Formation and Delimitation of Extended Metropolitan Regions (Emrs) in Central China: A Case Study in the Changzhutan EMR

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Abstract

The Global Economic Crisis has forced the Chinese government to take domestic demand as an important national development strategy. New EMRs in the inland China are designated by the central government to promote domestic demand. Remarkable among these are the Wuhan, Changzhutan (CZT), and Zhongyuan EMRs. Would these EMRs formed in the inland China share the same spatial characteristics and mechanisms as those in the coastal areas? The paper will first discuss the concept of the EMR and deliberate on the method of their delimitation in China. Using the CZT as a case, this paper demarcates it into the core, inner ring and outer ring through the GIS-based map of the intensity of socio-economic links. This spatial dynamics of each components of the EMR reveals that socio-economic gradients descend from the core to the periphery, such that heavy industries, labor-intensive industries, and transport are largely made in the inner zone, while service activities, including producer services and recreation activities, are located in the core to support the overall role of the EMR as a production and marketing platform especially in linking the region with more developed regions of China. In the meantime, domestic demand and investment, apart from global forces, have played increasing crucial roles in driving these EMRs' formation.

Key Words: Extended Metropolitan Regions; Changzhutan; formation; delimitation; Central China

1. Introduction

The Global Economic Crisis of 2008 has led to new economic dynamics, one of which is that the Chinese government has increasingly realized that the past strategy for achieving economic growth mainly through exports and foreign investments would be neither safe nor sustainable. According to China's 11th and 12th Five-year Plans, developing local demand has been emphasized as the crucial, new national development strategy. Central China has therefore stood out to become a new strategic focus due to its location advantage, being close to China's western and eastern regions. Indeed, it has already enjoyed remarkable economic and urban growth since 2000. A number of extended metropolitan regions have been designated by the central government of China. Noteworthy among these are the CZT EMR in Hunan province, the Zhongyuan EMR in Henan province, and the Wuhan EMR in Hubei province. Especially, the CZT EMR and the Wuhan EMR have been designated as the Reform Experimental Zones for the "two-oriented" society (resource conserving and environmental-friendly) by the State Council and the National Development and Reform Commission, being China's response to the global call for a "low-carbon economy" (SDRC, 2008). These EMRs represent the most attractive development opportunities as well as the most serious challenges that planners and policymakers have to face. Whether we can appropriately make use of these opportunities and formulate policies to solve those problems may well be determined by the appropriate delimitation method.

This paper will first discuss the concept of the EMR and deliberate on the method of their delimitation in China. It will then map out the spatial characteristics of these regions in the Central China and the important role of domestic demand and global forces in their rapid growth using the case of the CZT EMR. Through the GIS-based map of the intensity degree of socio-economic links, this paper demarcates the CZT into the core, inner ring and outer ring.

This spatial dynamics of each components of the EMR would be explored. It argues a new subset of EMRs is under way serving as a production and marketing platform especially in linking the region with more developed regions of China.

2. Grounding Our Understanding by Delimitation of the EMR

Since the 1980s, increased attention has been paid to a region-based urbanization in developing countries that shows significant differences from a city-based and continuous system of urban and suburban areas in developed countries (Geddes, 1915; Gottmann, 1957; McGee, 1991; Ginsburg, 1991; McGee and Greenberg, 1992; Lin, 1994; Sit, 1996, 2001; Zheng, 2009). McGee (1991) presented a model of the spatial configuration of a hypothetical Asian country by the major urban centers, the peri-urban, desakota, densely populated rural, and sparsely populated frontier areas (Figure 1). The Extended Metropolitan Region often incorporates the urban cores, peri-urban zones, and an extensive area of "desakota" with mixed urban-rural land use along the transportation routes. They are later on called as the core, inner and outer zones of the EMR by several studies. Its effective boundary is well beyond the official and statistical definitions of the metropolitan area and has been extended up to 100 kilometers for many Asian cities. (Insert Fig. 1 here)

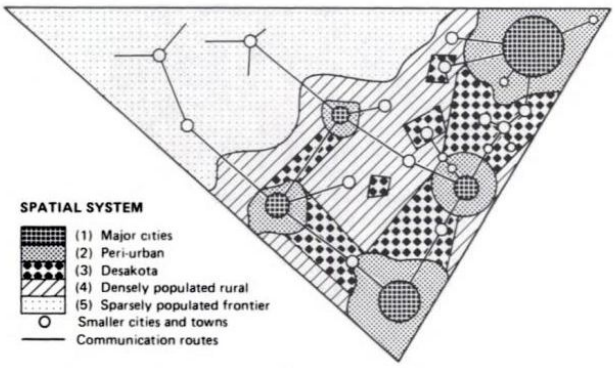

Figure 1 Spatial configuration of an EMR in a hypothetical Asian country

However, there is not much discussion on how to delimitate the EMRs. Most works seemed to only delimit them into two zones and take for granted that the biggest city of one country (as well as the biggest port and capital) is the central city, while the neighboring provinces and counties which take part in the central city's activities could be identified as its peripheral areas. They have been criticized to be not scientific by Sit (2005). Jones et al. (2000) and Mamas et al. (2001) have used the official metropolitan area as the core, while determined boundaries for an inner zone and an outer zone using various criteria in different cases. For instance, in Manila and Taipei, the inner zone was delimited by population density and proportion of employment in primary industry as the main criteria. In China, many scholars used the proportion of non-agricultural population and non-agricultural industrial output as major indexes to delimitate the inner structure of EMRs (Zhao, 1995; Yan, 1997; Ning, 1998; Hu, et. al, 2000; Sit, 2005). Zhou (1989) was the first one to put forward the delimiting standard for China's EMRs. The core city could be identified if the non-agricultural population exceeds 200 thousands.

The peripheral counties could be derived on the basis of non-agricultural GDP, non-agricultural employment, and geographically proximity. This was confirmed in the book, Studies on the spatial agglomeration and dispersion in China's coastal city and town concentrated areas, a more recent collection on mega-urban regions of China (Hu et al., 2000). Yan (1997) delimited the core city and the periphery of the PRD region through non-agricultural population of over 200 thousands and non-agricultural industry output of over 75% of its GDP respectively. Ning et al. (1998) used the proportion of non-agricultural activities (>75%), non-agricultural employment percentage (>60%), and geographical proximity as the indexes to define the peripheral areas of the YRD. Sit (2005), took actualized FDI/GDP, export/GDP, tertiary/GDP as indexes to delimitate EMRs, putting emphasis on the export-oriented feature of its economy. Still, none of these has regarded the connection among the core cities and the peripheral region. Socio-economic links between core cities and surrounding areas have been studied extensively, but little has been applied in the delimitation of EMRs. Most studies applied the fixed gravitational model to represent the socio-economic links between two cities (Russon and Vakil, 1995; Li, 2001; Matsumoto, 2004; He, 2004; Zheng, 2004; Miao and Wang, 2006; Chen, 2008).

This method was challenged, as the distance might not show a linear inverse ratio to the economic link (Li, 2010). Some studies, recently, applied the flows of population, cargo, capital, information, industry, and information, to identify socio-economic links in a region. For instance, Li (2010) collected 2113 questionnaire samples to identify the population flow between two cities in Central Zhejiang urban agglomeration. Luo et al. (2010) considered the economic connection between Shanghai and other surrounding cities through the flows of population, goods and information. Chen and Song (2010) combined the method of improved gravity model and the analyses of the production elements flow between two cities including information flows and passenger flows to define the boundaries of the CZT region. However, the grounding bases of these studies are usually too broad, such that they overlook the significant differences between counties or districts in one municipality. The above research provided many insights on the delimitation of EMRs in China and the measurement of the economic connection between two cities. Considering the availability of data, the paper will apply the index of economic link through population flow to indicate the economic connection between two counties. The population flow measured by transportation conducted in Luo et al. (2010) is believed to serve a good function to identify the economic connection between two cities.

3. The CZT EMR in the New National and Global Settings

The CZT EMR, located in Central China, has been officially designated out of a political strategy in 2006: an urban cluster that contains Changsha, Zhuzhou and Xiangtan as core cities surrounded by Yueyang, Changde, Yiyang, Loudi and Hengyang as the peripheral areas. It is called "three + five" for short.[4] The region has an area of 99,600 km2, comprising 8 prefecture-level cities, 12 county-level cities, 28 counties, and 24 municipal districts (See Figure 2). It is a major economic actor in Hunan province. With 57% of the province's population and 47% of its land area, in 2010 the cluster generated 78% of the province's GDP, 88% of secondary industry, 73% of tertiary industry, 88% of import and export, and attracted 78% of actual utilized FDI (AUFDI). (Insert Fig. 2 here)

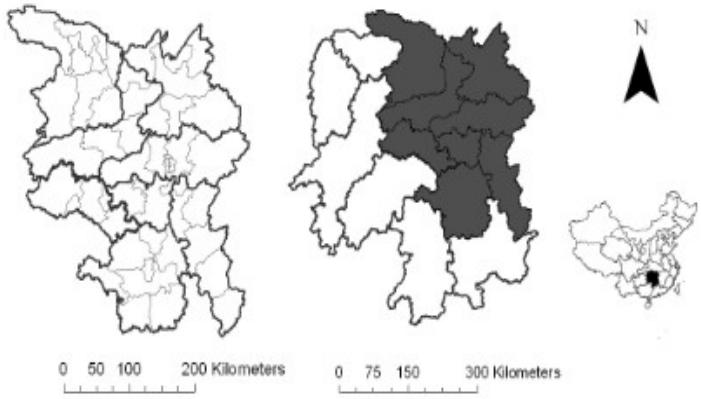

Figure 2 Map of the CZT EMR in Hunan Province

The transformation of this region has been remarkable since 2000 when China's policy started to bias towards interior areas such as the Great Western Development Strategies and the rise of Central China (See Table 1). The local GDP has grown from 2.6 billion yuan in 2000 to 12.6 billion yuan in 2010, with a yearly rate of up to 15% in 2010. Its GDP per capita has grown almost 4 times in this period. In GDP composition, the share of the primary sector has dropped dramatically from 21% in 2000 to 11% in 2010, while the share of the secondary sector has increased from 40% to 52% underlying a dramatic structural change. Meanwhile, investment in fixed assets has increased in 2000-2010 from 21 billion yuan to 755 billion yuan. AUFDI and the total amount of exports and imports have also increased almost 8 times and 6 times respectively in the period. (Insert Table 1 here)

4. Methodology

Considering about the political designation of this region, we would accept the original demarcation of this EMR, i.e. 8 municipalities. To precisely demarcate the component units of this EMR, i.e. the core city and the inner and outer rings, we propose intensity of socio-economic links in 2010 to identify the social-economic links between the core city and its peripheral area.

The intensity of socio-economic links is to be measured by population flow between two administrative spatial units of the CZT. Population flows are usually channeled by trains, long-distance buses, and private cars. With the further integration of the Changsha, Zhuzhou and Xiangtan, inter-city public buses have been put into operation since 2007 and hence have become one of the options for the movement of population in these three cities. Since it is difficult to obtain data on the movements of private cars, passenger data of trains, long-distance buses and inter-city public buses can be used as they are generally available. In general, the capacity for a long-distance bus is 50 persons, while that for a train compartment is 118 persons (Luo et al., 2010). The inter-city public bus has a similar capacity to the long-distance bus, so it is also 50 persons.

The newly operated high-speed train (since 2009) has a capacity for one compartment of 59. We then calculate the operating number (A_{ij}) of buses between city i and j (including long distance and inter-city public bus) per day based on their time table. In terms of train transportation, it is measured in different ways according to the two cities' condition in the train's route. In Luo et al. (2010)'s paper, this condition is divided into four types: (1) starting-terminal stations, (2) starting-way stations, (3) way-way stations, (4) way-terminal stations. We suppose the transportation flow would be two compartments in type 1 and 2, and one compartment for type 3 and 4. The amount of compartment a day for these four types of transportation between city i and j would be B_{1ij}, B_{2ij}, B_{3ij}, and B_{4ij}. In terms of the high-speed railway transportation, because its relatively set timetable, we would assume the capacity has no difference for these four types. The general number of compartment a day for the high-speed railway transportation (C_{ij}) is two. Hence, the population flow (PFij) and intensity of socio-economic links (Eij) between these two cities for one year would be calculated as follows:

$$PF_{ij} = [50*A_{ij} + 59*(B_{1ij} + B_{2ij} + B_{3ij} + B_{4ij} + C_{ij})]*365$$

$$E_{ij} = \frac{PFij}{\sum_{i=1,j=1}^{n} PFij}$$

As the biggest city in the CZT as well as the center of the economy, administration and polities of the province, Changsha Municipal District can be reasonably taken as the core city (Zhou, 2002; He, 2004). Therefore, this study will calculate the population flow and then the intensity of socio-economic links between each administrative unit (district and county) within the CZT with Changsha Municipal District to decide which unit should be included in the core area, inner and outer rings of the EMR. Changsha Municipal District itself is given the highest value. The information of the timetable of bus and train could be found in the internet (daba168.com and qunar.com respectively). It is double checked through the time table in each bus and train station.

We select the following thresholds for the inclusion of administrative units in the relevant parts of the EMR. The core is composed of urban units with significantly higher socio-economic links than other parts of the region, i.e. over three times the average (6.8). The inner ring consists of territorial units with above 0.6 time of the average (1.2), due to its high standard deviation of 3.25. The outer ring includes the rest of the territory of the eight municipalities. As in other studies on EMR delimitation, geographical contiguity is also applied in this study (Zhao, 1995; Yan, 1997; Ning, 1998; Hu, et. al, 2000; Sit, 2005). Those administrative units contiguous to the core or other units within the ring with slightly lesser values may be considered units to be included.

Figure shows that the closer the county is to Changsha municipal district, the higher the intensity of socio-economic links is formed. Not only counties in Changsha like Changsha County, Wangcheng and Ning Xiang are highly connected with the core municipal district, but also the municipal districts of Zhuzhou and Xiangtan. They form the core of the CZT. Six public buses operate specifically to link the municipal districts of Changsha, Zhuzhou and Xiangtan. The latter's connection to Changsha Municipal District is even higher than parts of its own counties like Liuyang which only have an intensity value of 2. The intensity values of higher than 1.2 are formed largely surrounding the core, including counties and districts in Changsha, Zhuzhou, Xiangtan, Hengyang, Loudi, Yiyang, and Yueyang with several exceptions, i.e. Xinxiang, and the municipal districts of Changde and Yueyang. This spatial structure of intensity of socio-economic links reveals that not only counties near the Changsha Municipal District show high socio-economic link, but also the key cities like municipal districts of Yueyang and Changde are also closely linked. Moreover, these administrative units stretch out along the high-speed railway, which explains the higher socio-economic links of Hengyang municipal district, Hengshan, and Biluo. (Insert Fig. 3 here)

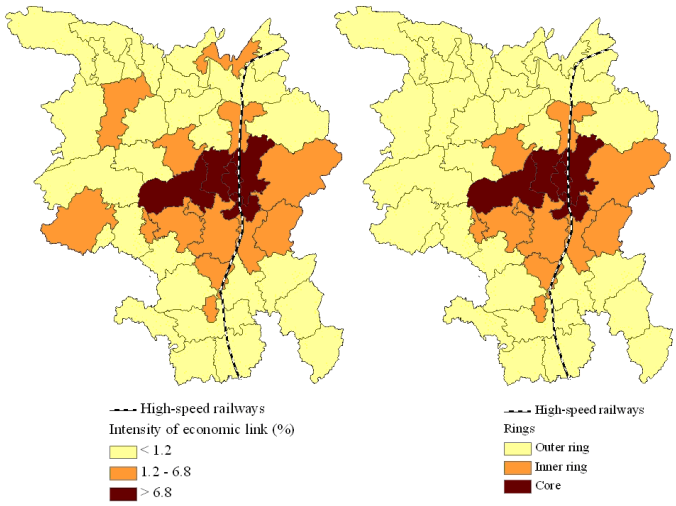

Figure 3. Spatial distribution of intensity of socio-economic links and the delimitation of the EMR

5. The Three Rings of the CZT and Their Spatial Dynamics

The delimitation result is obviously different from the official designation in which the core is composed of the municipalities of Changsha, Zhuzhou and Xiangtan, while the periphery is composed of the other five municipalities, without regard to the actual connection between the smaller units of municipalities.

The core of the CZT is composed of the municipal districts of Changsha, Zhuzhou and Xiangtan, and Changsha County, Wangcheng and Ningxiang of Changsha. It has an area of 7638 km^2 accounting for 8% of the whole EMR, with a population of 7.8 million accounting for 19% of the EMR, while it generated 517bn yuan or 43% of the EMR (in 2010). The inner ring is composed of Liuyang of Changsha, Zhuzhou County and Liling of Zhuzhou, Xiangtan County, Shaoshan and Xiangxiang cities of Xiangtan, municipal districts of Hengyang, Yiyang, Loudi, Biluo of Yueyang. Although municipal districts of Yueyang and Changde, Xinhua County of Loudi also satisfy this criterion, they are not selected in this study because they are not contiguous to the other part of this area. Thus the inner ring has an area of twice the core's and similar population, while it only generated half of the GDP to the core. The other districts and counties of the CZT form the outer ring. This periphery of the EMR has a large range of land area and concentrates a large population respectively 4 times and 3 times the amount of the core. However, it only generated the same amount of GDP as the core.

Table 2 illustrates the general decline from the core to the outer ring in terms of population density, urbanization level, per capita GDP, per capita IFA, and per area FDI. Population density is 2.5 times and 1.1 times higher than the average in its core and inner ring. The urbanization level also decreases from 78% in the core to 53% in the inner ring and further to 37% in the outer ring. The latter is even lower than the provincial and national average. As the economic center of the province, economic productivity in the EMR is mostly concentrated in the core, evidenced by the per capita GDP of 2.2 times the EMR average, while the inner ring and outer ring is decreasing with the value lower than the average. The sharp drop from core to periphery is more obvious in terms of per capita output of the tertiary sector. The core generated per capita output of the tertiary sector more than three times and four times than that in the inner ring and outer ring respectively. It also has a higher capacity to attract IFA and FDI. Thus the per capita IFA and per area FDI are around twice and four times the sum of those in the rings.

Although the inner ring shows a weaker performance in terms of per capita GDP, especially so in tertiary sector, compared to the core, it has achieved higher values in industrial output and export. Per unit GDP industrial output is highest in the inner ring, followed by the outer ring, suggesting the dispersion of manufacturing from the core to the periphery. Similarly, per unit GDP export is highest in the inner ring.

5.1 Tertialization in the Core Area

Changsha, being the province capital, serves as the seat for the provincial government and the center for the finance, business, education and culture of Hunan.

In 2010, the value added by its finance and insurance sector was 13bn yuan, around 28% of total in Hunan. The tertiary sector accounted for 58% of Changsha's GDP, and is mainly concentrated in Changsha's urban districts and the near suburbs. Changsha also leads in terms of education and research in Hunan. There are 48 colleges and universities, accounting for 48% of total in Hunan. Moreover it has 20 key national laboratories, 129 research institutions, 270,000 staff and 43 academicians and a group of well-known scientists. Changsha is also impressive by its cultural and creative industry. Hunan TV located in Changsha is the most influential TV entertainment brand in China and has been named "China's Top 500 Brands". It ranks first in output of animation industry. Enterprises like Great Dreams Cartoon Group and Sanchen Cartoon Group produce original cartoons at a speed of 250,000 minutes per year.

Although of much lesser significance, Zhuzhou and Xiantan municipal districts have also experienced rapid development in finance and insurance recently. In 2011, the sector had a total of 1067 enterprises generating 133.8bn yuan loans and is also highly concentrated in the inner urban districts of Zhuzhou and Xiangtan, where the tertiary sector as a whole contributed to over 34% and 35% of the local GDP respectively. This reflects the public bus has a similar capacity to the long-distance bus, so it is also 50 persons. The newly operated high-speed train (since 2009) has a capacity for one compartment of 59. We then calculate the operating number (A_{ij}) of buses between city i and j (including long distance and inter-city public bus) per day based on their time table. In terms of train transportation, it is measured in different ways according to the two cities' condition in the train's route. In Luo et al. (2010)'s paper, this condition is divided into four types: (1) starting-terminal stations, (2) starting-way stations, (3) way-way stations, (4) way-terminal stations. We suppose the transportation flow would be two compartments in type 1 and 2, and one compartment for type 3 and 4. The amount of compartment a day for these four types of transportation between city i and j would be B_{1ij}, B_{2ij}, B_{3ij}, and B_{4ij}. In terms of the high-speed railway transportation, because its relatively set timetable, we would assume the capacity has no difference for these four types. The general number of compartment a day for the high-speed railway transportation (C_{ij}) is two. Hence, the population flow (PFij) and intensity of socio-economic links (Eij) between these two cities for one year would be calculated as follows:

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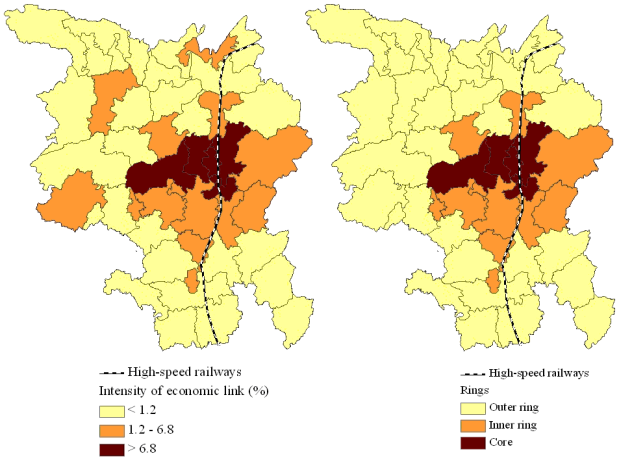

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5.2. Industrialization in the Inner and Outer Rings

The recent process of industrialization, which largely happens in the inner and outer rings, may be seen from three perspectives: industrial restructuring in the EMR, industrial shift from coastal areas of China facilitated by the construction of the high-speed railway, industrial reorganization in the districts within the EMR.

5.2.1. Industrial Restructuring

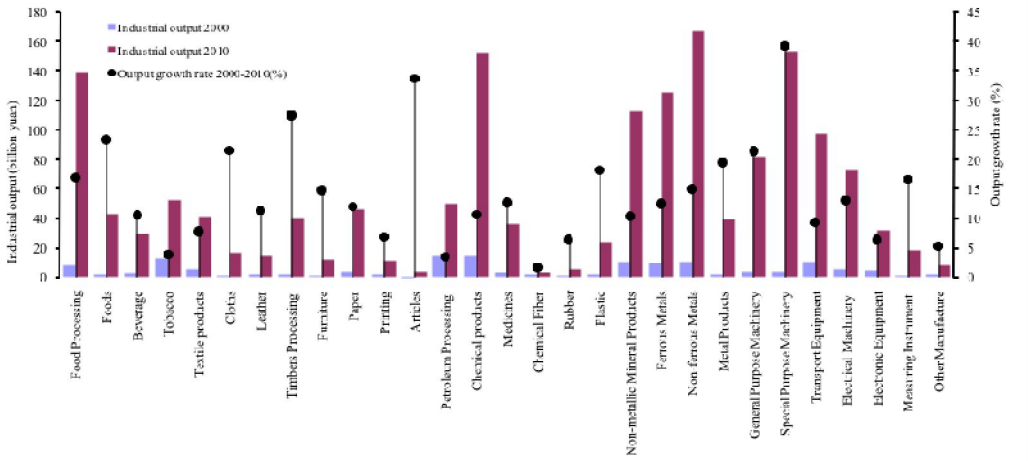
The inner ring, mostly composed of counties in Changsha, Zhuzhou and Xiangtan, is one of the centers of China's national heavy industries. It has been deliberately promoted by the state as regional center for advanced equipment manufacturing, new material, and electronic information for domestic market. Changsha's output of engineering machinery account for one fourth of the total in the country. Until October, 2010, this sector had an output value of more than 120bn yuan. Of these, Sanyi, Zoomlion, and Sunward Groups in total generated two thirds of the country's market value. The machinery products like metal-cutting machine tools are also predominant in the EMR (Table 3). Zhuzhou has been acknowledged as the "the cradle of China's electronic locomotive". It has the industry's biggest manufacturers, China CSR Zhuzhou Electric Locomotive Co. Together with Lince group, Gofront Equipment Corporation, and China Railway Track Corporation, they form an influential concentration of transportation engineering in the national market. The EMR's product plate class accounts for 70% of total in the province. Xiangtan is a pioneer in manufacturing equipment for engineering machinery. The static pile driver produced by New Timehope Corporation occupies 15% of China domestic market.

However, in the outer ring which is composed mostly of the other five municipalities, light industry is its major strength although the production of coal, and chemical medicine are also significant (Table 3). Hengyang and Loudi are important at the production of coal, while Yueyang is important in chemical medicine. Meanwhile, Yueyang surpassed other cities in the production of medicine-made paper, mixed fodder, yarn and edible vegetable oil. Changde has an obvious strength in the production of cloths. (Insert Table 3 here)

5.2.2. Industrial shift

The process of industrialization has been stimulated by a substantial amount of domestic investments came as industrial shift from the coastal areas of China. To achieve balanced regional development in China, the central government has pushed the coastal provinces to shift their processing trade industries into the central and western regions through a series of preferential policies and channels like "Expo Central China". In 2010, the CZT attracted 121bn yuan AUDDI from other provinces, almost 10 times the amount (12bn yuan) in 2002. It accounted for approximately 20% of the total IFA.

In comparison, the CZT has only attracted AUFDI of around 1/6 of AUDDI. In Hunan province since 2003, more than 60% of AUDDI has been invested in the secondary industry. Concomitantly, the gross industrial output has almost grown 10 times, i.e. from 172bn to 1515bn yuan. Figure 4 shows industrial output in 2010 and its growth in the period of 2000-2010. It can be observed that in 2000-2010 the manufactures that registered the rapid growth of higher than 20% are foods, textile and clothing, timber processing, as well as mechanical machinery. We may infer that the major industries that have shifted from other provinces into Hunan are mechanical machinery, timber processing, foods processing, textile and clothing, and electronic digital as identified in some of the governmental reports (DCHP, 2009). (Insert Fig. 4 here)



Note: The growth rate = Industrial Output in 2010/Industrial Output in 2000 -1.
Figure 4. Industrial outputs of major manufacturing sectors in 2000 and 2010

These growing industries have also been the major sources of exports of the EMR. The major exports commodities that account for 40% of total exports of Hunan in 2010 were rolled steel, fireworks and firecrackers, textile yarn, textile and related products, porcelain and pottery ware for household use, electrical apparatus for switching or protecting electrical circuits, unwrought manganese, fresh frozen pork, tea, hand tools and tools for machines, electrocircuit of presswork. Of these products, rolled steel registered the highest growth in 2000-2010, followed by motor vehicles parts and frozen pork. In other words, mechanical products enjoyed the highest growth, followed by foods processing. According to official statistics, mechanical and electronic products have accounted for almost 1/3 of total exports.

5.2.3. Industrial Reorganization

The EMR's industries have been spatially reorganized into the development districts. By 2010, 50 development districts have been established to reorganize the spatial layout of industry development. At present, industrial output and foreign investments have mostly been concentrated in the core and inner ring of the EMR with a share of 72% in terms of total output. In comparison, domestic investment has been largely located in the inner and outer rings. Around 76% of AUFDI has been attracted into the development districts in the core, while more than 63% of AUDDI has been located in the inner and outer rings (Figure 5). Meanwhile, more than 68% of the export value has been generated in the inner and outer rings, of which around 50% is from the inner ring. It indicates that the fastest process of industrialization in the inner and outer rings is largely stimulated by the domestic investment and exports. (Insert Fig. 5 here)

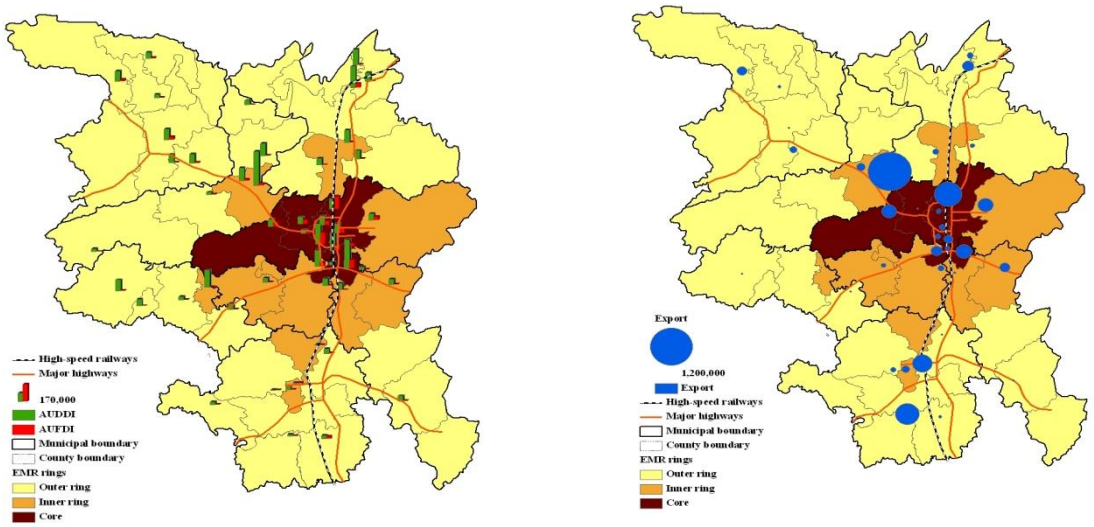


Figure 5. AUFDI, AUDDI, and exports in industrial districts in the CZT, 2010 (unit: yuan)

6. Discussion and Conclusion

This paper has explored the spatial structure of the CZT EMR through the socio-economic links between the core city and the surrounding area intending to provide more perspectives on the development and spatial pattern of EMRs in Central China. The delimitation result shows obvious difference from the official definition. There is a general decline that has occurred from the core to the outer ring in the key socio-economic indicators of population density, urbanization level, per capita GDP, per capita IFA, and per area AUFDI. This fits the traditional assumption of EMRs in developing countries, which indicates the method of socio-economic links in this study is applicable and may be further applied in future case studies for other mega-urban regions in China or developing countries.

These spatial dynamics in the EMR reveals that the socio-economic gradient descends from the core to the periphery, such that heavy industries, labor-intensive industries and international trade are largely located in the inner and outer rings. However, service activities, especially producer services, are located in the core city to support the overall role of the EMR as a production and marketing platform in linking the EMR with overseas markets and more developed regions of China. In addition, domestic investment and demand, apart from global forces, has played increasing roles in driving EMR formation in Inland China. Given these roles, the search for an efficient method to harness domestic and global forces is of particular importance for regional competition and to avoid potential risks in its economy and environment. In future year the economic development with more capital and technology input as well as environmental preservation in the process of industrial growth will be increasingly the predominant trends. Therefore policies for the EMR development should be based on careful analyses of the geographical extent of such urban-regions formations.

References

Chen, Q. and Song, Y. (2010). Methods of dividing the boundary of urban agglomerations: Chang-zhu-tan urban agglomeration as a case. Scientia Geographica Sinica, 30(5): 660-666.

Chen, Keda (2008). A study on economic cooperation of the Changzhutan region. Master Thesis. Hunan: Hunan Normal University.

Geddes, P. (Eds.) (1915). Cities in Evolution. London: Williams and Norgate.

Ginsberg, N. (1991). Extended Metropolitan Regions in Asia: A new spatial paradigm. In N. Ginsberg, B. Koppel and T.G. McGee (Eds.), The Extended Metropolis: Settlement Transition in Asia (pp. 93-108). Honolulu: University of Hawaii Press.

Gottmann, J. (1957). Megalopolis, or the urbanization of the northern seaboard. Economic Geography, 33: 189-200.

He, J. (2004). The Research on Structural Character and Structural Optimizing of Changzhutan Urban Agglomerations. Hunan: Hunan University. Master thesis (in Chinese).

Hu, X. W., Zhou, Y. X. and Gu, C. L. (2000). Studies on the Spatial Agglomeration and Desperation in China's coastal City-and-Town Concentrated Area. Science Press, Beijing (in Chinese).

Jones, G. W., et al. (2000). Demographic and employment change in the mega-cities of South-East and East Asia, Third World Planning Review, 22(1): 1-28.

Li, G., Wang, L., Yang, K. (2001). The measurement and analysis of economic relationship between Shenzhen and Zhujiang Delta Economic Geography, 21(1): 33-37.

Li, W. (2010). Structural characteristics in Central Zhejiang Urban Agglomeration based on regional connection analysis. Master Thesis. Zhejiang University.

Lin, G. C. S. (1994). Changing theoretical perspectives on urbanization in Asian developing countries. Third World Planning Review, 16: 1-23.

Luo, S., Jin, F., Huang, R. (2010). The measurement of economic flow of Shanghai Metropolitan Regions. Economic Geography, 30(1): 80-85.

Mamas, S. G. M, Jones, G. and Sastrasuanda, T. (2001). A zonal analysis of demographic change in Indonesia's megacities. Third World Planning Review, 23(4): 155–174.

Matsumoto, H. (2004). International urban systems and air passenger and cargo flows : some calculations. Journal of Air Transport Management, 10: 241—249.

McGee, T. G. (1991). The emergence of desakota regions in Asia: expanding a hypothesis. In: N. Ginsberg, B. Koppel and T.G. McGee (Eds.), The Extended Metropolis: Settlement Transition in Asia (pp. 3-25). Honolulu: University of Hawaii Press.

Miao, C. and Wang, H. (2006). On the direction and intensity of urban economic contacts in Henan Province. Geographical Research, 3: 222-232.

Ning, Y. M. (1998). New urbanization process: on China's urbanization dynamics and characteristics. In: X. Xu, F. Xue and X. Yan (Eds.), China's rural-urban transition and coordinated development (pp. 201-207). Beijing: Science press (in Chinese).

Russon, M. G., Vakil, F. (1995) Population, convenience and distance decay in a short—haul model of United States air transportation. Journal of Transport Geography, 3(3): 179-185.

SDRC (State Development and Reform Council) (2008). The notice on designating Wuhan and the CZT EMR. [Online] Available: http://wh2xsh.wh.gov.cn/gjwj/2008/08/04110953.html (7 January, 2011).

Sit, V. F. S. (1996). Mega-city, Extended Metropolitan Region, Desakota, and Exourbanziation: An introduction. Asian Geographer, 15: 1-2.

Sit, V. F. S. (2001). Increasing Globalization and the Growth of the Hong Kong Extended Metropolitan Region. In F.C. Lo and P.J. Marcotullio (Eds.), Globalisation and Sustainability of Cities in the Asia Pacific Region (pp. 199-238). Tokyo: UNC Press.

Sit, V. F. S. (2005). China's Extended Metropolitan Regions: Formation and delimitation. International Development Planning Review, 27(3): 297-332.

Sit, V. F. S. and Yang, C. (1997). Foreign-investment-induced exo-urbanziation in the Pearl River Delta. Urban Studies, 34(4): 647-678.

Yan, X. P., Guo, J. G. and Hu, Y. B. (1997). A study of the dynamics of Guangzhou, Hong Kong, Macao megalopolis. Geographical Research, 16(2): 22-29 (in Chinese).

Zhao, Y. G. (1995). Formation, development and implication of the metropolitan interlocking region in China. Geography and Territorial Research, 11(1): 15-22 (in Chinese).

Zheng, G., Zhao, Q. (2004) Research on the main direction of economic contact of Shandong. Areal Research and Development, 23(5): 92-96.

Zheng, Y. et al. (2009). Regional concentration and region-based urban transition: China's mega-urban region formation in the 1990S. Urban Geography, 2009, 30, (3): 312–333.

Zhou, G. H., Tang, C. L. and Zhu, X. (2002). A Study on the form mechanism of the urban system in Changsha-Zhuzhou-Xiangtan. Human Geography, 17(3):13-17 (in Chinese).

Table 1 Economic indicators of the CZT EMR and their shares

Item	2000		2010	
	Total amount	Share in Hunan province (%)	Total amount	Share in Hunan province (%)
Population (10000)	3918.8	59.7	4008.16	56.5
Built-up land area (square km)	462.4		793.26	
GDP (100 million yuan)	2589.1	70.1	12558	78.3
GDP per Capita (yuan/person)	6606.7		31842.85	
Primary Industry	550.24	70.1	1444.11	62.1
Secondary Industry	1028.82	79.6	6491.75	88.4
Tertiary Industry	1010.02	68.6	4622.95	72.6
Investment in Fixed Assets (100 million yuan)	213	52.7	8266.05	84.2
AUFDI (USD 10000)	53506	78.5	407830	78.7
Export and import (USD 10000)	239145	95.2	1297079	88.3

Source: Hunan Statistical Yearbook 2001, 2011.

Table 2 Structure and economic indicators of the CZT EMR

	Core	Inner ring	Outer ring
Administrative units (counties and districts)	Municipal districts of Changsha, Zhuzhou and Xiangtan, Changsha county, Wangcheng, and Ningxiang	Liuyang, Zhuzhou county, Liling, Xiangtan county, Shaoshan, Xiangxiang, Biluo municipal districts	Rest of the CZT
Area (sq. km)	7638 (8)*	17881 (18)*	71359 (74)*
Population (10 thousands persons)	778 (19)*	797 (20)*	2444 (61)*
GDP (100m yuan)	5167.8 (43)*	2231.5 (19)*	4612.8 (38)*
Population density (persons/sq. km)	1018 (2.5)☆	446 (1.1)☆	342 (0.8)☆
Urbanization Level (%)	78 (1.6)☆	53 (1.1)☆	37 (0.8)☆
Per capita GDP (yuan)	66453 (2.2)☆	27995 (0.9)☆	18878 (0.6)☆
Per capita output of tertiary sector (yuan)	28491 (2.5)☆	8641 (0.8)☆	6609 (0.6)☆
Per capita IFA (yuan)	39729 (2.7)☆	13175 (0.9)☆	7038 (0.5)☆
Per area AUFDI (US$ per sq. km)	24 (6.3)☆	5 (1.4)☆	1 (0.3)☆
Export per unit GDP (US$ per 10000 yuan)	41 (1.0)☆	54 (1.3)☆	35 (0.9)☆
Per unit GDP Industrial output (%)	111 (0.9)☆	147 (1.2)☆	133 (1.1)☆

Source: Hunan Statistical Yearbook 2011

*Bracketed figures with * are its percentage in the CZT.*

Bracketed figures with ☆ are location quotients (LQs) of average value.

Table 3 Output of major industrial products of cities and prefectures

City and Prefect	Metal-Cutting Machine Tools (unit)	Cigarettes (10 000 cases)	Cement (10 000 tons)	Plastics (ton)	Plate Class (10 000 weight cases)
Total*	3904	350.55	8691.20	482880	1756.20
Changsha	2963	128.03	1461.96		19.20
Zhuzhou			524.61	151709	1241.62
Xiangtan			650.04		0.33
Hengyang			741.81		
Yueyang	89		359.13	245778	0.26
Changde		97.91	941.85	9400	90.71
Yiyang	852		589.94		35.53
Loudi			702.28		
City and Prefect	Steel Products (10 000 tons)	Steel (10 000 tons)	Pig Iron (10 000 tons)	Chemical Medicine (ton)	Coal (10 000 tons)
Total*	1811.73	1766.52	1700.64	6442.1	7670.12
Changsha	9.42		3.37		419.69
Zhuzhou	6.53		26.96	93.04	884.51
Xiangtan	641.64	719.61	686.23		87.06
Hengyang	127.32	121.10	1.37	23.26	1503.83
Yueyang	0.71		0.40	4099	
Changde		0.06		258.8	146.42
Yiyang	27.62				36.60
Loudi	933.20	921.28	885.96		1453.26
City and Prefect	Machine- made Paper and Paperboard (10 000 tons)	Mixed Fodder (10 000 tons)	Yarn (10 000 tons)	Cloth (100m meters)	Edible Vegetable Oil (10 000 tons)
Total*	384.63	993.73	78.53	4.65	219.31
Changsha	21.36	108.84	3.64	0.03	5.65
Zhuzhou	2.21	168.66	3.95	0.09	1.63
Xiangtan	6.70	8.49	3.34	0.44	10.24
Hengyang	16.60	90.22	1.26	0.08	5.33
Yueyang	109.30	340.87	27.57	0.20	145.74
Changde	40.09	107.09	18.31	1.96	30.23
Yiyang	56.37	39.20	8.32	0.43	6.82
Loudi		3.32	0.44		0.05

Source: Hunan Statistical Yearbook 2011
**Total in Hunan province*