Journal of Computational Science & Engineering 19 (2015) 629-633

Available at http://www.asocse.org ISSN 1710-4068

Analysis of land use structure in Liaoning province based on Lorenz curves and Gini coefficient

Jiabao Wang, Xiaofan Zhao

College of Management, Shenyang Normal University, Shenyang 110034, China

Abstract: **The expansion of construction land was regarded as appearance of urbanization. In order to analyze the relationship between urban construction land and economic development, we improved decoupling elastic analysis and establish decoupling analysis model of urban construction land and the economic development. Take the Liaoning province around the urban construction land and non-agricultural GDP related data and analyze the coupling relationship between Liaoning province to city construction land and the growth rate of GDP. In the period 2002-2009, the results showed that Dalian City, Dandong City, Yingkou city and Fuxin city completed change from the weak to strong decoupling state; Liaoyang City, Panjin City, Chaoyang City, Huludao City, Anshan City, Shenyang city and Fushun city in addition to the individual year in growth or growth negative decoupling state link state, the rest are in the weak decoupled state; Benxi City showed from the weak decoupling state to the growth state of negative unhook, then from growth negative decoupling state to the weak from the transition of the state; in the city of Jinzhou at this time has been in a weak decoupled state.**

Keywords: City construction land; Decoupling analysis; Elastic analysis; Liaoning province

Received 29 April 2015, Revised 23 July 2015, Accepted 25 July 2015

* Corresponding Author: Jiabao Wang

1. Introduction

Since the reform and opening up, economic and social development of Liaoning province has made significant progress, the results of in reform and opening up have laid a good foundation for further development. However, it is still not fundamentally solved that a system and structural contradiction restricted economic society development of Liaoning, especially the economic development is still extensive, the development of regional economy is unbalance, resource is restricted to the development of increasingly outstanding, environmental pressure is increasing largely. Therefore, it is inevitably choice but nothing to carry out the transformation of the mode of economic development, promoting regional economic and social development as the core of the construction of Ecological Province, which has become the economic society lasts, healthy, rapid development of Liaoning province.

How to break through the economic development of the resource constraints, to break relationship between the economic growth and resources occupation, to realize the decoupling, it is an important breakthrough point that to realize the transformation of the mode of economic development for the future of Liaoning province. The land resources, especially the city construction land intensive use, making economic development and city construction land from, is a key ring to break the economic development resource constraints, to achieve the transformation of economic development mode.

2. Material and methods

2.1. Study area

Liaoning Province covers an area of 145,900 square kilometers and has a population of 40.41 million. It is located in the southern part of China's Northeast. Border on the Yellow Sea and the Bohai Sea in the south and the Korean Peninsula in the east and face Japan to its southeast. Liaoning province lies in the east of the Eurasian Continent. It features temperate continental monsoon climate with a long winter, a warm summer and a short spring and autumn. The province receives annual sunlight radiation ranging from 100-200 calories per square cm, and 2100-2600 hours of sunlight with average temperature of 7-11o C. It enjoys 130- 200 days frost free period and 600-1100mm of precipitation every year. The annual rainfall is 1100mm in the east hilly area; however, in the west hilly region which is connected with Inner Mongolian plateau, the yearly precipitation is 400mm. The rainfall in central plain is moderate with about 600mm per year.

There are 5.91 million staff members in the total enterprises. The independent accounting units of the whole province possess RMB 269,900 million of original. In 1995 the total output value of village and above-village-level industry of the whole province amounted to 354.4 billion Yuan, an increase of 18.4% comparing that in 1994. Of those, light-industry total output valued at 86.4 billion Yuan, 6.9% higher than that of 1994; heavy-industry total output value reached 268 billion Yuan, increased by 8.5%; sales value amounted to 339.6 billion Yuan, an increase of 12.3%, producing and marketing rate is 94.6%; light-industry sales value hit 81.4 billion Yuan, an increase of 19.6%; heavy-industry sales value fulfilled 258.2 billion Yuan , soaring 10.2%; increasing value fulfilled is 102.3 billion Yuan which increased by 4.7% as per the comparison caliber; light-industry increasing value amounted to 25.3 billion Yuan which increased by 7.3%; heavy-industry increasing value achieved 77

2015 © The American Computational Science Society. All rights reserved.

billion Yuan which increased by 3.6%.

2.2. Land use scenarios

In 2010, Liaoning province has total land area of 14,806,400 hectares. 11,763,624.53 hectares of agricultural land, accounting for 79.5 percent of the province's total land area, of which arable land is 4,174,785.46 hectares, accounting for 28.2 percent of the province 's land area, garden area is 648,048.25 hectares, accounting for 4.0 % 5937841.02 hectares is woodland area, accounting for 40.1% (including 5.4 million hectares of forest area, forest coverage rate reached 37%), grassland area is 605,007.34 hectares, accounting for 4.1%, water 397,942.46 hectares, accounting for 2.7%, construction land is 1,589,847.68 hectares, accounting for 10.7 percent of the province's land area. Urban village and the industrial land area is 1,126,512.93 hectares, accounting for 7.5%, of which transportation land is 231,165.02 hectares, accounting for 1.6%, water conservancy facilities land area is 232,169.73 hectares, accounting for 1.6 %. Unused land area is 1,452,898.46 hectares, accounting for 9.8% of the total land area.

Table 1. Accumulation of cultivated lands in Liaoning province in 2005 (%)

Area	Location entropy of Arable land	Arable land	Accumulation of arable land	Land	Accumulation of land
Benxi	0.29391	0.01669	0.01669	0.05680	0.05680
Fushun	0.40398	0.03075	0.04744	0.07612	0.13292
Dandong	0.49800	0.05055	0.09800	0.10151	0.23443
Yingkou	0.76773	0.02781	0.12581	0.03623	0.27067
Huludao	0.78574	0.05527	0.18108	0.07034	0.34101
Chaoyang	0.83765	0.11144	0.29253	0.13304	0.47405
Anshan	0.93745	0.05852	0.35105	0.06242	0.53648
Dalian	0.96782	0.08849	0.43954	0.09143	0.62791
Panjin	1.14513	0.03148	0.47103	0.02749	0.65541
Fuxin	1.30465	0.09096	0.56199	0.06972	0.72513
Liaoyang	1.34593	0.04309	0.60508	0.03202	0.75715
Jinzhou	1.39859	0.09550	0.70059	0.06828	0.82544
Tieling	1.51270	0.13246	0.83306	0.08757	0.91301
Shenyang	1.91903	0.16693	1	0.08698	1

2.3. Data sources

This paper adopts the 2005 - 2010 Statistical Yearbook of Liaoning Province and annual changes of land use survey data of 2005 – 2010 of Liaoning Province, established a database according to the land-use types of agricultural land (cultivated land, garden land, woodland and grassland), construction land and unused land, and formed the data of main land use types. Simultaneously, this paper conducts a contrastive analysis of changing regularity of time and space variation of each type of land use in Liaoning province of years from 2005to 2010.

2.4. Lorenz curve

Lorenz curve was used to analyze the interrelationship between wealth, land and income fairness, which is put forward by the United States economic statistician M. Lorenz. In the field of economics, Lorenz curve analyzes income gap or wealth inequality of different areas as an approach, to describe inequalities (centralized or decentralized) degree by plotted curve of frequency of the cumulative number. In the coordinate axes, Lorenz curve means: the points on the horizontal axis and vertical axis are composed by the cumulative percentage, and each point on the curve represent a certain percentage of the population has a percentage of wealth. The curve is called absolutely uniform line when the curve is at 45 ° angle with the horizontal axis. When the curve is closer to the absolutely uniform line, it means income gap is small and a more equal distribution of wealth among different regions, while large income gap and unequal distribution of wealth will appear.

The application of this principle on land research not only can study the degree of dispersion or concentration of land use types but also can judge the degree of specialization of land use in different county according to the slope of the curve and the inflection point position in a particular district. Points start from the axis 0 point on the Lorenz curve, and the order consists with the location entropy of the land use types. When the slope of one point on the curve, it means the proportion of a certain land use type of an area accounting for this type of land use of the total study region is higher than the proportion of the total land area of an area accounting for the total area of the study region. On the contrary, it is lower than the proportion of the total land area of an area accounting for the total area of the study region.

2.5. Steps to draw the Spatial Lorenz curve

Firstly, the location entropy of the 14 cities of Liaoning province can be calculated by using the raw data of all types of land use of the year of from 2005 to 2010. Location entropy, also known as a specialized rate, it refers to the ratio between the areas of land use types of a certain area accounting for the total areas of the regional land use types and the total land areas of a

2015 © The American Computational Science Society. All rights reserved.

certain area accounting for the total land areas of the study region.

Secondly, percentage and the accumulative percentage refer to the areas of all types of land use of all area accounting for the total land areas, which can be calculated according to location entropy size. (Table1, 2 taking the cultivated land of the year2005 and construction land of the year of 2010 of Liaoning province for example) The formula of calculating location entropy as follows:

$$Q = (A_1 / A_2) / (A_3 / A_4)$$

Q represents location entropy. A_1 represents the areas of one type of land use of a certain area. A_2 represents the total areas of one type of land use of Liaoning province. A_3 represents the total areas of a certain area, A_4 represents the total areas of Liaoning province.

Table 2. Accumulation of construction lands in Liaoning province in 2010 (%)

Area	Location entropy of construction land	Construction land	Accumulation of construction land	Land	Accumulation of land
Dandong	0.51284	0.05205	0.05205	0.10151	0.10151
Fushun	0.53261	0.04054	0.09260	0.07612	0.17763
Chaoyang	0.55546	0.07390	0.16650	0.13304	0.31067
Benxi	0.66704	0.03789	0.20439	0.05680	0.36748
Fuxin	0.81074	0.05652	0.26092	0.06972	0.43720
Huludao	0.85516	0.06015	0.32107	0.07034	0.50754
Tieling	0.92120	0.08067	0.40174	0.08757	0.59511
Jinzhou	0.98000	0.06692	0.46866	0.06828	0.66340
Anshan	1.14022	0.07117	0.53984	0.06242	0.72582
Liaoyang	1.43839	0.04605	0.58590	0.03202	0.75784
Panjin	1.50253	0.04131	0.62721	0.02749	0.78534
Shenyang	1.69586	0.14752	0.77473	0.08698	0.87233
Dalian	1.76150	0.16106	0.93579	0.09143	0.96376
Yingkou	1.77182	0.06420	1	0.03623	1

Finally, Coordinate graphs will be draw by taking the cumulative percentage of the total land areas for the horizontal axis and by taking the cumulative percentage of the areas of one type of land use vertical axis. Then we can get the curve by taking each cumulative number for coordinate point. The deviation of the curve from the absolute uniform line is measurement of differences between the real distribution and the Uniform distribution of this type of land in the study region.

2.6. Spatial Gini coefficient

Although Lorenz curve can visualize the differences of space distribution of some kind of land use types in the study region, but it cannot quantitatively describe the difference (or the degree of equilibrium is not balanced). To this end, the author introduces the Gini coefficient, which is commonly used in the field of economics to calculating assignment degree of social income, to further quantitatively describe the distribution situation of each kind of land use type in counties. There are many kinds of methods of calculating Gini coefficient, and the commonly used formula:

$$G = \sum_{i=1}^{n-1} (M_i Q_{i+1} - M_{i+1} Q_i)$$

In this formula, G is the Gini coefficient. Mi represents areas cumulative percentage of one type of land use of a certain area. Q_i is the areas cumulative percentage of areas of a certain area accounting for the areas of the whole study region. Because of choosing 14 prefecture-level cities in Liaoning Province as the study region, the Value range of i is range from 0 to 15 as integer. It is generally acknowledged that if the Gini coefficient is lower than 0.2, it means distribution of the mean absolute, and if the Gini coefficient ranges from 0.2 to 0.3, it means more equitable distribution, and if the Gini coefficient ranges from 0.3 to 0.4, it means relatively reasonable, and if the Gini coefficient ranges from 0.4 to 0.5, it means relatively large gap, and if the Gini coefficient is higher than 0.6, it means the gap of distribution is wide.

3. Results and discussion

3.1. Analysis results of Lorenz curve

From the Lorenz curve of each kind of land use type of Liaoning province of year of from 2005 to 2010 (figure1. 2), we can conclude that the Lorenz curve of cultivated land forest land and construction land are close to absolute uniform line. It means these three types of land Province are dispersed in Liaoning, which is to say that they are evenly distributed. While Lorenz curve of garden land, grass land and unused land are far away from absolute uniform line, it means these three types of land is unevenly distributed in Liaoning Province , in other words, the distribution of these three types of land are concentrated.

2015 © The American Computational Science Society. All rights reserved.

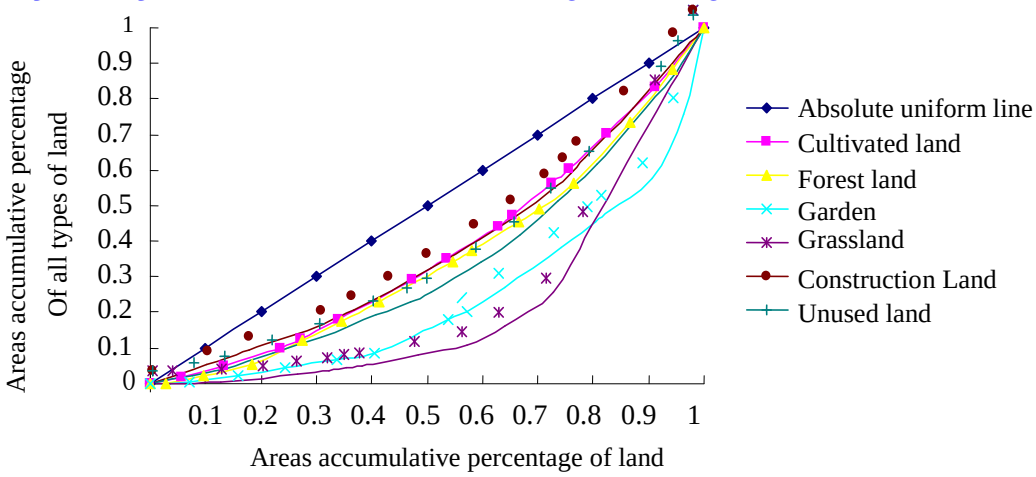

Figure 1. Lorenz curves of different land use types in Liaoning province in 2005.

Taking Lorenz curve of grassland of year 2005 as an example (figure3), we can see each point, which starts from the origin point, separately represents Yingkou city, Dalian city, Fushun city, Anshan city, Benxi city, Liaoyang city, Panjin city, Dandong city, Tieling city, Jinzhou city, Shenyang city, Fuxin city, Chaoyang city and Huludao city. The line slope is small from Yingkou City to Jinzhou city, it means grassland of these ten cities are less distributed. However, the line slop is increased from Shenyang city to Huludao city, that is to say, the areas of grassland of Shenyang city, Fuxin city, Chaoyang City and Huludao city is larger than other cities.

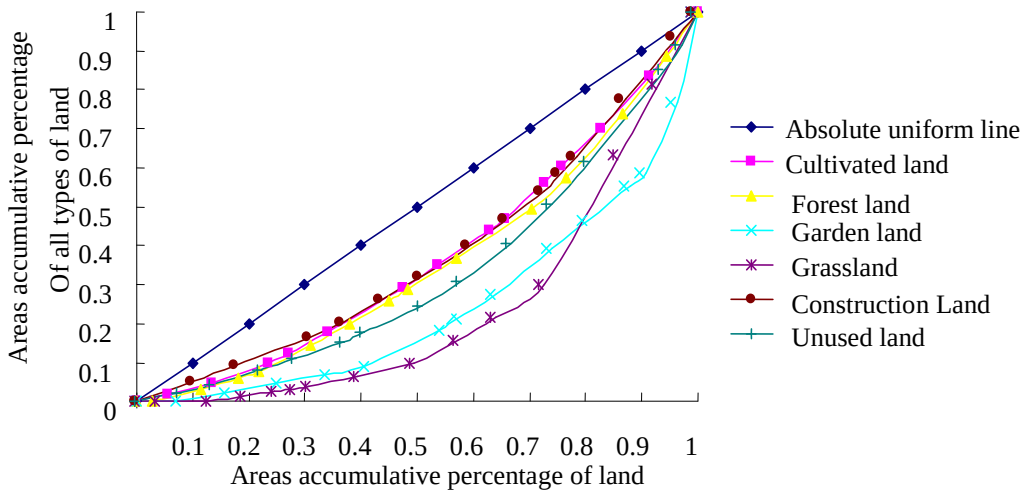

Figure 2. Lorenz curves of different land use types in Liaoning province in 2010.

3.2 Analysis results of Gini coefficient (Table 3)

In the year of 2005, the Gini coefficients of cultivated land, forest land and construction land are 0.2596, 0.2970 and 0.2504 respectively, it means they are evenly distributed in Liaoning province, the Gini coefficient of unused land is 0.3348, it represents the this type of land use are not uniformly distributed but still relatively reasonable, while the Gini coefficients of garden land and grass land are 0.5280 and 0.5682, which are more than 0.4 of the international warning line, it means the difference of exploit is large and lopsided. In the year of 2010, the change of Gini coefficients for forest land, garden land and grass land are positive, it means the distribution discrete degree of the three land use categories is increased, that is to say, the areas of these land use has relative changed. While the change of Gini coefficients for cultivated land, construction land and unused land are negative. It means that the three land uses are in a more balanced distribution. In addition, the Gini coefficients of garden land, grass land and unused land are high all the time. It means the difference of exploit of these land uses is large and lopsided in different cities.

2015 © The American Computational Science Society. All rights reserved.

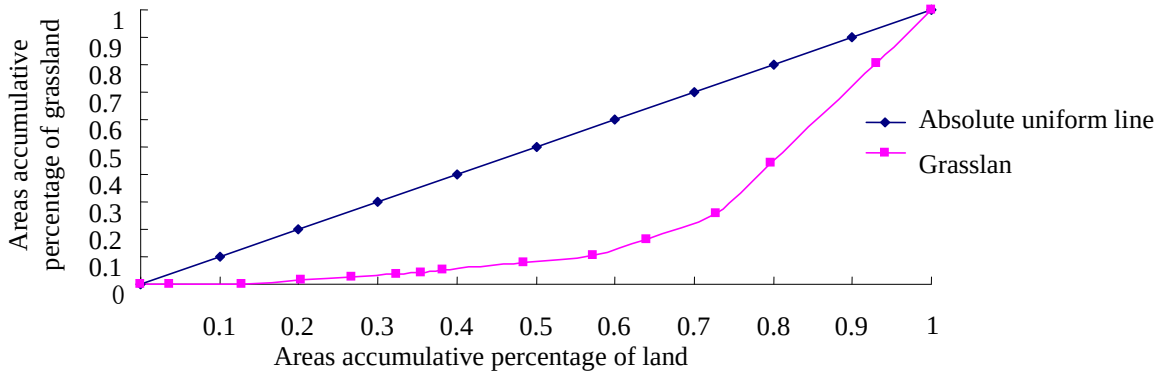

Figure 3. Lorenz curves of grass land in Liaoning province in 2005.

Table 3. Major Gini coefficients of land use types in Liaoning province between 2005 and 2010

Year	Cultivated land	Forest land	Garden land	Grassland	Construction land	Unused land
2005	0.2596	0.2970	0.5280	0.5628	0.2504	0.3348
2010	0.2606	0.2918	0.5218	0.5274	0.2544	0.3452
2005-2010	-0.001	0.0052	0.0062	0.0408	-0.0040	-0.0104

4. Conclusion

From the Lorenz curve and Gini coefficients of each types of land use, we can understand the spatial distribution characteristics and variation tendency of land use clearly and intuitively. In space, cultivated land, forest land and construction land are more dispersed in Liaoning province and evenly distributed in 14 cities. It means that social self-adjusting ability is declining. While the distribution of garden, grass land and unused land is concentrated. It means social self-adjusting ability is enhanced. At the same time, the Gini coefficient of woodland, garden and grassland are enlarged, and the distribution degree of dispersion are increased, while the Gini coefficient of cultivated land, construction land and unused land are correspondingly decreased and in a more balanced distribution, which reveals spatial structure characteristics of land use of Liaoning province in the years of 2005 and 2010. Scientific basis for rational use of land resources and structural adjustment will be providing by analyzing the spatial and temporal distribution of land and changes in Liaoning Province.

Acknowledgments

This research was supported by funds from Outstanding scientific and technological personnel support plan in Shenyang Normal University (201403), Social Science Planning Fund project in Liaoning province of China (L15BGL026), and Base authorized project of social and economic development from Federation of Social Science in 2016 in Liaoning Province of China（2016lsljdwt-39）.

Reference

[1] Y.F. Huang, C.M. Xu, Y.J. Huang, Journal of Jiangxi Normal University (Natural Sciences Edition), 2 (2003) 11-15.
[2] R.X. Li, A. Xue, J.R. Ni, Acta Scicentrirum Naturelum Universitis Pekinesis, 4 (2005) 115-121.
[3] F.W. Zhu, W.Z. Peng, J.Z. Ding, Economic Geography, 2 (2001) 98-93.
[4] G.J. Zhang, P.T. Zhang Pengtao, H.W. Li, Journal of Agricultural University of Hebei, 1 (2008) 24-30.
[5] J.W. Che, X.B. Kong, F.X. Zhang, Journal of China Agricultural University, 4 (2006) 330-336.
[6] X. Sun Xiao, W.K. Liu, Journal of Pingdingshan Institute of Technology, 2 (2005) 221-227.

2015 © The American Computational Science Society. All rights reserved.