Decoupling Analysis of Urban Construction Land Expansion and Economic Growth: A Case Study of Cheng-Yu Economic Zone

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Abstract. With the development of urban economy, urban construction land is accelerating to expand, and the expanded city provides more development space for economy. This article based on the decoupling theory analyzes the relationship between economic growth and urban construction land expansion in chengdu-chongqing economic zone and the law of evolution. The main conclusions are drawn as follows. First, from 2008 to 2016, the expansion rate of urban land in chengdu-chongqing economic zone was lower than the growth rate of urban GDP. Second, there are great differences in the relationship between economic growth and land expansion in chengdu-chongqing economic zone. Third, the decoupling status of ya'an, yibin, neijiang and nanchong developed from weak decoupling to expansionary negative decoupling, which showed a great difference in the years before and after.

Introduction

With the rapid development of China's economy, industrialization and urbanization progresses, China's urban problems have become a hot academic topic. The most direct manifestation of urbanization reflected in space is the expansion of urban construction land. At the same time, the expansion of construction land space is the inevitable result of economic growth (huang and zhu, 20070). The growth of urban economy will drive the expansion of construction land, but whether the expansion of construction land will drive the growth of economy and how to analyze the relationship between the two. Using decoupling theory to quantitatively analyze the relationship between urban construction land expansion and economic growth has become one of the fields concerned by domestic scholars.

Chengdu-chongqing economic zone is located in the upper reaches of the Yangtze river and the sichuan basin. It is an important population, town and industrial agglomeration area in the western region. It is an important support for accelerating the development of the western region and promoting the opening up of China's inland. With the rapid economic development, more and more land development activities are taking place in urban construction, and the contradiction between economic development and limited land resources is becoming more and more prominent0. Therefore, it is of great practical significance to study the relationship between urban economic growth and urban expansion in chengdu-chongqing economic zone.

Data and Methods

Data

Chengdu-chongqing economic zone includes 16 prefecture-level cities, including chengdu, chongqing, ya, deyang, mianyang, leshan, luzhou, yibin, zigong, crosshairs, dazhou, ziyang, neijiang, nanchong, meishan and suining.data span is 2007-2016 years, the study on urban construction land area within the jurisdiction of the data and the GDP data are from China city statistical yearbook. In order to ensure the accuracy and comparability of economic data, all GDP data used in this study are revised to 2006 constant price data.
Methods

Decoupling Theory

Decoupling theory was originally applied in the field of physics, which means that the correlation between two or more physical quantities is from being to nothing. When rapid economic growth is unable to get rid of environmental pressures and resource consumption, the implementation of related policies and the use of advanced science and technology may accelerate economic growth, a process known as "decoupling" (Liu Baotao, 2017). In terms of scientific definition of decoupling index, decoupling theory has been widely used in researches on resource consumption and economic growth, carbon emission and economic growth, and environmental pollution and economic growth in China. Scholars have different definitions of decoupling. Foreign scholar studies the relationship between environmental pressure and economic growth in the global scope by using the comprehensive analysis method of change, and divides the decoupling type into strong decoupling, weak decoupling, expansionary decoupling, strong decoupling, weak decoupling and recession decoupling. Based on the relevant theoretical basis of "environmental kuznets hypothesis", Tapio further subdivided the decoupling model into three states and eight types of coupling, decoupling and negative decoupling, and improved the decoupling index system. Tapio's classification is the main basis for domestic and foreign scholars to study decoupling. For example, Wang Xifeng et al. improved the input-output model and constructed the regional decoupling effect model by referring to Tapio's classification. The measurement results showed that the true water-saving effect of Beijing had reached the bottleneck period from 2010 to 2012.

Index Selection and Calculation Method

Based on Tapio's definition and calculation method, this paper adopts the elastic coefficient method, which can directly reflect the dynamic changes of the relationship between resource and environment consumption and economic growth ($T = \frac{\Delta EP}{EP_{start}} \times \frac{DP_{start}}{\Delta DP}$), analyzed the evolution of the relationship between urban land expansion and economic growth as well as the spatial characteristics differences in 16 cities from 2008 to 2016. In terms of index selection, according to the principle of pertinence, rationality and availability, considering the accumulation of years of construction and development to support the expansion of urban construction land, selected the city construction land area ($EP$) and its variation ($\Delta EP$) as the index of urban land expansion; Regional production output ($DP$) and its variation ($\Delta DP$) as the research measure indicators of economic growth. When Li Xiaolong simulated this time-delay effect through the finite published lag model, he found that the contribution rate of construction land to economic growth reached the maximum after 1 year of expansion. Therefore, the lag period of GDP is set as one year in this study, namely the data of construction land expansion from 2007 to 2015 and the GDP data from 2008 to 2016 for decoupling analysis.

$$T = \frac{\Delta EP}{EP_{start}} \times \frac{DP_{start}}{\Delta DP}$$

Based on the calculated elasticity coefficient $T$ value (formula 1), the relationship between urban economic growth and land expansion is divided into 8 categories (Table 1). Among them, when cities are in a state of strong decoupling, it means that their current economic growth has got rid of excessive dependence on construction land resources, and the quality and efficiency of land use are relatively high. Cities have the ability to improve resources and environment while pursuing economic growth.
Table 1. Decoupling definition table.

| ∆EP | ∆DP | T  | status                        | implication                                                                 |
|------|------|-----|-------------------------------|-----------------------------------------------------------------------------|
| > 0  | > 0  | T > 1.2 | expansive negative decoupling |                                                                                 |
| > 0  | < 0  | T < 0  | strong negative decoupling    | The increased input of land factors has not been fully transformed into economic growth and the land use efficiency is low |
| < 0  | < 0  | 0 < T < 1 | weak negative decoupling    | The economy is declining faster than the consumption of land                   |
| > 0  | > 0  | 0 < T < 0.8 | weak decoupling           | The speed of economic growth exceeds the speed of urban expansion, and the degree of intensive land use is higher, but the difficulty of land use still exists |
| ≤ 0  | > 0  | T ≤ 0  | strong decoupling            | Economic growth is getting rid of excessive dependence on land resources and land use is efficient |
| < 0  | < 0  | T > 1.2 | recessive decoupling         | The rate of economic decline has been slower than the rate of land use decline |
| > 0  | > 0  | 0.8 < T < 1.2 | expansive coupling | The speed of urban expansion has increased in step with the speed of economic development |
| < 0  | < 0  | 0.8 < T < 1.2 | recessive coupling         | The rate of decline in the consumption of land resources coincides with the decline in the rate of economic development |

Dynamic Analysis of Decoupling Index

The change rates of construction land expansion and economic growth of prefecture-level cities in chengdu-chongqing economic zone from 2008 to 2016 were calculated respectively, and the decoupling index of cities from 2008 to 2016 was calculated according to formula (1) (Table 2-3). It can be seen that the result calculated by the chengdu-chongqing economic zone construction land expansion and economic growth of decoupling relationship as a whole in the decoupling state, while industrial output growth is 4.6 times, urban area is expanded by a factor of 1.8, and the land resources guarantee ability and to improve the management level, economic growth has begun to gradually get rid of the dependence on the land. In terms of the overall trend, the decoupling state of the two is unstable, showing a continuous "w-shaped" change trend. In 2008, 2009, 2011, 2012, 2015 and 2016, it is a decoupling type. Connected in 2010, 2013 and 2014; by region, the frequency of weak decoupling is the highest, Accounting for 52.78% of the number of statistical periods, The extended negative decoupling type accounted for 15.28% of the statistical period, Strong decoupling accounted for 18.75% of the statistical period (Table 4).
| Year  | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|-------|------|------|------|------|------|------|------|------|------|------|
| Chengdu | 11.67% | 8.46% | -4.13% | 5.74% | 7.01% | 6.98% | 2.57% | 5.97% | 9.82% | - |
| Chongqing | 5.81% | 5.79% | 0.00% | 23.20% | 10.53% | -9.10% | 7.22% | 11.73% | 8.45% | - |
| Ya'an | 0.00% | 0.00% | 6.25% | 5.88% | 0.00% | 16.67% | 4.76% | 13.64% | 20.00% | - |
| Deyang | 0.00% | 7.50% | 18.60% | 5.88% | 12.96% | 4.92% | 9.38% | 2.86% | 5.56% | - |
| Deyang | 0.00% | 0.00% | 3.75% | 24.10% | 0.00% | 2.91% | 3.77% | 0.00% | 13.64% | - |
| Leshan | 4.35% | 2.08% | 2.04% | 4.00% | 3.85% | 3.70% | 8.93% | 9.84% | 2.99% | - |
| Luzhou | 6.98% | 13.04% | 34.62% | 15.71% | 9.88% | 7.87% | 9.38% | 2.86% | 6.48% | - |
| Yibin | 31.43% | 13.04% | 0.00% | 1.92% | 18.87% | 25.40% | 13.92% | 8.89% | -23.47% | - |
| Zigong | 13.64% | 6.00% | 28.30% | 17.65% | 12.50% | 11.11% | 6.00% | 2.83% | 2.75% | - |
| Guang'an | 0.00% | 5.00% | 28.57% | 11.11% | 3.33% | 9.68% | 38.24% | -2.13% | 4.35% | - |
| Dazhou | 0.00% | 21.05% | 8.70% | 28.00% | 0.00% | 12.50% | 2.78% | 94.59% | 9.72% | - |
| Ziyang | 0.00% | 64.71% | 14.29% | 12.50% | 5.56% | 2.63% | 5.13% | 4.88% | 2.33% | - |
| Neijiang | 10.00% | 12.12% | 108.11% | -48.05% | 5.00% | 7.14% | 28.89% | 13.79% | 9.09% | - |
| Nanchong | 7.02% | 4.92% | 10.94% | 9.86% | 16.67% | 10.99% | 7.92% | 7.34% | -1.71% | - |
| Suining | 0.00% | 0.00% | -2.04% | 2.08% | 26.53% | 4.84% | 6.15% | 8.70% | 0.00% | - |
| Meishan | 2.63% | 2.56% | 0.00% | 5.00% | 0.00% | 2.38% | 0.00% | 0.00% | 4.65% | - |
| All areas | 5.84% | 10.39% | 16.12% | 7.79% | 8.29% | 7.54% | 9.69% | 11.61% | 4.67% | - |

Table 3. Decoupling index of construction land use expansion and economic growth in chengdu-chongqing economic zone from 2008—2016.

| Year  | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | Average |
|-------|------|------|------|------|------|------|------|------|------|---------|
| Chengdu | 0.39 | 0.38 | -0.22 | 0.29 | 0.30 | 0.54 | 0.19 | 0.37 | 0.71 | 0.33 |
| Chongqing | 0.26 | 0.13 | 0.00 | 0.76 | 0.63 | -0.93 | 0.37 | 0.73 | 0.46 | 0.27 |
| Ya'an | 0.00 | 0.00 | 0.47 | 0.29 | 0.00 | 3.37 | 0.49 | 1.53 | 3.29 | 1.05 |
| Deyang | 0.00 | 0.38 | 0.80 | 0.29 | 0.98 | 0.64 | 1.48 | 0.57 | 0.61 | 0.64 |
| Deyang | 0.00 | 0.00 | 0.32 | 1.10 | 0.00 | 0.25 | 0.40 | 0.00 | 0.65 | 0.30 |
| Leshan | 0.17 | 0.10 | 0.14 | 0.18 | 0.22 | 0.39 | 1.64 | 1.22 | 0.44 | 0.50 |
| Luzhou | 0.29 | 0.57 | 2.14 | 0.67 | 0.55 | 0.71 | 0.84 | 0.27 | 0.83 | 0.76 |
| Yibin | 1.81 | 1.09 | 0.00 | 0.05 | 1.10 | 2.94 | 2.55 | 1.43 | -0.03 | 1.22 |
| Zigong | 0.59 | 0.34 | 2.01 | 0.95 | 0.75 | 0.89 | 0.85 | 0.42 | 0.39 | 0.80 |
| Guang'an | 0.00 | 0.30 | 2.10 | 0.53 | 0.19 | 0.85 | 3.61 | -0.21 | 0.65 | 0.89 |
| Dazhou | 0.00 | 0.74 | 0.66 | 1.41 | 0.00 | 0.81 | 0.02 | 37.71 | 1.89 | 0.62 |
| Ziyang | 0.00 | 2.86 | 0.80 | 0.52 | 0.26 | 0.25 | 0.50 | 0.72 | 0.29 | 0.69 |
| Neijiang | 0.35 | 0.59 | 6.51 | -2.25 | 0.28 | 0.81 | 3.47 | 3.75 | 1.15 | 1.63 |
| Nanchong | 0.42 | 0.23 | 0.70 | 0.44 | 0.87 | 1.05 | 1.08 | 1.04 | -0.20 | 0.63 |
| Suining | 0.00 | 0.00 | -0.17 | 0.09 | 1.88 | 0.39 | 0.69 | 0.57 | 0.00 | 0.38 |
| Meishan | 0.14 | 0.10 | 0.00 | 0.23 | 0.00 | 0.24 | 0.00 | 0.00 | 0.10 | 0.09 |
| All areas | 0.28 | 0.49 | 1.02 | 0.35 | 0.50 | 0.82 | 1.14 | 0.78 | 0.70 | 0.67 |
### Table 4. Decoupling state of construction land use expansion and economic growth in Chengdu-Chongqing economic zone from 2008—2016.

|          | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | Average |
|----------|------|------|------|------|------|------|------|------|------|---------|
| Chengdu  | WD   | WD   | SD   | WD   | WD   | WD   | WD   | WD   | WD   | WD      |
| Chongqing| WD   | WD   | SD   | WD   | WD   | SD   | WD   | WD   | WD   | WD      |
| Ya’an    | SD   | SD   | WD   | SD   | EN   | ND   | WD   | EN   | ND   | EC      |
| Deyang   | SD   | WD   | EC   | WD   | EC   | WD   | EN   | WD   | WD   | WD      |
| Deyang   | SD   | SD   | WD   | EC   | SD   | WD   | WD   | SD   | WD   | WD      |
| Leshan   | WD   | WD   | WD   | WD   | WD   | EN   | EN   | WD   | WD   | WD      |
| Luzhou   | WD   | WD   | EN   | WD   | WD   | EC   | WD   | EC   | WD   | WD      |
| Yibin    | END  | EC   | SD   | WD   | EC   | END  | END  | END  | SD   | END     |
| Zigong   | WD   | WD   | EN   | D   | EC   | WD   | EC   | WD   | WD   | WD      |
| Guang’an | SD   | WD   | EN   | WD   | WD   | EC   | END  | EN   | WD   | WD      |
| Dazhou   | SD   | WD   | END  | SD   | EC   | WD   | EN   | EN   | WD   | WD      |
| Ziyang   | SD   | EN   | EC   | WD   | WD   | WD   | WD   | WD   | WD   | WD      |
| Neijiang | WD   | WD   | EN   | SD   | WD   | EC   | END  | EN   | EC   | END     |
| Nanchong | WD   | WD   | WD   | EC   | EC   | EC   | EC   | SD   | WD   | WD      |
| Suijing  | SD   | SD   | SD   | WD   | EN   | WD   | WD   | SD   | WD   | WD      |
| Meishan  | WD   | WD   | SD   | WD   | SD   | SD   | SD   | WD   | WD   | WD      |
| All areas| WD   | WD   | EC   | WD   | WD   | EC   | WD   | WD   | WD   | WD      |

**Spatial Differentiation Analysis of Prefecture-level Cities**

In order to better evaluate the spatial differences of decoupling indexes in different regions and avoid the influence of extreme values in individual years, there are only 4 types of decoupling: strong decoupling, weak decoupling, expansionary negative decoupling and expansive coupling. This article will scree each year of decoupling index remove individual abnormal extreme value, take the average analysis of Chengdu-Chongqing economic zone construction land expansion and economic growth of the space difference of decoupling relationship, and it can be divided into decoupling relationship between stability and decoupling relationship between floating.

**Decoupling is Stable**

The evolution trend of the relationship between economic growth and land expansion in Chengdu, Chongqing and Meishan is consistent with the general trend of Chengdu-Chongqing economic zone. Every year, the urban area expands to different degrees with the economic growth, and it is in a stable decoupling state from 2008 to 2016. In particular, Meishan city was in a state of strong decoupling in 2010, 2013, 2014 and 2015. It can be seen that Meishan city supported its economic growth with relatively stable construction land area and was the city with the best decoupling among the 16 prefecture-level cities in Chengdu-Chongqing economic zone. Meishan city has a good location advantage and rich tourism resources, is located in Chengdu metropolitan area, close to Tianfu new area, in 2016 was the asia-pacific region (second and third-tier cities) preferred tourist destination title. The urbanization rate of Meishan city in Sichuan province is still not high. With the development of Tianfu new area, the urbanization process of Meishan city will continue to deepen. It is still unknown whether it can maintain a good decoupling relationship in the future. The two core cities of Chengdu-Chongqing economic zone and Chengdu economic zone can well maintain the weak decoupling state, which also indicates that the economy of Chengdu and Chongqing has been transformed to the connotative development, and the effect of "stable growth and structural adjustment" is obvious.
Decoupling Floats

From the perspective of large time span, most cities in chengdu-chongqing economic zone are in a state of weak decoupling, but the relationship between economic growth and land expansion in ya'an, yibin, neijiang and nanchong is quite different in recent years. In 2012-2016 years, the construction land expansion speed, decoupling relationship in a dilated negative decoupling state. Unbalanced industrial structure and inadequate technical level are the main reasons for the unsatisfactory decoupling status in these regions. The government should accelerate the adjustment of industrial structure, promote the improvement of technological innovation capacity, and realize the sustainable use of regional land by strictly controlling the total amount of construction land and reusing the stock. The excessive expansion of urban construction land will lead to inefficient economic growth. This mode of promoting economic growth by replacing inadequate technology with land resources has limited potential, and will be constrained by resources and environment, making sustainable development difficult. Therefore, in the process of economic development, it is necessary to constantly improve the technical level, promote the intensive and efficient use of land resources, and continue to promote high-quality economic development. The relationship between regional economic growth and urban expansion is not stable. On the one hand, it is related to the development stage of cities.

Conclusion

Using decoupling theory analysis of this research study the chengdu-chongqing economic zone economic growth and the relationship between urban land expansion, the following conclusions:

(1) From 2008 to 2016, the expansion rate of urban land in chengdu-chongqing economic zone continued to be lower than the growth rate of urban GDP. The problem of urban economic development and farmland protection has not been fundamentally solved.

(2) The relationship between economic growth and land expansion and the law of evolution in chengdu-chongqing economic zone cities are quite different. The relationship between economic growth and land expansion in chongqing, chengdu and meishan is in a stable decoupling state, among which meishan city is in a stable strong decoupling development.

(3) ya'an, yibin, neijiang, nanchong and other cities accelerated their expansion after 2012 due to the built-up area, and their decoupling status changed from weak decoupling to expansionary negative decoupling, which showed a great difference in the previous years. The economic growth model based on the consumption of construction land resources is unsustainable, so it is necessary to take active measures to promote sustainable economic development, continue to improve the intensity of construction land, and prevent the blind expansion of construction land is one of the main tasks of land management in the region.

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