

# Analysis of the Development of China's Green Building Space Difference Measure Based on the Theil Index

Jianbin WANG, Yao JIA

*School of Management, Xi'an University of Architecture and Technology, Xi'an 710055, China*

**ABSTRACT:** Taking the development of China's green building as the research object, the article uses *theil index* to estimate the spatial difference of green building development in China from star class green building, two-star green building, three-star green building four aspects, then the four types of index of total variance is broken up into interregional differences and intra-regional differences based on the east, central and western three areas. Through analyzing the spatial difference, theoretical support and the relevant policy recommendations about promoting the development of green building scale are provided for deepen the green building standards and incentive policy in our country in the future.

**KEYWORD:** Green Building; Spatial Difference; Theil Index

## 1 INTRODUCTION

In the field of construction, developing green building action is the important measure to cope with the global climate change, energy crisis and realize the sustainable development of the global. Development of green building has become an international consensus; countries have promulgated the green building evaluation standard, such as the BREEAM of British, LEED in the United States, CASBEE of Japan, and GBTool in Canada [1], etc. The legislation and incentive policies are constantly strengthened to promote the development of green building.

At present, the domestic scholars' research on green building development space difference is less, mostly qualitative analysis, quantitative research is very scarce. Ye Zu da by statistics method studied the geographical distribution of green building in our country, he thinks that due to different urban economy and the real estate market condition expecting the different green building market value, so the number of projects in different cities also have obvious geographical distribution difference namely "spatial heterogeneity", this also shows that green building policies and local economy market conditions are inseparable. [2]

## 2 RESEARCH OBJECT AND METHOD

### 2.1 *The object of study*

This article selects the green building of 31

provinces and municipalities in China as the research object, analysis the space difference of the current green building development from the level of the whole development of green building, green building structure, namely one, two, three star four types of green building development level index.

### 2.2 *Data sources and scoping*

Data used in study come from the national bureau of statistics web site and green building map data in 2013. The green building can be classified by one – star green building, two-star green building, and three-star green building according to green building evaluation standard issued by the housing and urban-rural development.

### 2.3 *The division of spatial unit*

Based on the existing national bureau of statistics statistical caliber, according to the way of dividing for the eastern, central and western regions, the 31 provinces are divided into the eastern region including Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong and Hainan; The central region including Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, Hunan; In the western region including Sichuan, Chongqing, Guizhou, Yunnan, Tibet, Shanxi, Gansu, Qinghai, Ningxia, Xinjiang, Guangxi, Inner Mongolia. The provinces with no development during the study period are eliminated

for the data requirement and the early development of the green building.

#### 2.4 The method of measure the spatial difference

This article selects the theil index method; it is put forward from using the concept of entropy in information theory by Theil (Theil, 1967). This paper calculated the theil index of green building development in our country with the GDP for weight and the weight of the added value of real estate. The former can reflect the regional economic development level responding on the differences in green building development. The latter can reflect the real estate market prosperity of difference influencing the development of regional green architecture [3].

The calculation method of theil index reflecting spatial difference of green building development is as follow:

$$T_e = \sum_{i=1}^n \frac{GDP_i}{GDP_e} \cdot \ln \left\{ \frac{GDP_i / GB_i}{GDP_e / GB_e} \right\} \quad (1)$$

$$T_m = \sum_{i=1}^n \frac{GDP_i}{GDP_m} \cdot \ln \left\{ \frac{GDP_i / GB_i}{GDP_m / GB_m} \right\} \quad (2)$$

$$T_w = \sum_{i=1}^n \frac{GDP_i}{GDP_w} \cdot \ln \left\{ \frac{GDP_i / GB_i}{GDP_w / GB_w} \right\} \quad (3)$$

$$T_1 = GDP_e \ln(GDP_e / GB_e) + GDP_m \ln(GDP_m / GB_m) + GDP_w \ln(GDP_w / GB_w) \quad (4)$$

$$T_2 = GDP_e \cdot T_e + GDP_m \cdot T_m + GDP_w \cdot T_w \quad (5)$$

$$T = T_1 + T_2 \quad (6)$$

$$\frac{T_e}{T} + GDP_e \cdot \frac{T_e}{T} + GDP_m \cdot \frac{T_m}{T} + GDP_w \cdot \frac{T_w}{T} = 1 \quad (7)$$

Te, Tm and Tw, respectively, indicate theil index of eastern, central and western regions; T1, T2 respectively reflect the interregional theil index and intraregional theil index of green building development spatial difference. T reflects total theil index in the development difference of Chinese green building. GDPi means its province GDP accounted for the proportion of the sample space GDP; GDPe, GDPm, GDPw represent the eastern, central and western regions GDP accounted for proportion of the entire sample space GDP; GBi indicate the number of green building in its province amount or proportion of the total sample space green building; GBe, GBm, GBw represent the eastern, central and western region of the green building amount or proportion of the total sample space green building. (The above formula is based on GDP weight calculation formula of Theil index, GDP is replaced by the corresponding area of the added value of real estate industry can get the added value of real estate industry as the weight of index formula).

### 3 THE RESULTS OF THE STUDY AND ANALYSIS

#### 3.1 The spatial difference of the development of Chinese green building measure with two kinds of weights

The number of green building development is selected as a green building development level index, through calculating GDP and the added value of real estate as the weight to measure difference with Theil index, three major areas in the eastern, central and west is further decomposed, the calculation results as shown in table 1 and table 2.

Table1 the spatial difference level of green building development with GDP

	Te	Tm	Tw	T2	T1	T
index value	0.0603	0.0648	0.1079	0.0707	0.0232	0.0940
contribution value	0.3562	0.1695	0.2266	0.7523	0.2477	1.0000

Table2 the spatial difference level of green building development with added value of real estate

	Te	Tm	Tw	T2	T1	T
index value	0.0694	0.0464	0.0858	0.0676	0.0011	0.0687
contribution value	0.6870	0.1214	0.1760	0.9844	0.0156	1.0000

By (table 1), the difference in the zone constitute the main reason for the development of China's green building space difference, its contribution to total difference reached 75%, spatial difference of three big area is characterized by western > central > eastern, But the eastern region space difference is bigger than other two regions. Combined with the

original data to see, the difference of the green building development is not only big, but also its overall development level is low. The number of the green building in some province such as Shanxi (32) is much more than others (1).so the spatial difference in west region is very imbalance. Overall development level in east green building is higher,

but its internal difference is also bigger, but relatively smaller, compared with the western region. In the eastern region, the green building development also shows the unbalance of area.

Compared the above two tables, with GDP for the weight of the overall Theil index is greater than the added value of real estate as. It shows that the development of green building mercerization degree is not high, that due to the construction of the green building to pay more than ordinary building construction costs and green building in China is still in the initial stage of development are the main reason. so the development of green building is subject to the development of local economy and government policy guidance, it also explains the GDP as the weight of Theil index and green building development level in our country have better compatibility (later all analysis based on GDP as the weight of index).

### 3.2 Measure the spatial difference of three-star green building development

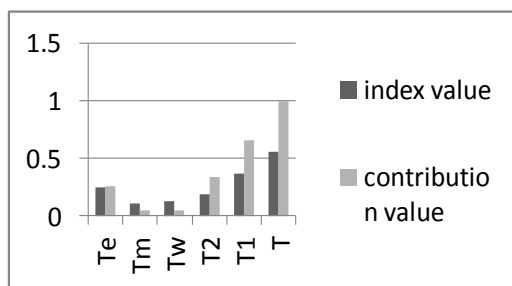


Figure 1 the spatial difference level of three-star green building development

By (figure 1), the theil index the three-star green building development in our country is 0.5575, is greater than the area differences between regions, and regional difference has contributed 66% to the overall difference, it suggests that three-star green building development space difference is mainly caused by interregional the difference. For regional differences, east>west>central, contribution of the

Table 3 the spatial difference level of two-star green building development

	Te	Tm	Tw	T2	T1	T
index value	0.1223	0.1503	0.0695	0.1207	0.0028	0.1235
contribution value	0.6163	0.2760	0.0849	0.9772	0.0228	1.0000

### 3.4 Measure the spatial difference of one-star green building development

The one-star green building is the lowest level in china; its spatial difference is 0.0914 which is close to the whole development level. the spatial difference of one-star green building is mainly caused by the intraregional, the contribution is up to

eastern region difference is the largest. Intra-regional differences are mainly caused by the differences of the eastern region. Combined with the original data, east has 99 three-star green building, middle and west areas have 14 and 18 respectively, great imbalance between regions are showed obviously. The three –star green building requires the highest level, it must costs most, economic development level in east is higher than other regions, and so the number of three-star green building is more than others. For intraregional difference, the east not only has most three-star green building, but also the imbalance in it, Although the development of three-star green building in central and west is more balanced, but the overall level is low. The good development province only has three to four. So the difference level of three star green building developments in central and west is smaller.

Spatial difference of three-star green building development in our country is relatively obvious, the difference is mainly caused by interregional differences, which with the development of green building whole space difference is inconsistent. The intraregional difference is caused by the east, the level of the green building development in central and west is low.

### 3.3 Measure the spatial difference of two-star green building development

By (table 3), space difference index of two-star green building development is 0.1235, the intraregional difference (0.1207) is greater than the interregional (0.0028), it is consist with the overall development of China's green building. The difference of two-star green building development in central is the largest, then east. But the contribution of east is also largest.the east region for232, the central for 64, the west for 49, therefore in the east the contribution is always the biggest of all. Therefore two-star green building no matter interregional or intraregional, the difference is bigger, the unbalance is more obvious.

79%, the interregional difference is only 0.0195,its contribution is 21%. this is similar to the overall green building development. Incremental cost of one-star green building is lower than others, so some areas whose economical development level is lower are more likely to choose it. So Shanxi in west has the most one-star green buildings, the other zones

are much less than it. In a word, one-star green building development is closer to the overall green building development.

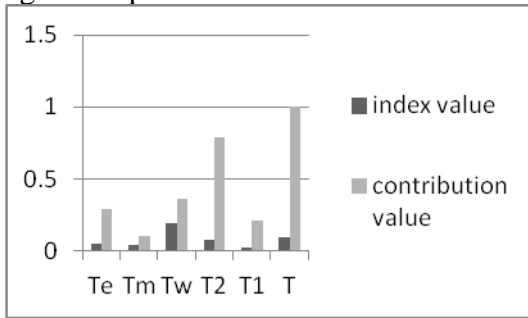


Figure 2 the spatial difference level of one-star green building development

#### 4 CONCLUSION

(1) This paper measure the spatial difference of green building development by theil index in china 2013, the research shows that the green building development exist obvious spatial difference, the three-star is biggest, its interregional difference is also biggest . The two-star and one-star green building are relatively popular in central and west.

The incremental cost is an important cause of green building development and mercerization. In the future the government should pay attention to correlated industry of green building, gradually build a green building development industry chain and promote green building related technology to reduce the construction cost and ensure that large-scale development green building works smoothly.

(2) The spatial difference of green building development in china is mainly caused by the intraregional difference; the level is not very high. so the government should take the intraregional difference not only interregional when setting relative policy, according to the different climate zones to divide the green building development areas, different climate zones according to their own characteristics using the most economic green building technology, in the most economical way to realize the green building development. Current "national standard" has a guiding role, the provinces should be actively carry out the green building

development practice at the same time, prepare the appropriate local standards, according to the characteristic of oneself in order to solve the problem of regional differences, and establishing green building is suitable for the local social development.[4]

(3) The intraregional difference of green building development in west is obvious, the study found that green building development in Shanxi is faster than other areas in the west, colleges and universities in Shanxi province is more to formulate strong cultural atmosphere, green building promotion is easy to be accepted in this area. The government should intensify publicity of the green building to make the developers and owners to be able to recognize the green building and continue to implement the green building incentive and subsidy policy which is still an important work for the development of green architecture in the future. The government should establish different star green building cost effective database, analysis economic cost and benefit of the different green building technology application in different parts to make the society and the market have more universal and exact understanding of it, only do this [5], can we promote the market development of green building, narrowing the difference of the green building development space, realize green building large-scale development.

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