

Analysis on Competitiveness of Regional Central Cities: the case of Yangtze River Delta

Xiaolin Pang, Xiaolong Chen, Bingjie An, National Bureau of
Statistics of China

Central cities have both agglomeration function and radiation function. They play a key role in promoting regional even national economic development by aggregating capital, technology and human resources from other places and radiating economic dynamic, industry structure, advanced technology to the surrounding areas. It not only has practical significance but also has policy implication to analyze competitiveness of central cities in promoting economic growth of a region.

In this paper, we will analyze competitiveness of central cities by building a comprehensive indicator system. First we will define the concept of central city and its competitiveness, then review growth pole theory on which our study base, discuss the mechanism of regional central cities' competitiveness function, build a comprehensive indicator system according to the central cities' function to their region. Then we take central cities in Yangtze River

Delta as an example case to analyze their competitiveness and affect factors.

1. Definition of central city and its competitiveness

1.1 Definition of central city

Central city has been widely discussed in recent years while urban agglomerations and Metropolitan areas formed. In some western countries, central city is defined as one or two cities which have the largest population or location advantage among a group of adjacent, economy-related cities and towns. It plays a leading role around these areas concerning economy, society and culture development. Nowadays, large cities such as New York, London, Tokyo and Paris are generally accepted central cities all over the world.

The concept of central city was introduced into China in 1980's. In China, central city means a big or medium-sized city which has such comprehensive function or some kinds of leading function to attract various production factors and to radiate advanced productivity to economic hinterland that it is indispensable to economic and social development of a region or a nation. Central city is classified into

nation-level, regional-level, province-level and prefecture-level and so on.

1.2 Definition of regional central city competitiveness

Regional central city competitiveness is a relative strength compared with other central cities in promoting regional social and economic development. It includes influence, promote strength and radiation strength.

2.Theory review

Experts of urban economics and spatial economics have been focusing on the study of cities' contribution to the regional economic development for decades. Certain influential theories and models were created, some of which have been adopted by policy makers when they make regional planning policies. Of all these theories, growth pole theory which was first brought forward by French economist François·Perroux attracted most attention and is widely applied in policy making. Growth pole theory is regarded as one of the basis of western regional economics and foundation of imbalance growth theory.

Growth pole was first introduced by François Perroux in 1950, was further sharpened in his following publications, and finally evolved into an idea that came to take on a meaning rather different from the one posited by Perroux. Growth pole refers to the concentration of highly innovative and technically advanced industries that stimulate economic development in linked businesses and industries. The core idea of the theory is that economic development, or growth, is not uniform over an entire region, but instead takes place around a specific pole. This pole is often characterized by a key industry around which linked industries develop, mainly through direct and indirect effects. The expansion of this key industry implies the expansion of output, employment, related investments, as well as new technologies and new industrial sectors. Because of scale and agglomeration economies near the growth pole, regional development is unbalanced. Transportation, especially transport terminals, can play a significant role in such a process. The more dependant or related an activity is to transportation, the more likely and strong this relationship.

While Perroux had conceived a growth pole to be a focus of economic development in an abstract economic space, it was interpreted by his disciples, particularly Jacques Boudeville, to be a

focus of development in geographic space, an idea that was readily adopted by regional planners and economic geographers who were pressed into making economic development plans on a regional scale. Some interpreters even take central cities as growth poles of a region economy. Therefore, the development of a region completely depends on the development of central cities.

3.Mechanism of regional central city competitiveness

Central cities dominate an important economic position in a region, function as economic engine to a region economy. So central cities could be characterized as growth pole. The competitiveness of central cities mainly depend on the role they play in driving regional economy development.

3.1 Economic core function

As a leader and promoter of regional economic development, the central cities can improve the coordinate development of regional economy function as economic core to their region. Central cities account for a large part of economy of their region and their economy growth rate exceed the average level of their region, concentrate excellent human resources, advanced industry structure

and technology, supply convenient transportation and telcommunication facilities. They are representatives of advanced productivity in their region. It's basic characteristic of central cities that they play an example and radiation role to surrounding areas.

3.2 Agglomeration function

Relying on their advantages over economy of scale, location advantage, market capacity, service level, convenient transportation, telcommunication, well-developed infrastructure and comfort living condition, central cities attract resources, information, human resources, production factor, economic activity from other areas in their region. In light of agglomeration effect , central cities can achieve economy of scale to increase efficiency and reduce cost.

3.3 Radiation function

When central cities reach economy of scale and their market capacity is saturated, they must export their output and service to outside areas , the surrounding areas certainly are the best choice. By exporting production factors and services to surrounding areas

central cities can narrow the disparity between them to arrive new balance of regional economy.

3.4 Innovation function

With all kinds of advanced production factors , central cities supply an innovation environment to exploit new technology, new technique, create new thinking and ideas, invent new products and service, explore new industry development path and model to promote their economy develop quickly and consolidate their core position. Through their radiation effect , central cities spread the innovation to surrounding areas to help them improve their competitiveness.

3.5 Foreign exchange function

Central cities function as promotion and radiation effect to surrounding areas inner their region and as window and cutting-edge of foreign exchange. In cooperation with foreign countries, central cities introduce advanced production method and management ideas to their region, participate in international division of labor and cooperation, improve opening-up level and stimulate regional export-oriented economy develop.

4. Indicator system building and methodology

4.1 Indicator system building

In recent years, Most Chinese researchers studied urban competitiveness and strength using objective indicators covering economy, society, culture, environment and infrastructure construction. The comprehensive indicators only differ in indicator classify and weight determination according to different aim of study.

Considering the growth pole theory and mechanism of regional central cities' competitiveness and the limitation of data, we choose 33 indicators classified into a hierarchy of 2 levels to measure the competitiveness of central cities: the highest level include five categories indicators concerning "economic core", " polarization function", "radiation function", "innovation function", "foreign exchange function". The lowest level comprises 33 statistical indicators. The classifications of the indicator system are given in Table 1.

Table 1 Indicator system of competitiveness of regional central cities

Economic Core Function	Per capita GDP	X ₁
	Growth rate of GDP	X ₂
	Ratio of value added of tertiary industry to GDP	X ₃
	Government revenue per capita	X ₄
	Saving Deposits of Urban and rural Residents at year-end	X ₅
	Gross industrial output value per capita	X ₆
	Total retail sales of consumer goods per capita	X ₇
	Fixed assets investment per capita	X ₈
	Per capita disposal income of urban households	X ₉
Agglomeration Function	Total population	X ₁₀
	Ratio of employed persons of tertiary industry to all the employed persons	X ₁₁
	Number of public vehicles of bus and trolley bus per 10 000 population	X ₁₂
	Business volume of postal and telecommunication services per capita	X ₁₃
	Area of roads per capita	X ₁₄
	Per capita building space areas	X ₁₅
	Green land per capita	X ₁₆
Number of doctors per 10 000 population	X ₁₇	

	Proportion of persons covered by the Basic pension insurance of employment	X ₁₈
	Total volume of cargo movements	X ₁₉
	Total volume of passengers	X ₂₀
	Broadband Internet connections households per 10000 population	X ₂₁
Radiation Function	Number of persons using mobile phone per 10000 population	X ₂₂
	Total sales of wholesale and retail enterprises above designated size	X ₂₃
	Total value of export	X ₂₄
	Number of regular institutions of higher education per 10 000 population	X ₂₅
Innovation Function	Number of students in regular institutions of higher education per 10 000 population	X ₂₆
	Expenditure of R&D	X ₂₇
	Number of accepted patents applying	X ₂₈
	Technology workers per capita	X ₂₉
Foreign Exchange Function	Total value of export	X ₃₀
	Amount of actual usage of foreign capital	X ₃₁
	Number of foreign tourists	X ₃₂

4.2 Analyzing method

Multitudinous statistical methods are applied to assess comprehensive indicator system. All the methods can be classified into qualitative analysis and quantitative analysis according to different way of weight determination. Qualitative analysis such as analytical hierarchy process and delphi technique method is easily affected by subjective factors resulting in exaggerating or reducing effects of some indicators. Quantitative analysis such as principal component analysis and factor analysis determines weight by compute correlation and coefficient of variation of indicators so as to avoid the influence of subjective factors.

In order to keep the final result objective and accurate, we adopt principal component analysis method to measure the relationship of indicators selected. We execut principal component analysis in SPSS Statistics 17.0.

5. Positive Analysis

5.1 Data sources and processing

We choose to research central cities (prefecture-level and above city) in the Yangtze River Delta which comprises 16 central cities located in Shanghai municipality, Jiangsu and Zhejiang provinces. Regarded as a well-developed economy, Yangtze River Delta was an across provinces economy-related region first established in China. In 2009, GDP of 16 central cities in Yangtze River Delta is 36.09 billion Yuan, increased by 13.0% compared to the year before, 0.7 percent higher than the national average level, make up 18.6% of all the 287 prefecture-level and above cities in China. Therefore, evaluating competitiveness of central cities in Yangtze River Delta is meaningful to further study of other regional central cities.

The data comes from “urban social and economic situation statistics” of National Bureau of Statistics of China. We choose data of the 16 prefecture-level and above cities (excluded counties under the jurisdiction of such cities) in Yangtze River Delta, replacing missing data with data of last year multiply its growth rate.

Firstly, standardize data to ensure all the data is comparable.

Secondly, we copied data of the 16 central cities into SPSS to conduct principal component analysis to get total initial eigenvalues, percentage of variance, the cumulative percentage of variance given in table 2 and component matrix. The first 5 components account for more than 85% of cumulative variance, so we choose the 5 components as the principal components.

Table 2 Initial eigenvalues, percentage of variance and cumulative variance

Component	Initial eigenvalues	% of Variance	Cumulative %
1	15.56	47.16	47.16
2	5.39	16.33	63.49
3	3.38	10.24	73.73
4	2.62	7.95	81.68
5	1.94	5.88	87.55

Thirdly, from the results of component matrix, we note that the coefficients of components are not clear to explain. It's necessary to rotate the axis to maximize the variance of the 'new' component, while minimizing the variance around the initial component. Execute varimax orthogonal rotation to attain rotated eigenvalues, Percentage

of rotated variance, cumulative rotated variance (see Table 3) and matrix of rotation (see Table 4).

Table 3 Rotated eigenvalues ,Percentage of Rotated Variance and Cumulative Rotated Variance

Component	Rotated eigenvalues	% of Rotated Variance	Cumulative Rotated Variance %
1	11.86	35.94	35.94
2	6.40	19.40	55.34
3	3.89	11.78	67.12
4	3.48	10.55	77.67
5	3.26	9.89	87.55

Table 4 Matrix of Rotation

	1	2	3	4	5
Saving deposits of urban and rural residents at year-end	0.98	0.09	0.12	0.04	-0.09
Total population	0.97	0.06	0.08	0.15	-0.06
Total sales of wholesale and retail enterprises above designated size	0.96	0.09	0.15	0.09	-0.14
Amount of actual usage of foreign capital	0.96	0.23	0.04	0.03	0.04

Number of foreign tourists	0.95	0.16	0.14	0.04	0.07
Expenditure of R&D	0.95	0.19	0.09	0.06	0.18
Total volume of cargo movements	0.93	0.06	0.19	0.03	-0.17
Broadband Internet connections households	0.92	0.26	0.22	-0.05	-0.03
Total value of import	0.89	0.19	0.09	-0.09	0.34
Total value of export	0.82	0.26	0.15	-0.10	0.42
Government revenue per capita	0.75	0.59	0.11	0.02	0.14
Number of accepted patents applying	0.74	0.35	0.11	-0.08	0.50
Gross industrial output value per capita	0.23	0.90	-0.10	-0.06	0.29
Fixed assets investment per capita	-0.03	0.83	-0.32	0.17	0.12
GDP per capita	0.20	0.81	-0.05	0.02	0.45
Technology workers per capita	0.40	0.78	0.13	0.30	0.06
Proportion of persons covered by the basic pension insurance of employment	0.22	0.75	0.49	0.12	-0.12
Number of public vehicles of bus and trolley bus per 10000 population	0.21	0.70	0.39	0.41	-0.02
Number of doctors per 10000 population	0.12	0.67	0.55	0.27	-0.10
Number of persons using mobile phone per 10000population	0.20	0.67	0.62	0.07	0.27
Total retail sales of consumer goods per	0.47	0.64	0.31	0.24	0.33

capita					
Per capita disposable income of urban households	0.49	0.29	0.73	0.11	0.12
Ratio of value added of tertiary industry to GDP	0.61	0.03	0.63	0.34	-0.04
Growth rate of GDP	-0.22	0.14	-0.90	0.10	0.07
Total volume of passengers	0.13	0.37	0.46	0.36	0.46
Number of regular institutions of higher education per 10000 population	-0.02	0.17	-0.12	0.94	0.05
Number of students in regular institutions of higher education per 10000 population	0.01	0.24	0.32	0.84	0.06
Green land per capita	0.46	-0.04	0.03	0.73	0.27
Per capita building space areas	0.14	-0.16	0.00	-0.72	0.21
Area of roads per capita	-0.27	0.07	-0.10	0.15	0.82
Ratio of employed persons of tertiary industry to all the employed persons	0.45	-0.11	-0.43	0.15	-0.65
Business volume of postal and telecommunication services per capita	0.19	0.11	0.04	-0.08	0.45

Fourthly , standardized scores multiply by rotated matrix are scores of principal components (see Table 5).

Finally, according to the principal componet analysis, we can build a comprehensive evaluate indicator function (see below) to measure competitiveness of regional central cities, of which the 5 principal components are function as independent variables and percentage of rotated variances function as coefficient.

$$Z=0.35936Y_1+0.19401Y_2+0.11782Y_3+0.10549Y_4+0.09885Y_5$$

5.2 Analysis of results

5.2.1 Analysis of components

It's suggested in Table 4 that coefficients of saving deposits of urban and rurual residents at year-end, total population, total sales of wholesale and retail enterprises above designated size, amount of actual usage of foreign capital, number of foreign tourists, expenditure of R&D, total volume of cargo movements, broadband Internet connections households, total value of import, total value of export, government revenue per capita, number of accepted patents applying score highly on component 1. The list of indicators reflects

economic dynamism of the central cities. The higher the score is, the more dynamic the economy is and the faster the economy grows.

Indicators such as gross industrial output value per capita, fixed assets investment per capita, GDP per capita, technology workers per capita, proportion of persons covered by the basic pension insurance of employment, number of public vehicles of bus and trolley bus per 10000 population, number of doctors per 10000 population, number of persons using mobile phone per 10000 population, total retail sales of consumer goods per capita have high score on component 2. These indicators represent comprehensive development strength of central cities. The higher the score is, the stronger the comprehensive development strength is.

Comparatively high score on component 3 got by per capita disposable income of urban households, ratio of value added of tertiary industry to GDP, growth rate of GDP, total volume of passengers. They implicate quality of residents' life. Higher score suggest higher life quality.

Indicators such as number of regular institutions of higher education per 10000 population, number of students in regular institutions of

higher education per 10000 population, green land per capita, per capita building space areas score higher on component 4. The indicators reflect social resources per capita. Higher score indicates better social development.

Indicators area of roads per capita, ratio of employed persons of tertiary industry to all the employed persons, business volume of postal and telecommunication services per capita reflecting the quality of social service score highly on component 5.

5.2.2 Analyzing the final Comprehensive scores

We can conclude from the final score that Shanghai get the highest score followed by Suzhou, Ningbo, Hangzhou and Nanjing, etc. Besides Shanghai municipality, Jiangsu and Zhejiang provinces share the same proportion of the five strongest central cities of Yangtze River Delta. The rank suggest that the layout of Yangtze River Delta is forming, of which Shanghai is surely the core and Suzhou, Nanjing of Jiangsu province, Ningbo and Hangzhou of Zhejiang province is the two swings.

5.2.2.1 Shanghai as an international metropolitan deserves the core of Yangtze River Delta. Shanghai scores highest and leaves other cities far behind it. For further insight, we can see that Shanghai scores highest on component 1 and component 3, which suggest its highest economic dynamism and quality of life of resident among Yangtze River Delta.

5.2.2.2 From Table 5 demonstrates that Suzhou in Jiangsu province and Ningbo in Zhejiang province surpass their capital city Nanjing and Hangzhou respectively, making bigger contribution to push on the regional economic development. It suggest that the competitiveness of a central city in a region more relates to the contribution it makes to the region than its political position. Also we can conclude from Table 5 that Ningbo scores higher than Hangzhou only on component 2, but it ranks higher than Hangzhou. It suggest that although competitiveness score integrates indicators of different aspects, significant development in certain aspect can finally influence the final result.

5.2.2.3 From cities' different rank on different componet, it can be concluded that central cities develop imbalance. Take Shaoxing for example, it ranks 8 both on component 1 and component 2, but it

ranks 4 or 5 on the last three components. The result soundly proves growth pole theory. All the central cities proceed in the light of local conditions, exploiting their own particular advantages for mutual benefit and development.

Table 5 Component scores , comprehensive scores and rank of competitiveness of central cities

City	Component 1 Score	Component 2 Score	Component 3 Score	Component 4 Score	Component 4 Score	Compre -hensive score	Rank
Shanghai	41.31	11.56	9.22	2.16	3.21	18.72	1
Suzhou	10.04	11.34	2.95	1.21	11.46	7.42	2
Ningbo	5.37	13.10	6.73	3.66	1.95	5.84	3
Hangzhou	7.93	8.37	6.82	5.04	-0.10	5.80	4
Nanjing	4.52	1.87	1.73	9.72	0.59	3.27	5
Wuxi	2.38	7.70	0.41	0.62	4.99	2.96	6
Shaoxing	-4.75	-0.03	3.85	3.35	1.53	-0.75	7
Changzhou	-3.01	1.24	-2.94	-1.20	-1.27	-1.44	8
Jiaxing	-5.73	-2.42	0.72	-0.50	-1.73	-2.67	9
Zhenjiang	-7.46	-3.95	-6.45	-0.44	-1.07	-4.36	10
Yangzhou	-7.66	-5.25	-5.47	-2.65	-2.89	-4.98	11

Zhoushan	-7.33	-7.73	-1.25	-2.31	-6.17	-5.13	12
Nantong	-7.45	-7.67	-5.83	-4.14	-2.62	-5.55	13
Taizhou	-7.40	-10.51	0.74	-6.86	-2.28	-5.56	14
Huzhou	-9.98	-9.66	-2.88	-4.29	-3.53	-6.60	15
Taizhou	-10.81	-7.96	-8.35	-3.37	-2.09	-6.97	16

6. Conclusion

In this paper, we choose 33 indicators to build a comprehensive indicator system to evaluate competitiveness of central cities in Yangtze River Delta. Execute Principal component analysis in SPSS with the values of 33 indicators chose to calculate comprehensive score of each cities and rank them according to the score. The result suggests that the comprehensive indicator system is valid and is available to evaluate the other regional central cities. The analysis also proves or deepen growth pole theory that not only cities develop imbalance but also a city develop imbalance in different aspects. It's valuable for regional planners and regional policy-makers to compare competitiveness of regional central cities as the method allow them to wei-gh development disparity and explore advantages of these cities.

Because the indicators are selected subjectively according to the function of central cities to their region and also considering to the limitation of the data source, the indicator system maybe not very accurate and reasonable which could be improved in future studies.