A Comprehensive Evaluation of Industrial Land Intensive Use in Hubei Province Based on Typical Industrial Enterprises

CHEN Yu*

School of Economics and Management, Zhengzhou University of Light Industry, Zhengzhou 450002, China

Abstract: Here, we used Bayes methods to evaluate land use intensity in 365 typical industrial enterprises across nine manufacturing industries in Hubei, China and calculated the potentiality of enterprises with moderate and low intensive land use. We did this by constructing an evaluation index system of intensive land use for industrial enterprises comprised of four sub-objective layers including land use structure, land use intensity, land input and land output, and nine element layers. We found that among 365 enterprises, 82 enterprises use land intensively, accounting for 22.47% of our sample; 215 enterprises use land moderately or have low use, accounting for 58.90% of our samples. Enterprises with intensive use tended to be metal smelting and rolling processing industries and communication equipment, computer and other electronic equipment manufacturing industries. Enterprises with moderate and low use tended to be from the special equipment manufacturing industry, pharmaceutical manufacturing industry and chemical raw materials and chemical industry. The potential area for enterprises with moderate and low land use is approximately 865.70 ha and accounts for 42.38% of total current land approved, indicating that their potentiality for intensive use is large.

Key words: land resource management; land intensive use; Bayes discrimination; industrial land; potential excavation

1 Introduction

Land is an indispensable natural resource that supports regional economic development, and to preserve a certain amount of plough is the foundation of our existence and development (Ye and Pu 2007). Urbanization and industrialization has been so rapid that construction land has been expanding constantly and plough decreasing rapidly; this trend seriously threatens food security and ecological security across China (Wu and Qu 2007). Industrial land is the biggest part of increased construction land and also the most important component of urban land, but its rate of output is far below the average level of developed countries (Zhao et al. 2011). It has become consensus that China should alter land use and maintain intensification in order to lessen pressure on land resources in urban developments (Gu et al. 2006). Existing research has focused on establishing an evaluation index system of intensive land use (Thinń et al. 2002; Hong and Xue 2006), evaluating the degree of intensive land use (Liu et al. 2008; Zhai et al. 2006), analyzing driving forces (Lei et al. 2009; Cao et al. 2008) and methods of achievement in large and medium cities and development zones (Wu and Chen 2004; Kono and Kaneko 2008; Joshi and Kono 2009). A few studies have tentatively examined the relationship between land intensive use and industrial restructuring (Ding and Tian 2007; Wang et al. 2005), influential elements of industrial intensive use and the formulation of countermeasures from the perspective of the manufacturing industry (Jia et al. 2010; Huang et al. 2009). Most studies have adopted the method of vague comprehensive evaluation, principal component analysis, entropy and GIS spatial analysis (Zheng and Shen 2008; Shao et al. 2007; Zhang and Hao 2008; Zhou et al. 2009). However, the entity of potential release in land intensive use is the individual enterprise, so it is more effective and realistic to analyze urban land use intensity and potential from the perspective of enterprises themselves. Here, based on questionnaires from 365 typical
enterprises in Hubei, China, we used interval estimation to determine ideal indices of different industries and analyze urban land intensive use of different enterprises using Bayesian methods. Our aim is to provide a reference for the evaluation of urban land intensive use and the ratio of industrial land intensive use in China.

2 Region and data sources

2.1 The focal region

Hubei is a traditional industrial and agricultural base in China. In the early Reform and Opening-up to the Outside World period, based on its geographical advantages, Hubei’s economic development focused on transportation and heavy industries such as equipment manufacturing. In 1980, the proportion of agriculture, industry and service in GDP changed from 45.20:38.70:16.10 (1979) to 35.70:46.00:18.30 and the output of the industry exceeded agriculture for the first time. The first transition of industrial structure was completed. Hubei then began to focus on the development of service. In 1992, the proportion of the three main industries’ contribution to GDP was 27.80:40.90:31.30. A historical change from the order of industry, agriculture and service to that of industry, service and agriculture was realized. In 2010, the ratio of added value of the three industries was 13.45:48.64:37.91 and the proportion of the industry was up to 42%. However, with the quick pace of industrialization, it is becoming more and more obvious that finite land will impede economic development, especially when technological and intellectual industries are not strong enough and the model of mainly developing heavy industry necessitates more land. Therefore, keeping to a path of urban land intensive use is the infallible choice in order to realize further industrial development, the optimization of resource allocation and sustainable development of the economy.

2.2 Data sources

Questionnaires from typical industrial enterprises in Hubei from March to September in 2011 were conducted. By using self-administered questionnaires and having face-to-face interviews, we determined the covering areas of industrial enterprises, construction area, number of staff, and total output. A total of 600 questionnaires were distributed and 512 questionnaires were found to be valid (85%). According to classification criteria in China’s industrial sector, these enterprises were divided into 22 industries such as textile and clothing and footwear manufacturing, food manufacturing, furniture manufacturing, pharmaceutical manufacturing, and electrical equipment manufacturing. In order to make the results more representative, 365 enterprises from nine industries were reserved as research objects after some other industries such as timber processing, bamboo products, furniture manufacturing, and petroleum processing, coking and nuclear fuel industry among the 22 industries were rejected because valid questionnaires numbered less than 20 (Table 1).

3 Empirical research

3.1 Construction of the evaluation index system

Compared with residential and commercial land, more emphasis is put on the economic benefits derived from labor, capital and technology in industrial land use. Therefore, not only should importance be attached to structural optimization and land intensity in evaluating industrial land intensive use but input-output results should be taken into account. Considering the possibility of acquiring data, nine indicators from four aspects regarding the structure of land use intensity, land input and land output were evaluated. In order to make sets of discrimination and classification, we transform the ratio of the open yard and operative land use into two negative correlation indices (Table 2). The conversion formula is as follows:

$$R_{ai} = 1 - R_i$$  \hspace{1cm} (1)

where, $R_{ai}$ refers to the index after transformation; and $R_i$ stands for the index before transformation.

Table 1 Distribution of questionnaires.

<table>
<thead>
<tr>
<th>Name of industry</th>
<th>Total questionnaires</th>
<th>The valid questionnaires</th>
<th>Valid questionnaires ratio (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transportation equipment manufacturing</td>
<td>54</td>
<td>42</td>
<td>11.51</td>
</tr>
<tr>
<td>Textiles and clothing, footwear, headgear manufacturing</td>
<td>78</td>
<td>69</td>
<td>18.90</td>
</tr>
<tr>
<td>Non-metallic mineral industry</td>
<td>44</td>
<td>36</td>
<td>9.86</td>
</tr>
<tr>
<td>Metal smelting and rolling processing industry</td>
<td>40</td>
<td>36</td>
<td>9.86</td>
</tr>
<tr>
<td>Chemical materials manufacturing</td>
<td>51</td>
<td>41</td>
<td>11.23</td>
</tr>
<tr>
<td>Pharmaceutical manufacturing</td>
<td>27</td>
<td>22</td>
<td>6.03</td>
</tr>
<tr>
<td>Communications equipment, computers and other electronic equipment manufacturing</td>
<td>32</td>
<td>25</td>
<td>6.85</td>
</tr>
<tr>
<td>General equipment manufacturing</td>
<td>48</td>
<td>42</td>
<td>11.51</td>
</tr>
<tr>
<td>Food manufacturing</td>
<td>61</td>
<td>52</td>
<td>14.25</td>
</tr>
<tr>
<td>Total</td>
<td>435</td>
<td>365</td>
<td>100.00</td>
</tr>
</tbody>
</table>
3.2 Determination of ideal values for indices

For industrial land use, ideal values for indices of volume rate and intensity of buildings should be different because the production characteristics and manufacturing techniques for different industries are different; this means that the height and space of their buildings are different. For example, the large equipment manufacturing and furniture industry requires a lot of space for storage, which leads to low plot ration; it is hard to compare them to other industries. Some research has proved that the level of industrial intensive land use has much to do with the regional economy, stage of urban development and different industrial characteristics (Tan et al., 2009; Zhao et al., 2010).

Therefore, based on real indices of different industries, we adopted the interval estimated method to determine ideal values by analyzing real interval values of 95% samples. Using the transportation and equipment manufacturing industry as an example, ideal values of evaluated indexes are indicated in Table 3.

3.3 Constructing known classification set

With reference to classification of types of Intensive Land Use in The evaluation of Intensive Land Use for construction TD/T1018-2008, which defines [100%I, 95%I] as overuse, (95%I, 75%I] as intensive use, (75%I, 50%I] as moderate use, (150%I, 0%I] as low use (Table 4).

3.4 Discriminant function

According to the classification set of land intensive use evaluation in transportation equipment manufacturing, Bayes discriminant functions are set up and significance inspected (Table 5).

The model’s significance is inspected using Wilks statistic. The inspection result (Table 6) shows that the model is more evident at the level of 1% significance and the discriminant result is good.

3.5 Discriminant results

According to established discriminant functions, the analysis of 42 companies from transportation equipment manufacturing is presented in Table 7.

3.6 Potential calculation

Based on the ideal values of indices, the potential area of enterprises with moderate use and low use can be calculated by applying the method of geometry averages.

$$Q = \sum_{i=1}^{n} S_i (1 - P_i)$$

$$P_i = \sqrt[\prod R_j]{I_{ij}}$$

where, $Q$ represents the potential total area of typical enterprises; $S_i$ represents the total area of company $i$; $P_i$ represents the comprehensive degree of intensity of company $i$; $R_{ij}$ represents the reality of index $j$ in the company $i$; and $I_{ij}$ represents the ideal value of index $j$ in the company $i$.

3.7 The evaluation and potential analysis of land intensive use for typical industrial enterprises

The same method is applied to judge the degree of land intensity in 323 companies from eight industries (e.g. food industry, mineral industry, and chemical industry) and judge the potential of companies with moderate and low land use.
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3.8 Analysis of evaluation results

Among 365 enterprises, 68 use land excessively, accounting for 18.63% of the total sample; 82 are evaluated to use land intensively, accounting for 22.47% of the total sample; 215 use land moderately and low, which accounts for 58.90% of the total sample (Table 8). The larger proportion of enterprises with intensive use are from the metal smelting and rolling processing industry, accounting for 66.67%; and communication equipment, computer and other electronic equipment manufacturing accounting for 40.00%. The larger proportion of enterprises with moderate use and low use are special equipment manufacturing industries, accounting for 83.33%; the pharmaceutical manufacturing industry accounted for 77.27%, and the chemical raw materials and chemical industry accounted for 68.29%. The potential area for enterprises with moderate and low use is approximately 865.70 ha and accounts for 42.38% of total current land approved. These data indicate that the potentiality of intensive use is huge.

4 Proposals

The intensive use of industrial land is guaranteed by perfect economic policy, technical specification and administrative and legislative policies. Existing policies on urban land intensive use are often limited to administrative and legislative policies and other aspects need to be strengthened. In terms of the economic policy and system,
their incentives should be exploited by levying land-unused tax, increasing the rate of taxation on land use, added-value taxes of land use and taxes on the use of plough and by granting tax preferences to capital-intensive and technology-intensive enterprises. In terms of the technological system and policy, criteria for scientific land use should be formulated by considering the characteristics of different industries and once the criteria of land use are established, they must be executed strictly. The authority of land administration should reinforce supervision and examination of utilized land to urge land users to invest and construct according to planning. As for land that lacks project funds or where funds are insufficient, land with low efficiency could be separated and used by enterprises that run well and need more land through negotiation and compensation. The land that has not been invested and constructed must be taken back and deployed again. As for land that has already been completed with investment and construction, controlling indices such as intensity of investment, density of buildings and its rate of capacity must be written clearly into the contract of land sales. Those who break the contract must pay a large sum or fine to urge land users to use land intensively.

The present mechanism and pattern of ‘supply determined by demand’ chiefly based on negotiation must be changed to plan control, plan orientation and marketing operation so that all industrial land enters development and industrial-clustered zones. The mechanism of marketing supply in industrial land must be perfected and the basic function of price in allocating land resources must be exploited, and the proportion of the rate of inviting bids and sales must be increased. In addition, the published system of the lowest price of industrial land must be established to suppress immoral behavior in inviting investment.

## References


湖北省工业用地集约利用综合评价
——基于365家典型工业企业的问卷调查

陈 昱

郑州轻工业学院经济与管理学院，郑州 450002

摘要：通过构建由用地结构、用地强度、土地投入和土地产出4个子目标层、9个因素层组成的工业企业土地集约利用评价指标体系，采用Bayes判别法，对湖北省9个工业行业的365家典型工业企业土地集约度进行判别分析，并对中度和低度利用企业可挖掘潜力进行了测算。结果显示：365家企业中，集约利用企业共82家，占企业总数的22.47%，中度和低度利用企业共215家，占企业总数的58.90%；集约利用企业比例较大的是金属冶炼及压延加工业和通信设备、计算机及其他电子设备制造业，中度和低度利用企业比例较大的是专用设备制造业、医药制造业和化学原料及化学品制造业。中度和低度企业集约利用潜力总面积为865.70ha，占企业批准用地总面积的42.38%，土地集约利用潜力巨大。

关键词：土地资源管理；集约利用；Bayes判别；工业用地；潜力挖掘