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Evaluation of Talent Attraction in New First-Tier Cities – Based on Entropy Weight Matter-Element Theory

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Abstract: Talent is a strategic asset of urban development, and it is a component of the comprehensive competitiveness of cities. Under the background of increasing competitions for talents in various places, it is particularly important to scientifically and objectively evaluate the attraction of urban talents. On the basis of constructing a comprehensive evaluation index system of urban talent attraction, the weight of evaluation index is determined by entropy weight method to establish the evaluation model. Based on the panel data of 10 new first-tier cities in Chengdu, Hangzhou, Nanjing, Wuhan, Tianjin, Xi'an, Chongqing, Qingdao, Shenyang, and Changsha from 2017 to 2019, the entropy weight matter-element model is constructed to measure and evaluate the talent attraction in new first-tier cities. Countermeasures and suggestions for urban talent absorption and management are put forward in this paper.

Keywords: Urban talent attraction; Entropy weight method; Matter element theory; Comprehensive assessment

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1. Introduction

Knowledge has given birth to a new round of thinking on urban development strategy. There is no doubt that talents play a key role in this game of urban competitiveness. The change in China's population structure is forcing big cities to seek new ways to compete for talents under the pressure of aging and declining demographic dividend. In 2017, Wuhan, Changsha, and other cities took the lead in introducing policies to encourage the introduction of talents. So far, the "competition for talents" has started with high profile in various cities. In 2019, Xi'an started allowing national talents with bachelor's degree and college students to settle down directly, with no age limit set. In the same year, Qingdao issued a one-off payment policy of 100,000 yuan as settling-in expenses for postgraduates. In 2020, Hangzhou issued full-time undergraduate and junior college degrees, in which students can settle down after paying social security for one month. Coincidentally, these cities with the first echelon joining in the battle for talents all have a common label – "new first-tier cities."

The concept of new first-tier cities is new and relative to first tier cities. It was first proposed by China Business Weekly (now, known as YiMagazine) in 2013. It mainly uses brand data according to five indicators: business resource agglomeration, urban hub, urban people's activity, lifestyle diversity, and future plasticity. The user behavior data of internet companies and the big data of data institutions are ranked from 337 cities above prefecture level in China. Fifteen cities are selected based on the index data every year to generate a list. This paper selects 10 cities in the list of new first-tier cities since 2017,

calculates the weight of measurement indicators through entropy weight method, and uses the matter-element theory to evaluate and rank the talent attraction of the aforementioned cities, in order to explore which indicators are sensitive to new first-tier cities, so as to provide administrative suggestions for local talent attraction.

2. Literature review

The attraction of urban talents is a hot issue in many disciplines, and existing literatures have expressed the purport of this issue. The related research shows three characteristics. First, the multi-disciplinary nature of research entry and perspective. For example, from the perspective of comfort theory in the field of economics, some scholars have summarized the problems that need to be focused on and solved to enhance the attraction of urban talents [1,2]; some have used spatial economics based on the idea of "with or without comparison" and factor analysis to test the talent attraction of stations and cities along the Wuhan-Guangzhou high-speed railway [3]; others have used the transportation channel theory and center periphery theory to explore the internal relationship between transportation and urban development as well as urban employment attraction [4]. Second, focus on the diversity of city types. For example, study the talent attraction of single cities, such as Shenzhen and Wuhan, or explore the key factors affecting the level of talent attraction by taking the province as a unit. There are many scholars who are trying to put forward a universal evaluation method of urban talent attraction, which is verified by the data of provincial capital cities. However, although these data are rich and complex, there is a lack of attention to the talent attraction of new first-tier cities [5-10]. Third, most research methods are based on statistical reasoning. At present, the research on the attraction of urban talents mostly adopts mathematical and statistical methods, such as factor analysis and cluster analysis, along with SPSS data processing technology. The index weight is determined by subjective weighting methods, such as expert scoring method and AHP analytic hierarchy process. There is no fixed way to determine the classic domain and section domain. Although some scholars have begun to introduce objective weight methods such as entropy weight method, the evaluation of urban talent attraction only stays in the ranking based on the score of the entropy weight method, and the objective classification of urban talent attraction index has not been studied step by step.

In view of this, this paper first introduces the matter-element theory into the urban attraction evaluation and creatively converts the index value into the objective evaluation result grade combined with the entropy weight method. In this way, the weight obtained by the entropy weight method can be used for the final evaluation of the matter-element theory, or the results of dimensionless data processing by the entropy weight method when the classical domain and node domain are determined by the matter-element theory, specifying the range of classical domain and node domain between [0.1], which not only facilitates calculation and analysis, but also maintains the authenticity of data to the greatest extent.

3. Research methods and theoretical basis

3.1. Constructing an evaluation index system

Although the list of new first-tier cities has existed for eight years now, due to the influence of the concept of "National Central City," the evaluation indicators are constantly updated and unstable, and the publishing media are not unified, resulting in the unavailability of the list data in short term. Until 2017, the "Research Institute of New First-Tier Cities" was officially established, with stable data evaluation indicators, unified media, and continuity. Therefore, this paper has collected and sorted out the new first-tier cities from 2017 to 2019, selected cities that have been included in the list of new first-tier cities every year, and removed those that have not been selected yearly. The new first-tier cities in 2017-2019 are shown in **Table 1**.

Table 1. List of new first-tier cities in 2017-2019

Year	New first-tier cities
2017	Chengdu, Hangzhou, Wuhan, Nanjing, Chongqing, Tianjin, Suzhou, Xi 'an, Changsha, Shenyang, Qingdao, Zhengzhou, Dalian, Dongguan, and Ningbo
2018	Chengdu, Hangzhou, Chongqing, Wuhan, Suzhou, Xi 'an, Tianjin, Nanjing, Zhengzhou, Changsha, Shenyang, Qingdao, Ningbo, Dongguan, and Wuxi
2019	Chengdu, Hangzhou, Chongqing, Wuhan, Xi 'an, Suzhou, Tianjin, Nanjing, Changsha, Zhengzhou, Dongguan, Qingdao, Shenyang, Ningbo, and Kunming

After sorting out, ten cities including Chengdu, Hangzhou, Nanjing, Wuhan, Tianjin, Xi'an, Chongqing, Qingdao, Shenyang, and Changsha are retained as the research samples. As the aforementioned cities have been continuously selected as new first-tier cities in the list during the sample period, the index data has the characteristics of continuity and stability, which facilitates the construction of balanced panel data.

3.2. Constructing an evaluation index system of urban attraction

Combing relevant research literatures on urban attractiveness, it is not difficult to find that in the selection various evaluation indicators of urban talent attractiveness, scholars unanimously believe that the level of economic development, urban environment, and living conditions are the three most commonly referred factors. Therefore, based on existing research results [12], this paper further solicits the opinions of job-hunting college students and experts. Finally, five secondary indicators (e.g., economic development) and 10 tertiary indicators (e.g., per capita regional GDP) are determined. The details are shown in **Table 2**.

Table 2. The evaluation index system of urban talent attraction

Primary indicator	Secondary indicators	Tertiary indicators
Evaluation index system of urban talent attraction	Economic development	C1: GDP per capita (yuan)
		C2: Investment in fixed assets (100 million yuan)
		C3: Per capita disposable income of urban residents (yuan)
		C4: Unemployment rate (%)
	Urban environment	C5: Green coverage rate in built-up area (%)
		C6: Number of hospitals (one)
	Cultural hygiene	C7: Ordinary institutions of higher learning (institutions)
	Living conditions	C8: Average selling price of residential commercial housing (RMB/m^2)
		C9: Consumer price index (%)
	Career platform	C10: Number of high-tech enterprises (individual)

3.3. Entropy weight method and matter-element model

Entropy weight method is a tool to calculate the weight of each index by using information entropy and to provide basis for multi-index comprehensive evaluation. According to the basic principles of information theory, information is a measure of the degree of order of a system, while entropy is a measure of the degree of disorder of a system. The greater the degree of dispersion of an index, the smaller the information entropy, the smaller the amount of information provided by the index, the smaller the role it plays in comprehensive evaluation, and the lower the weight should be [13]. Based on this feature of information entropy, when the degree of dispersion of the same index between different cities is greater, the smaller the information entropy, the smaller the amount of information provided, and the lower the weight of the index is set. The

evaluation of urban talent attraction is a complex project reflecting the characteristics of individual differences. Therefore, this paper uses the entropy weight method to calculate and determine the weight of all the indicators, so as to avoid the interference of human subjectivity as much as possible, thus reflecting the utility value of index entropy more accurately.

Matter element theory was put forward in the 1980s. It transforms the incompatible problems in reality into compatible problems. Considering the incompatibility between the value of each index and the attraction of urban talents, the matter-element theory is used to convert the original data of each urban talent attraction index into the correlation degree of the evaluation grade; the maximum membership principle is then used to determine the final attraction grade of each index; finally, it forms an objective evaluation of the talent attraction of the city.

4. Examples of the application of urban talent attraction evaluation

Based on the original data of the indicators of 10 sample cities that are processed dimensionless along with the calculation process of the entropy weight method, the weights of the tertiary indicators in the evaluation system of urban talent attraction from 2017 to 2019 (**Table 1**) can be obtained, as shown in **Table 3**.

Table 3. Tertiary index weight of urban talent attraction evaluation system in 2017-2019

Year	Evaluating indicator	Index weight	Evaluating indicator	Index weight
2017	C1	0.1196	C6	0.1207
	C2	0.1198	C7	0.1011
	C3	0.1313	C8	0.1281
	C4	0.0111	C9	0.0128
	C5	0.1188	C10	0.1367
2018	C1	0.1177	C6	0.1176
	C2	0.1210	C7	0.1038
	C3	0.1272	C8	0.1262
	C4	0.0111	C9	0.0128
	C5	0.1279	C10	0.1348
2019	C1	0.1251	C6	0.1231
	C2	0.1277	C7	0.1083
	C3	0.1359	C8	0.1288
	C4	0.0120	C9	0.0139
	C5	0.1070	C10	0.1182

According to the dimensionless treatment of the measured values of each city and each evaluation index, the degree of correlation between the evaluation indexes of 10 sample cities and the corresponding evaluation grades under the principle of maximum membership can be found as shown in **Table 4**, **Table 5**, and **Table 6**.

Table 4. Degree of correlation of talent attraction evaluation grades in 10 new first-tier cities in 2017

Evaluating indicator	Degree of correlation				Grade
	Excellent	Good	Average	Poor	
C1	-0.6000	-0.4000	0.1999	-0.1428	Average
C2	-0.3382	-0.0073	0.0145	-0.3317	Average
C3	-0.6277	-0.4415	0.1170	-0.0948	Average
C4	0.3333	-0.3333	-0.6667	-0.7778	Excellent
C5	-0.4074	-0.1111	0.2222	-0.3044	Average
C6	-0.5619	-0.3428	0.3144	-0.1930	Average
C7	-0.9188	-0.8783	-0.7565	0.2435	Poor
C8	-0.8185	-0.7278	-0.4555	0.4555	Poor
C9	-0.2000	0.3333	-0.3333	-0.5556	Good
C10	-0.7016	-0.5524	-0.1048	0.1048	Poor

Table 5. Degree of correlation of talent attraction evaluation grades in 10 new first-tier cities in 2018

Evaluating indicator	Degree of correlation				Grade
	Excellent	Good	Average	Poor	
C1	-0.5547	-0.3321	0.3358	-0.5547	Average
C2	-0.4423	-0.1635	0.3269	-0.2869	Average
C3	-0.3966	-0.0949	0.1898	-0.3092	Average
C4	0.2105	-0.7895	-0.8947	-0.9298	Excellent
C5	-0.3657	-0.0486	0.0971	-0.3218	Average
C6	0.0000	-1.0000	-1.0000	-1.0000	Excellent
C7	-0.1919	0.3115	-0.3443	-0.5628	Good
C8	-0.8400	-0.7601	-0.5201	0.4799	Poor
C9	-1.0000	-1.0000	-1.0000	0.0000	Poor
C10	-0.2664	0.4296	-0.2148	-0.4765	Good

Table 6. Degree of correlation of talent attraction evaluation grades in 10 new first-tier cities in 2019

Evaluating indicator	Degree of correlation				Grade
	Excellent	Good	Average	Poor	
C1	-0.2761	0.3834	-0.1917	-0.4611	Good
C2	-0.4195	-0.1293	0.2586	-0.2986	Average
C3	-0.6237	-0.4355	0.1290	-0.1025	Average
C4	-0.4453	-0.1680	0.3360	-0.2852	Average
C5	-0.1945	0.3184	-0.3408	-0.5605	Good
C6	-0.5654	-0.3481	0.3037	-0.1889	Average
C7	-0.3171	0.1334	-0.0667	-0.3171	Good
C8	0.4372	-0.7186	-0.4372	0.4372	Poor
C9	-0.4074	-0.1111	0.2222	-0.3044	Average
C10	-0.3097	0.1861	-0.0931	-0.3954	Good

5. Analysis of the evaluation results and policy recommendations

5.1. Analyzing the trend change of talent attraction of new front-tier cities in 2017-2019

In this paper, the degree of correlation of talent attraction evaluation grades of new first-tier cities in 2017-2019 is numerically summarized according to the principle of maximum membership. The graph drawn by MATLAB is shown in **Figure 1**.

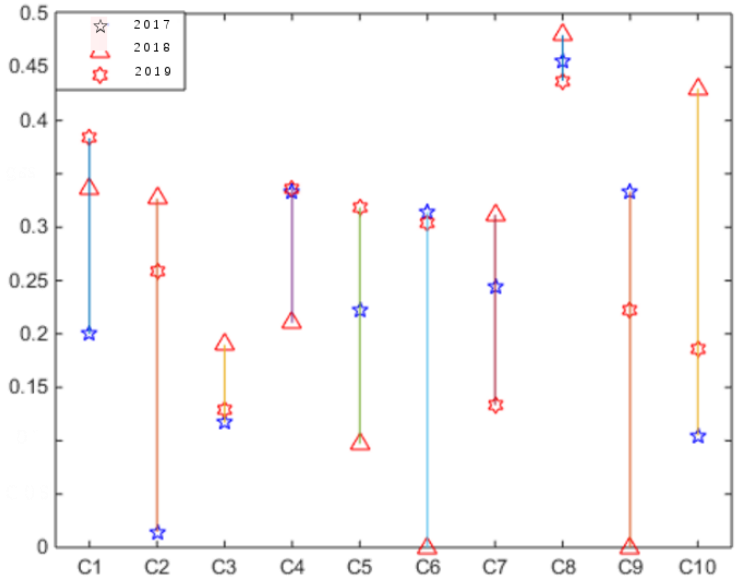

Figure 1. Summary chart of the degree of correlation of talent attraction evaluation grades in new first-tier cities from 2017 to 2019

By comparing the degree of correlation of talent attraction evaluation grades of 10 new first-tier cities, it can be seen that in the talent attraction model of new first-tier cities, the correlation degree of "poor" gradually decreases, while the correlation degree of "good" gradually increases, indicating that the talent attraction of new first-tier cities shows an increasing trend with the passage of time in the data period.

(1) The evaluation grade of C1 (per capita GDP) changed from "average" to "good." Observing the per capita GDP of 10 cities in 2017 to 2019, it can be seen that each city has increased in different degrees. As per capita GDP is the key indicator to reflect the macro-economic development of cities, we can infer that the macro-economic development of new first-tier cities has a positive influence on the attraction of talents.

(2) The impact of C4 (unemployment rate) on talent attraction is worthy of attention. The index changed from "excellent" in 2017 and 2018 to "average" in 2019. Further analysis showed that the unemployment rate in most of the 10 new first-tier cities is slowly decreasing and fluctuating. It can be seen that unemployment rate, as a key index to measure the employment saturation of a city, may become a key factor that directly affects the decline of talent attraction in new front-tier cities.

(3) The attraction of C5 (greening coverage rate of built-up areas) to talents has changed from "average" in 2017 and 2018 to "good" in 2019, indicating that the greening coverage rate of built-up areas in new first tier cities has increased to attract talents. In June 2018, the State Council issued a three-year action plan for tackling air pollution. The cities responded positively and took measures to improve the environment, such as car restrictions and increasing green areas. The efforts of urban environmental policies are further reflected in the effectiveness of attracting talents. Since 2019, the attraction of urban environmental indicators to talents has been improving.

(4) The degree of correlation of C8 (average selling price of residential commercial housing) has been "poor" over the three years, indicating that the average selling price of residential commercial housing in new first-tier cities has never been attractive to talents. The reason is that most of the new first-tier cities are provincial capitals or municipalities with relatively developed economy, and their property prices are generally higher than those of second-and third-tier cities. Therefore, it is obviously less attractive for talents with limited income.
(5) The degree of correlation of C10 (number of high-tech enterprises) has changed from "poor" in 2017 to "good" in 2018 and 2019, indicating that the number of high-tech enterprises in new first-tier cities is increasingly attractive to talents. Taking Chengdu as an example, the number of new technology enterprises in 2018 was three times more than that in 2017. Coupled with the agglomeration effect of the development of high-tech industries, the accumulation of talents has formed a reasonable and effective talent resource structure, which promotes the mutual utilization of human capital elements along with ideological and technological innovation, thus gradually increasing the attraction to talents.

5.2. Policy recommendations

First, seize the advantages and continue to expand the attractiveness of new first-tier cities in terms of per capita GDP, environmental greening, educational resources, and high-tech industries. Provide convenient and efficient settlement policies to attract talents to settle down. Appropriately increase the income of talents and provide employment subsidies as supplement to ensure that they are higher than the inflation rate, so as to effectively stimulate domestic demand and promote high-quality growth of per capita GDP. Beautify the urban environment and improve the level of public services and infrastructure. Pay attention to the gathering effect of high-tech industries on talents and the development of local colleges and universities. Vigorously set up high-tech industrial parks, create a high-speed and professional incubation environment, set up information exchange platforms in various parks, break the connection barriers between innovation subjects in the parks, strengthen exchanges and cooperation, promote collaborative production, as well as improve the innovation vitality and efficiency of the city. Secondly, change the weak and improve the competitiveness of new first-tier cities in terms of unemployment rate, medical conditions, and consumer prices. Introduce large enterprises to settle down and encourage innovation and entrepreneurship. Paying attention to living security after talent introduction and changing the one-off subsidy into medium and long-term small subsidies will not only reduce the sunk cost of brain drain after the subsidy is issued, but also resist the negative effect of difficult medical treatment and high prices on talent attraction to a certain extent. Finally, pay attention to property prices and retain talents. As the destination of young people in the city, houses play an important role in retaining talents. As the housing prices in new first-tier cities are higher than that in second- and third-tier cities, the average sales price index of residential commercial housing is lacking in the attempt to attract talents. Cities should actively introduce more strategies and measures to solve housing problems.

6. Shortcomings and prospects

This study was a bold attempt to combine the entropy weight method with matter-element theory to conduct quantitative research on the attraction of urban talents. There are several aspects that require improvement and should be promoted in follow-up research. First, when establishing the index system, exploratory research methods such as grounded theory can be used to trace the source of the index. Formulate universal evaluation indicators for the attraction of urban talents completely originating from the thematic position of the parties. Secondly, in follow-up studies, it would be beneficial to increase the number of cities and introduce more years for longitudinal time series research. Finally, adopting more scientific methods is the direction that still needs exploration and excavation in future research.

Disclosure statement

The author declares no conflict of interest.

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