Study on the coupling relationship between the transformation ability of resource based cities and urban resource pressure-- take Taiyuan as an example

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Abstract: Resource-based city as a special existence, it is very different from the economic structure and population structure of ordinary cities, China's economy has entered a new era, from the stage of rapid growth to the stage of high- quality development, require continuous optimization of industrial structure, constantly improve economic benefits. At the same time, with the advent of the era of experience, consumer demand is rapidly upgrading to a niche, personalized transformation. The ever-changing external environment has put forward new requirements on the speed, structure, mode and quality of the development of resource-based enterprises. Through the research on the coupling relationship between urban transformation capacity and urban resource pressure, this paper can objectively reflect the coordinated development degree of taiyuan's transformation capacity and resource pressure from 2013 to 2018, and provide scientific basis for taiyuan's future economic transformation. Through the factor analysis method, the urban transformation pressure and urban resource pressure of taiyuan from 2013 to 2018 were measured, and the coupling degree and coupling coordination degree models were analyzed. From 2013 to 2018, the transformation capacity of taiyuan increased year by year, and the resource pressure also increased year by year, but the coupling between the two declined year by year. This shows that there is a serious imbalance between the development of taiyuan's ability to transform and the development of resource pressure. Due to the slowdown of domestic economic growth, the economy continues to decline, leading to the reduction of industry competition intensity, less market noise, is a good opportunity for transformation. Taiyuan should carry out economic development on the premise of protecting the environment, and pay attention to the coupling between urban transformation ability and urban resource pressure in the future development path, so as to realize the coordinated development of transformation ability and resource pressure.

1. Study area overview

Shanxi Province is China's important coal base, known as the hometown of coal and iron, rich coal and iron and other mineral resources used to be the important foundation of shanxi's industrial start and economic development. However, excessive reliance on the high yield of the resource sector and long-term concentration of investment in the resource sector lead to a single industrial structure and a serious imbalance in the economic structure in shanxi. Coupled with the backward concept of resource-based enterprises in Shanxi Province, their sustainable development path is increasingly difficult, and their competitive advantages gradually disappear, so it is urgent to find a breakthrough, build sustainable competitive advantages, and build a new core value network. Taiyuan is a typical resource-based city. It used to be an important industrial town in north China, and located in the middle of the "coal sea", taiyuan once became an outstanding city of resource-based economic development. This mode of economic development has brought great pressure to taiyuan's economic structure, ecological environment and urban layout.

2. The research methods

2.1 Data sources and standardized processing

The sample data in this paper are all from the statistical yearbook of taiyuan (2013-2018), statistical bulletin of taiyuan's national economic and social development (2013-2018), and statistical yearbook of Shanxi Province (2013-2018). In order to eliminate the influence caused by different dimensions, we need to conduct standardization processing for each indicator data:

$$X^{*}=(X-u)/\sigma$$

X* is the normalized value; X is the original value of the index; U is the average value of the index data; Sigma is the standard deviation of the index data.

2.2 The evaluation index system of urban transformation ability was established

At present, the characteristics of structural overcapacity as "supply failure" are the characteristics of the new normal economy in our country, especially in behind the high input, low output of heavy pollution industry as a pillar industry of the performance is more outstanding in the resources city, on the supply side structural reforms is to break the supply "failure" dilemma and prompted the development of the positive transformation of resources city. Therefore, following the principles of scientificity, systematization, universality, feasibility and objectivity, this paper constructs the evaluation index system of urban transformation ability from four aspects of high-quality labor supply, resource supply, capital supply and environment supply. The specific evaluation index system is shown in table 1.

Table 1 evaluation index system of urban transformation ability

Level indicators	The secondary indicators	**Meaning**
The labour of supply	The number of graduates of secondary vocational education	reflects the quality of the supply of middle labor force
	The number of graduates from higher education	reflects the supply of higher labor force in that year
The resource of supply	The total annual supply of water	reflects the situation of urban tap water supply
	Industrial electricity consumption	reflects the power supply of industrial enterprises
	The use of natural gas	reflects the supply of natural gas in cities
The capital of supply	Capital supply the whole society fixed capital investment	reflects the city fixed assets Investment scale,reproduction capacity
	The proportion of output value of secondary industry	reflects the development level of urban secondary industry
	Exports	reflect the level of foreign economic development
The environment of supply	Environmental supply of high-tech enterprises	reflects the capacity of urban science and technology development
	The air pollution composite index	reflects the degree of air pollution
	Green space area	reflects urban green space supply capacity

(1)Urban transformation capacity calculation

Factor analysis model, as an important method in multivariate statistical analysis, can interpret data sets through dimensionality reduction to explore the potential factors that play a leading role among various related variables. In this paper, SPSS.23 software was used to measure the indicators of urban transformation ability to measure its impact on urban transformation ability. The calculation methods of common factor weight and comprehensive evaluation score are as follows

$$M=a_1+a_2+a_3+.....a_n$$

$$VarZ = \sum(a_i/M)z_i$$

Where, n represents the number of common factors, a_i represents the contribution rate of common

factors, M represents the sum of the contribution rates of each common factor, z_i is the characteristic value of common factors, and a_i/M represents the weight of common factors.

(2) Urban resource pressure calculation

The urban resource pressure index (URSI) was introduced to measure the urban resource pressure of ya 'an city. The urban resource pressure index is composed of four sub-indexes: land resource pressure index (LRSI), human resource pressure index (HRSI), water resource pressure index (WRSI) and electricity resource pressure index (ERSI), which are calculated according to the following formula:

$$URSI = LRSI * W1 + HRSI * W2 + WRSI * W3 + ERSI * W_4$$

Among them, the land resources pressure subindex (LRSI) expressed in urban per capita land area, land area is proper and the municipal districts at the end of the ratio of total population, human resources pressure subindex (HRSI) using the proportion of the tertiary industry practitioners and city than the value of the proportion of secondary industry practitioners, water stress index (WRSI) using the ratio of the total water supply for the whole year and at the end of municipal district population, electricity resources pressure index (ERSI) using industrial electricity consumption per capita.

(3) Coupling model

Let F(x) and G(x) be the comprehensive index values of the evaluation function of urban transformation capacity and urban resource pressure, respectively. The coupling degree model is as follows:

$$C=\{F(x)\times G(x)/[F(x)+G(x)]\}^{1/2}$$

(4) Coupling coordination degree model

$$D=(C\times T)^{1/2}\ T=aF(x)+bG(x)$$

Where C is the coupling degree; D is the degree of coupling coordination. The degree of coupling coordination reflects the high and low level of coupling coordination between urban transformation ability and resource pressure. T is the overall benefit evaluation index of urban transformation ability and resource pressure, with undetermined coefficient score and coefficient satisfaction $\alpha + \beta = 1$. Although urban transformation ability is a positive indicator and urban resource pressure is a negative indicator, the impact on the city is equally important, so $\alpha = \beta = 0.5$.

According to the actual development level of taiyuan city, the coupling and coordination degree between urban transformation ability and urban resource pressure is divided into 5 grades (table 2) : $0 < G \leq 0.30$, low coupling level and serious imbalance stage; $0.30 < G \leq 0.45$, lower coupling level and mild disturbance stage; $0.45 < G \leq 0.55$, intermediate coupling level and barely coordinated stage; $0.55 < G \leq 0.80$, high coupling level and intermediate coordination stage; $0.80 < G \leq 1.00$, high coupling level and good coordination stage.

3. Dynamic analysis of urban transformation ability and resource pressure in taiyuan

3.1 Analysis on the development of urban transformation ability

Through factor analysis, it was found that the common degree of the 11 indicators was above 88%, and there was a significant correlation between variables ($P<0.001$). Since the initial factor load matrix is not enough to reflect the load level of variables on the common factor, orthogonal rotation is used to obtain the rotated factor load matrix, and finally the eigenvalues and contribution rates of the three common factors calculated by the factor model are obtained (table 3). In the variable correlation matrix, the contribution rates of the three common factors are 38.431%, 34.431% and 23.382%, respectively. The cumulative contribution rates are 96.244%, and the eigenvalues are all greater than 1. The first public factor, medium and secondary vocational education, natural gas usage, green space area, high-tech enterprises and fixed capital investment in the whole society, has a large factor load, which reflects the joint effect of high-quality labor supply, resource supply, environment

supply and capital supply. In the second public factor, the proportion of the output value of the secondary industry, the export value, the comprehensive air pollution index and other factors are larger, which reflects the joint effect of capital supply and environmental supply. In the third public factor, the number of graduates from higher education, total annual water supply and industrial electricity consumption load are relatively large, which reflects the joint effect of high-quality labor supply and resource supply.

Table 2 total variance explanation table

Common factor	The eigenvalue	contribution/%	Cumulative contribution rate/%
1	6.896	38.431%	38.431%
2	2.491	34.431%	72.862%
3	1.200	23.382%	96.244%

By combining the eigenvalues and contribution rates of the common factors, the weights of the three common factors can be calculated as 0.40, 0.36 and 0.24, respectively. The comprehensive score of urban transformation ability can be obtained by multiplying the factor scores of each year and the weight of public factors (figure 1), revealing the fluctuation trend of urban transformation ability, resources and capital supply, high-quality labor supply and environmental supply and other first-level indicators in taiyuan from 2013 to 2018. Taiyuan, as the capital of Shanxi Province, is a typical resource-based city. From 2013 to 2018, urban transformation capacity showed an increasing trend year by year, with the greatest influence of public factor 1 (0.40). Combined with the data obtained, it can be seen that the number of employees in the tertiary industry increased year by year from 2013 to 2018, while the number of employees in the secondary industry showed a u-shaped curve from 2013 to 2018, which is consistent with the results of taiyuan's vigorous development of leisure agriculture and rural tourism in recent years. Shanxi Province will hold a promotion conference on leisure agriculture and rural tourism in 2019, increasing the number of employees in the secondary industry. However, the proportion of the output value of the secondary industry in the total output value decreased year by year from 2013 to 2018. In addition, the number of secondary education graduates decreased year by year from 2013 to 2018, on the contrary, the number of higher education graduates increased year by year, indicating that the supply of labor force is developing in the direction of quality. Taiyuan has also set up many eco-industrial parks, such as wanbailin west mountain wanmu eco-park, yuquan mountain eco-park, etc. Before these places, due to small coal mining, garbage dumping and other reasons, the vegetation on the mountain has been destroyed, soil and water loss is serious, garbage bags flying everywhere. When it's sunny, it's dusty and smelly, and when it's raining, it's muddy and dirty. Now it has become the largest urban ecological park in taiyuan. With the government's huge investment in environmental protection, taiyuan's transformation capacity is also increasing year by year.

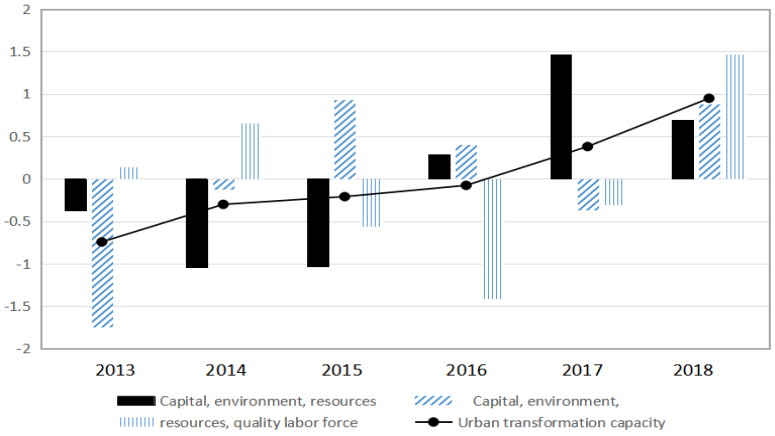

Figure 1 comprehensive evaluation value of taiyuan's urban transformation capacity from 2013 to 2018

3.2 Analysis of urban resource pressure development

Can be seen from the figure 2, there is an upward trend in taiyuan city resources pressure 2013-2017 of taiyuan city resources pressure through the steep rise - down - up stage, in 2017 after a slow decline phase, the pressure fluctuation of taiyuan city resources is very strong, taiyuan and did not form a sustainable measures to reduce the pressure for resources, have the very big uncertainty. The pressure of land resources is alleviated, which is related to the obvious expansion of built-up area in taiyuan, while the slow growth rate of population alleviates the pressure of land resources. However, the pressure of human resources is increasing year by year, which is the relationship between the increase of employees in the tertiary industry and the decrease of employees in the secondary industry. To sum up, the urban resource pressure in taiyuan is high and difficult to reduce.

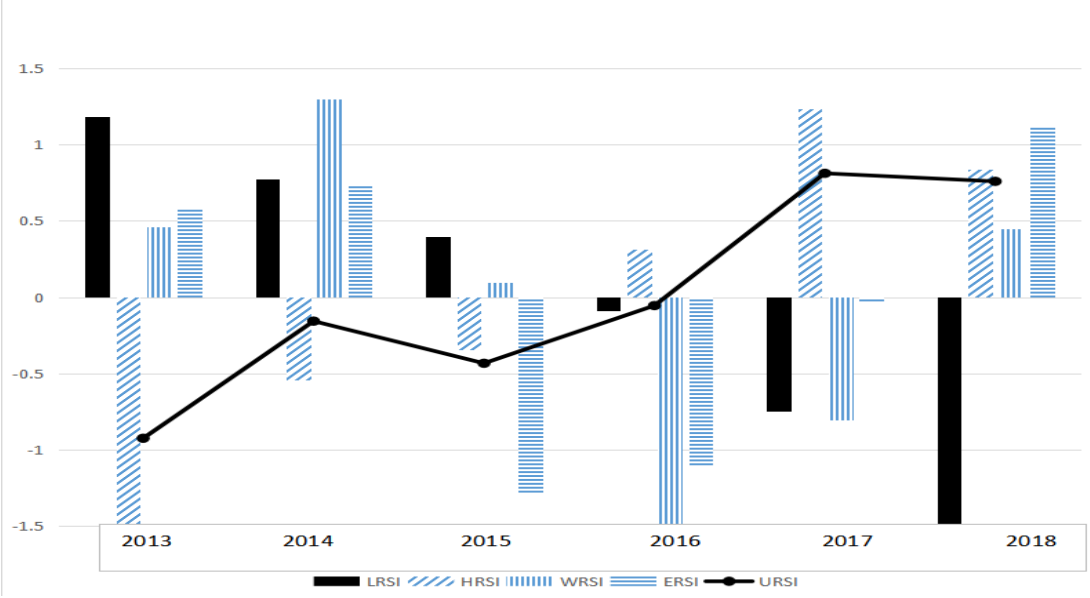

Figure 2 comprehensive evaluation value of urban resource pressure in taiyuan from 2013 to 2018

4. Study on the coupling relationship between urban transformation ability and urban resource pressure

4.1 Coupling analysis

The coupling degree between urban transformation ability and urban resource pressure has changed from high coupling level to low coupling level, and the low coupling level is becoming more and more serious. The degree of coupling coordination also went through the intermediate coordination phase -- the poor coordination phase -- the mild dysregulation phase -- the severe dysregulation phase, with a tendency toward more severe dysregulation, with a decline of 66%.

Table 3 coupling degree and coordination degree of urban transformation ability and urban resource pressure in taiyuan during 2013-2018

Time	2013	2014	2015	2016	2017	2018
The coupling	0.64	0.22	0.27	0.11	0.13	0.07
Coupling level	Higher coupling level	Low coupling level	Low coupling level	Low coupling level	Low coupling level	Low coupling level
Degree of coupling coordination	0.80	0.47	0.52	0.33	0.36	0.27
Degree of coupling coordination Level	Intermediate coordination stage	Barely coordinated stage	Barely coordinated stage	Stage of mild disorder	Stage of mild disorder	Stage of severe disorder

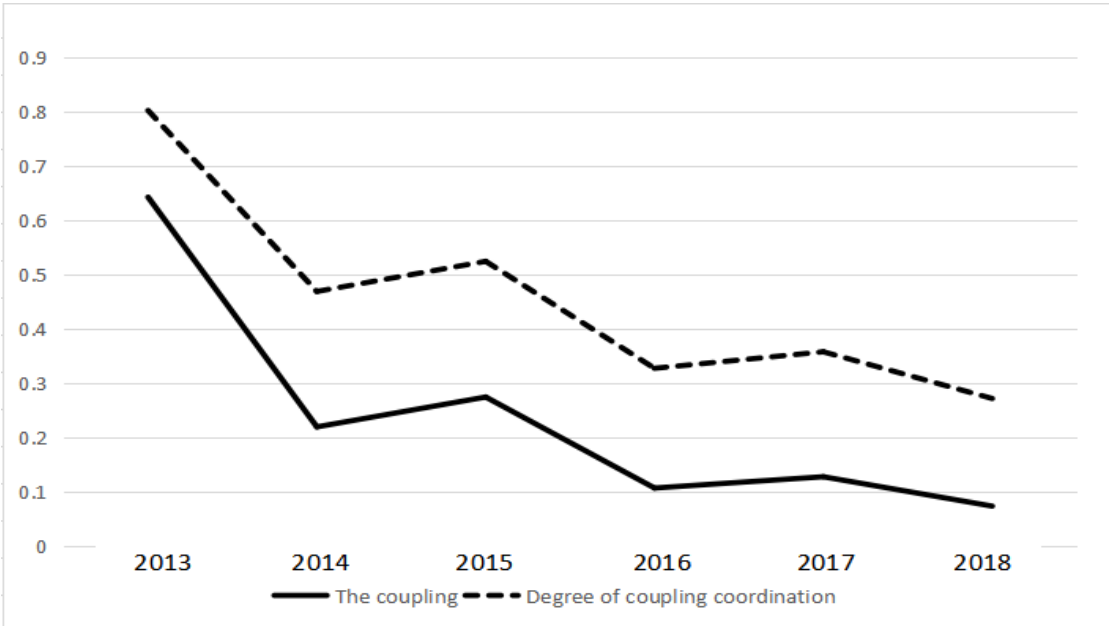

Figure 3 variation trend of coupling degree and coupling coordination degree in taiyuan from 2013 to 2018

5. Conclusion and discussion

From 2013 to 2018, the transformation capacity of taiyuan increased year by year, and the resource pressure also increased year by year, but the coupling between the two declined year by year. This shows that there is a serious imbalance between the development of taiyuan's ability to transform and the development of resource pressure. Taiyuan should carry out economic development on the premise of protecting the environment to realize the coordinated development of transformation ability and resource pressure.

Looking at the coupling relationship between urban transformation and urban resource pressure, the complexity and profundity require us to treat the speed and way of urban transformation carefully, and balance the contradiction with urban resource pressure. As a typical representative of resource-based cities, taiyuan's urban transformation mode and sustainable development and utilization of resources and environment have important reference value for other mountain resource-based cities. By summarizing and analyzing the coupling mechanism between urban transformation ability and resource pressure in taiyuan, this study provides theoretical value and practical significance for the development and transformation mode of mountain resource-based cities.

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