and the office price is 5-8 thousand Yuan per square metre in employment subcentres while it is 12-20 thousand Yuan per square metre.

#### IV. CONCLUSION AND DISCUSSION

##### A. Summary

The present study was designed to determine the effect of employment census data in 2004 to identify the employment subcentres and polycentricity by spatial analysis on the employment-to-area density of ten districts in combination with professional and literature knowledge in Guangzhou metropolis. It has proved that the employment subcentres and polycentricity has existed in Chinese metropolises. However, it is still quite mono-centric or the polycentricity is weak as the function of the employment subcentres is simple and the number of employment subcentres is less. This is similar to the situation in metropolises in North America and Western Europe. However, there are still some differences between the Guangzhou metropolis and the metropolises in North America and Western Europe. Although the research area and data of these metropolises are different, it is difficult to compare in categories and numbers of employment subcentres are different. Nevertheless, it can be sure that the driving forces of employment subcentres are various. For example, the driving force is the high-order services industry of tertiary industry in Montreal while it is the manufacturing industry of secondary

industry in Guangzhou.

##### B. Suggestion

In order to improve the quantity and quality of Guangzhou employment subcentre, four key recommendations should be made in terms of improving and promoting the employment subcentres and polycentricity. The first one is to boost the quantity of employment subcentres. The key way is to induce more companies and improve more employment. Favorable policies should be formulated to induce the more investors such as tax, land price by local government. Financial and credit assistance should be provided by local banks. Extension and advisory services and infrastructure should be given by local government. Marketing and market research, technical and training assistance should be done by local institute. The second one is to encourage industry cluster to boost the economic quality of employment subcentres. The present important industry chain should be established sustainably such as the garments, shoes, hat manufacturing industry chain in Xinhua Jiedao. Some potential industry chain should be encouraged such as the automobile industry chain in Xinhua jiedao and the high-tech industry chain in the Luogang District. The third one is to integrate industry parks to promote the environmental quality of employment subcentres. Local governments should make plans to integrate these industry parks such as promoting intensive and efficient use of industry land; combining present industry park to the national or world industry basement brand on the basis of the industry cluster; formulating a series of physical plans to realise the ambitious blueprint such as master plans and detailed plans of industry parks. The fourth one is to promote the multi-function of employment subcentres especially on tertiary industry. Local governments should provide plentiful productive services to develop the secondary industry such as technical information, technical advice, intellectual property rights trading, new products and new technology research and development, education, training, product launches, and so on. They should enrich wholesale and retail trade, and accommodation and catering industry to improve the substance living standards of inhabitants; improving culture, sports and entertainment industry to improve the spirit living stands of dwellings; urging education industry to improving for the quality of residents.

##### C. Discussion

Based on the employment census data of the first economic investigation, the researcher primarily studies on Guangzhou employment subcentre and polycentricity. However, along with the economic activities developing and clustering, and urban area expanding, employment subcentres will be changeable such as the number and function of employment subcentres improving, the driving force changing and the spatial structure of polycentricity enhancing. These issues will be done dynamic study, as employment census data can be available every four years since 2004.

## REFERENCES

- [1] D.P. McMillen, and S.C. Smith, The number of subcenters in large urban areas. *Journal of Urban Economics*, Vol. 53, 2003, pp.321–338.
- [2] D.P. McMillen, Nonparametric employment subcenter identification. *Journal of Urban Economics*, Vol. 50, 2001, pp.448–473.
- [3] R. Shearmur, W. Coffey, C. Dube, et al., Intrametropolitan Employment Structure: Polycentricity, Scattering, Dispersal and Chaos in Toronto, Montreal and Vancouver, 1996–2001. *Urban Studies*, Vol. 44, No. 9, 2007, pp.1713–1738.
- [4] T.M. Stanback, *The New Suburbanisation*. Boulder, CO: Westview Press, 1991.
- [5] R. L. Forstall and R.P. Greene, Defining job concentrations: the Los Angeles case. *Urban Geography*, Vol. 18, 1997, pp.705–739.
- [6] G. Giuliano and K.A. Small, Subcenters in the Los Angeles Region. *Regional Science and Urban Economics*, Vol. 21, 1991, pp.163–182.
- [7] G. Giuliano, and K.A. Small, The determinants of growth of employment subcenters. *Journal of Transport Geography*, Vol. 7, 1999, pp.189–201.
- [8] P. Gordon and H.W. Richardson, beyond polycentricity: the dispersed metropolis, Los Angeles, 1970–1990. *Journal of the American Planning Association*, Vol. 62, 1996, pp.289–295.
- [9] T. Fuji and T. Hartshorn, The changing metropolitan structure of Atlanta, Georgia: locations of functions and regional structure in a multinucleated urban area. *Urban Geography*, Vol.16, 1995, pp. 680–707.
- [10] T.A. Harshorn and P.O. Muller, Suburban downtowns and the transformation of metropolitan Atlanta's business landscape. *Urban Geography*, Vol.10, 1989, pp.375–395.
- [11] W.T. Bogart and W.C. Ferry, Employment centres in greater Cleveland: evidence of evolution in a formerly monocentric city. *Urban Studies*, Vol. 36, 1999, pp. 2099–2110.
- [12] R. Cervero and K.L. Wu, Polycentricity, Commuting, and Residential Location in the San Francisco Bay Area. *Environment and Planning A*, Vol.29, 1997, pp.865–886.
- [13] R. Cervero and K.L. Wu, Sub-centring and Commuting: Evidence from the San Francisco Bay Area, 1980–90. *Urban Studies*, Vol. 35, No. 7, 1998, pp.1059–1076.
- [14] J. F. McDonld, The identification of urban employment subcentres. *Journal of Urban Economics*, Vol. 21, 1987, pp. 242–258.
- [15] J. McDonld and P. Prather, Suburban employment centres: the case of Chicago. *Urban studies*, Vol. 31, 1994, pp.201–218.
- [16] D.P. McMillen and J.F. McDonld, Suburban subcenters and employment density in metropolitan Chicago. *Journal of Urban Economics*, Vol. 43, 1998, pp.157–180.
- [17] S.G. Craig and P.T. Ng, Using quantile smoothing splines to identify employment subcenters in a multicentric urban area. *Journal of Urban Economics*, Vol. 49, 2001, pp. 100–120.
- [18] W.J. A. Coffey and R. G. Shearmur, Agglomeration and Dispersion of High-order Service Employment in the Montreal Metropolitan Region, 1981–96. *Urban Study*, Vol. 39, No. 3, 2002, pp.359–378.
- [19] R. G. Shearmur and W.J. A. Coffey, Tale of four cities: intrametropolitan employment distribution in Toronto, Montreal, Vancouver, and Ottawa—Hull, 1981–1986. *Environment and Planning A*, Vol.34, 2002a, pp:575–598.
- [20] R. G. Shearmur, and W.J. A. Coffey, Urban employment subcenters and sectoral clustering: complementary approaches to the study of urban form. *Urban Geography*, Vol.23, No.2, 2002b, pp. 103–130.
- [21] F. Riguelle, et al., Measuring urban polycentricity: a European case study and its implications. *Journal of Economic Geography*, No.7, 2007, pp. 193–215.
- [22] S. Musterd and I.V. Zelm, Polycentricity, Households and the identity of Places. *Urban Studies*, Vol. 38, No. 4, 2001, pp.679–696.
- [23] X.Q. Xu, et al., *Urban Geography*. Business Press, 2005 (In Chinese).
- [24] W.Y. Wu and X. Y. Ma, Polycentric Population Density Functions and Modelling: The Case of Shanghai. *Modern Urban Research*, No.12, 2006, pp.45–52 (In Chinese).
- [25] Guangzhou Urban Planning, Design and Survey Institute, *Guangzhou 2020: Urban overall development strategy planning consult*. 2007, Unpublished (In Chinese).
- [26] D.P. McMillen, Employment densities, spatial autocorrelation and subcenters in large metropolitan areas. *Journal of regional science*, Vol.44, No.2, 2004, pp. 225–243.
- [27] N.B. Anderson and W. T. Bogart, The structure of sprawl: identifying and characterizing employment centers in polycentric metropolitan areas. *American Journal of Economics and Sociology*, Vol.60, 2001, pp.147–169.
- [28] F. Gaschet, The new intra-urban dynamics: suburbanisation and functional specialisation in French cities. *Regional Science*, Vol.81, 2002, pp.63–81.
- [29] A. Anas, et al., Urban spatial structure. *Journal of Economic Literature*, Vol.36, No.9, 1998, pp.1462–1464.
- [30] Guangzhou Municipal Statistics Bureau, *Guangzhou Statistics Yearbook*. Beijing: China Statistics Press, 2009.
- [31] Guangzhou Municipal First National Economic Census Leading Group Office and Guangzhou Municipal Statistics Bureau, *The first national economic census bulletin of Guangzhou*. Guangzhou Daily, 5th, January, 2010.
- [32] Guangzhou Baiyun District First National Economic Census Leading Group Office and Guangzhou Baiyun District Statistics Bureau, eds., *Guangzhou Baiyun District of the first national economic census report in 2008*. Guangzhou Baiyun District Statistics Bureau (In Chinese), 2010.
- [33] Guangzhou Haizhu District First National Economic Census Leading Group Office and Guangzhou Haizhu District Statistics Bureau, eds., *Guangzhou Haizhu District of the first national economic census bulletin in 2008*. Guangzhou Haizhu District Statistics Bureau (In Chinese), 2010.
- [34] Guangzhou Huadu District First National Economic Census Leading Group Office and Guangzhou Huadu District Statistics Bureau, eds., *Guangzhou Huadu District of the first national economic census bulletin in 2008*. Guangzhou Huadu District Statistics Bureau (In Chinese), 2010.
- [35] Guangzhou Huangpu District First National Economic Census Leading Group Office and Guangzhou Huangpu District Statistics Bureau, eds., *Guangzhou Huangpu District of the first national economic census bulletin in 2008*. Guangzhou Huangpu District Statistics Bureau (In Chinese), 2010.
- [36] Guangzhou Liwan District First National Economic Census Leading Group Office and Guangzhou Liwan District Statistics Bureau, eds., *Guangzhou Liwan District of the first national economic census bulletin in 2008*. Guangzhou Liwan District Statistics Bureau (In Chinese), 2010.
- [37] Guangzhou Luogang District First National Economic Census Leading Group Office and Guangzhou Luogang District Statistics Bureau, eds., *Guangzhou Luogang District of the first national economic census bulletin in 2008*. Guangzhou Luogang District Statistics Bureau (In Chinese), 2010.
- [38] Guangzhou Panyu District First National Economic Census Leading Group Office and Guangzhou Panyu District Statistics Bureau, eds., *Guangzhou Panyu District of the first national economic census bulletin in 2008*. Guangzhou Panyu District Statistics Bureau (In Chinese), 2010.
- [39] Guangzhou Tianhe District First National Economic Census Leading Group Office and Guangzhou Tianhe District Statistics Bureau, eds., *Guangzhou Tianhe District of the first national economic census bulletin in 2008*. Guangzhou Tianhe District Statistics Bureau (In Chinese), 2010.
- [40] Guangzhou Yuexiu District First National Economic Census Leading Group Office and Guangzhou Yuexiu District Statistics Bureau, eds., *Guangzhou Yuexiu District of the first national economic census bulletin in 2008*. Guangzhou Yuexiu District Statistics Bureau (In Chinese), 2010.
- [41] Guangzhou Urban Planning, Design and Survey Institute, *Guangzhou municipal electronic map at Jiedao level*. Unpublished (In Chinese), 2006.