

# GEM-based evaluation of competitiveness of enterprise cluster

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## Abstract

Enterprise cluster development can improve development capacity of enterprises and industrial competitiveness by lowering cost, stimulating innovations, increasing efficiency and intensifying competition. It is one key industrial development trend in the future and an important consideration of enterprises in choosing regions. Recently, industrial cluster in China has achieved primary development. Provinces and cities are putting great efforts to creating industrial parks of Industrial Cluster. This plays an important role in promoting regional economic development and regional industrial competitiveness. In this paper, a competitiveness evaluation model of enterprise cluster was established using the GEM model. It was applied to the furniture enterprise cluster in Guangdong Province. Accuracy, time effectiveness, advantages and disadvantages of the model was analyzed through the case study. Advantages and disadvantages of regional enterprise cluster can be identified from competitiveness analysis of the model. Countermeasures to these disadvantages were suggested.

*Keywords:* GEM model cluster competitiveness

## 1 Introduction

Industrial cluster is a spatial aggregate of enterprises of an industry with different scales and levels as well as behavioral agents related to their development (e.g. institutions and organizations) within a certain region. They have clear division of labor and are closely connected through a complicated network. Industrial cluster represents a new form of economic organization between enterprise and market. Enterprise cluster development is overwhelming in the world, thus attracting great attentions from economists and managerialists. Facing with economic globalization and regional economic integration, enterprise cluster development has become a new organizational pattern and development trend of regional economy. It enables enterprises to make full use of their advantages and achieve scale economies effect at a small scale, improving competitiveness of both enterprises and enterprise cluster. Currently, research attentions are paid to evaluation of competitiveness, advantages and disadvantages of enterprise cluster as well as analysis of measures to improve competitiveness. Industrial cluster development in China just starts. Scholars focus on qualitative research of enterprise cluster, but reported few model-based researches on the competitiveness of enterprise cluster. This paper established a competitiveness evaluation model of enterprise cluster based on GEM model, which was used to analyze competitiveness of the furniture enterprise cluster in Guangdong Province.

## 2 Competitiveness evaluation model of enterprise cluster

### 2.1 MEDEL CONSTRUCTION

GEM model is improved from the diamond model by Tim Padmore and Hervey Gibon, which can be used for quantification. It determines 6 major influencing factors of cluster competitiveness: resources, facilities, suppliers and relative assistance industries, enterprise strategies and competition, local market and external market. They can be divided into three groups: 1) fundamental factors: resources and facilities; 2) enterprise factors: suppliers and relative assistance industries as well as enterprise strategies and competition; 3) market factors: local market and external market. Compared to the diamond model, GEM model is superior for factor quantification. Factor quantification includes three steps:

Step 1: Assignments. These 6 influencing factors are level-1 evaluation indexes. To evaluate them, level-2 indexes will be generated and assigned with value. Suppose these 6 influencing factors are  $A, B, C, D, E$  and  $F$ , and their level-2 indexes are  $A(a_1, a_2, \dots, a_i)$ ,  $B(b_1, b_2, \dots, b_j)$ ,  $C(c_1, c_2, \dots, c_l)$ ,  $D(d_1, d_2, \dots, d_n)$ ,  $E(e_1, e_2, \dots, e_m)$ ,  $F(f_1, f_2, \dots, f_u)$  and, respectively. Score these level-2 indexes from 0-5. The higher the better and 3 is the mean level or pass line.

Step 2: Calculation. Assignments are often implemented by several experts or senior management of the industry. Mean of their assignments shall be calculated.

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Moreover, different level-2 indexes have different weights because of their different influences. Scores of level-1 indexes shall be calculated according to weights of corresponding level-2 indexes:

$$\left\{ \begin{array}{l} a_1 = \frac{\sum_{q=1}^N a_{1q}}{N} \\ a_2 = \frac{\sum_{q=1}^N a_{2q}}{N} \\ \dots \\ a_i = \frac{\sum_{q=1}^N a_{iq}}{N} \end{array} \right\} \left\{ \begin{array}{l} b_1 = \frac{\sum_{q=1}^N b_{1q}}{N} \\ b_2 = \frac{\sum_{q=1}^N b_{2q}}{N} \\ \dots \\ b_j = \frac{\sum_{q=1}^N b_{jq}}{N} \end{array} \right\} \left\{ \begin{array}{l} c_1 = \frac{\sum_{q=1}^N c_{1q}}{N} \\ c_2 = \frac{\sum_{q=1}^N c_{2q}}{N} \\ \dots \\ c_l = \frac{\sum_{q=1}^N c_{lq}}{N} \end{array} \right\} \left\{ \begin{array}{l} d_1 = \frac{\sum_{q=1}^N d_{1q}}{N} \\ d_2 = \frac{\sum_{q=1}^N d_{2q}}{N} \\ \dots \\ d_n = \frac{\sum_{q=1}^N d_{nq}}{N} \end{array} \right\} \left\{ \begin{array}{l} e_1 = \frac{\sum_{q=1}^N e_{1q}}{N} \\ e_2 = \frac{\sum_{q=1}^N e_{2q}}{N} \\ \dots \\ e_m = \frac{\sum_{q=1}^N e_{mq}}{N} \end{array} \right\} \left\{ \begin{array}{l} f_1 = \frac{\sum_{q=1}^N f_{1q}}{N} \\ f_2 = \frac{\sum_{q=1}^N f_{2q}}{N} \\ \dots \\ f_u = \frac{\sum_{q=1}^N f_{uq}}{N} \end{array} \right\} \quad (1)$$

$N$  is number of people participated in the assignments.

$$\begin{aligned} A &= \sum_{p=1}^{p=i} \alpha_p a_p, B = \sum_{p=1}^{p=j} \beta_p b_p \\ C &= \sum_{p=1}^{p=l} \gamma_p c_p, D = \sum_{p=1}^{p=n} \phi_p d_p, \\ E &= \sum_{p=1}^{p=m} \varphi_p e_p, F = \sum_{p=1}^{p=u} \theta_p f_p \end{aligned} \quad (2)$$

where  $(\alpha, \beta, \gamma, \phi, \varphi, \theta)$  is weight of level-2 indexes, respectively.

Step 3: Calculate and convert factor groups, and calculate the final results:

$$P_1 = \frac{A+B}{2}, P_2 = \frac{C+D}{2}, P_3 = \frac{E+F}{2} \quad (3)$$

$$DEM = 2.5 \left[ \prod_{i=1,2,3} P_i \right]^{2/3} \quad (4)$$

### 2.2 MODEL APPLICATION

The established model was used to evaluate competitiveness of furniture enterprise cluster in Guangdong Province. Beijing Forestry University investigated furniture enterprise cluster in Guangdong Province in 2012. Level-2 indexes of resources include labor supply, technician supply, raw material supply and fund supply. Level-2 indexes of facilities are facilities of industrial park, transportation conditions, public R&D institutions, support of industry association and business environment. Level-2 indexes of assistance industries include professional level of local suppliers, local device supply and cooperation & communication with local associated enterprises. Level-2 indexes of enterprise strategies and competition are goal orientation of enterprise development strategies, property right structure, competition and ambition of senior executives. Level-2 indexes of local

market are domestic market share, influence of domestic market and domestic market prospect. Level-2 indexes of external market include international market share, influence of international market, entry barriers of international market and international market prospect. Assignments of 6 level-1 indexes are listed in Table 1.

TABLE 1 The value of the variable

A	B	C	D	E	F
3.40	3.82	3.96	3.97	3.77	3.59

According to the Table 1, competitiveness of the furniture enterprise cluster in Guangdong Province can be calculated:

$$P_1 = \frac{A+B}{2} = 3.61$$

$$P_2 = \frac{C+D}{2} = 3.97,$$

$$P_3 = \frac{E+F}{2} = 3.68$$

$$\begin{aligned} DEM &= 2.5 \left[ \prod_{i=1,2,3} P_i \right]^{2/3} = \\ &2.5 [3.61 \cdot 3.97 \cdot 3.68]^{2/3} = 35.15 \end{aligned}$$

Above analysis data reveal that the furniture enterprise cluster in Guangdong Province has limited competitive edges.

Firstly, resources and external market are inferior. Resources are calculated 3.40, the lowest one and least competitive of 6 influencing factors. The external market is calculated 3.59. Although it is higher than resources, its competitiveness is still unsatisfying and needs further improvement. They are against the overall competitiveness of enterprise cluster. Specifically, labor shortage is a common problem in furniture industry. Some enterprises even suffer collective strikes for low wage level. Although China's furniture industry is facing with raw materials shortage, especially imported timbers, the raw material supply in Guangdong Province is strongly

supported by its geographical advantages and stable import channels built for years. Moreover, Guangdong Province is one of wealthy regions in China, which intensifies support to furniture industrial development. The furniture industry in Guangdong Province depends on external markets significantly. The furniture industry in Guangdong Province developed from processing trade-oriented joint ventures with Hong Kong and Taiwan investment. Later, supported by geographical advantages and the reform and open up, it shows stronger export preference than other regions in China. However, its furniture products enter into the international market as original equipment manufacturer (OEM) products and have no real influence in international market. This determines the high susceptibility of Guangdong furniture export to international market fluctuations. Viewed from international market prospect, with rich export experiences and advantages, furniture industry in Guangdong Province has stronger market penetration than rest regions in China.

Secondly, enterprise strategies and assistance industries have a distinct advantage. In Table 1, enterprise strategies get the highest scores, indicating the strongest competitiveness than other factors. For assistance industries, the furniture industrial cluster in Guangdong Province is poorer than those in other regions. It is characteristic of "big cluster-small enterprise". According to level-2 indexes, most furniture enterprises in Guangdong haven't made long-term strategic development plan yet. Vicious competition among similar enterprises is universal, such as mutual imitation and race to keep the prices down. Most executives didn't receive high education and have no ambitions and entrepreneur spirit. On the contrary, support of suppliers and relative assistance industries in Guangdong furniture industry ranks the top in China. Since furniture industrial cluster began early in Guangdong Province, it has established a developed division of labor within the industry, leading to the high professional level of suppliers and strong local device supply. However, limited by traditional competition concept between enterprises, cooperation and communication of furniture enterprises in Guangdong Province with local associated enterprises still has a great development space.

Thirdly, facilities and local market are not so competitive. Facilities of industrial park are evaluated less competitive. This is because the furniture enterprise cluster in Guangdong Province is formed spontaneously under the drive of market economy, without government leading and normal planning. In transportation, Guangdong possesses well-developed highways, railways and ports, which improve logistics efficiency of local furniture industry significantly. Furniture enterprise cluster in Guangdong province has cutting edges in public R&D institutions, support of industrial association and business environment. Guangdong Province, the earliest region developing market economy in China, has standard business environment and clear orientation of industry

association. These can provide favorable services and supports for industrial development. Furniture enterprise cluster in Guangdong province occupies at least 30% domestic market share, the highest in China. Influenced by traditional regional brands and promoted by furniture exhibition, it takes the dominant role in domestic market. However, its development prospect in domestic market is gloomy. This is caused by its attention on labor-intensive products with low value added, intensifying competition with other domestic regions and higher production cost than Chinese mainland.

### 2.3 MODEL ANALYSIS

**Accuracy.** Model accuracy is mainly determined by the reasonability of level-2 indexes, that is, whether level-2 indexes can reflect conditions of level-1 indexes comprehensively. If yes, the model has high accuracy and the calculated results can reflect the real competitiveness of level-1 indexes; otherwise, the evaluation results will deviate from real performance of level-1 indexes.

**Time effectiveness.** Given fixed settings, any model can only provide short-term time effectiveness, because any condition change of industry cluster will change the corresponding environment accordingly. As a result, the time effectiveness of mode is limited. However, this can be solved by using same calculation method but changeable indexes (both level-1 and level-2 indexes). Actually, environment keeps stable in a short period. For long-term evaluation, level-2 indexes shall be changed accordingly, followed by level-1 indexes. If there's great environmental change, level-1 and level-2 indexes shall be changed simultaneously.

**Advantages and disadvantages.** Model advantages can be analyzed quickly from data collected through a simple survey. Since 6 level-1 indexes involve both internal and external environmental changes and the level-2 indexes can be updated as needed, the model can reflect competitiveness of enterprise cluster comprehensively. However, it still has some disadvantages. Firstly, it requires professional surveys. The number of people participated in assignments is proportional to the model accuracy. Secondly, its calculation is simple. Indexes couldn't represent all aspects of enterprise clusters.

### 3 Suggestions

The model is used to evaluate competitiveness of regional enterprise cluster, but its ultimate goal is to improve competitiveness of regional enterprise cluster. In view of the involved six influencing factors, it is suggested to:

Enhance policy support and perfect soft and hard environments. Policy support includes direct support and indirect support. Direct support refers to financial assistance and preferential policies to enterprises within the cluster. Indirect support refers to governmental supports through optimizing infrastructures and market order. In China hard environmental improvement refers

to perfect infrastructures in places of enterprise cluster, such as transportation, water, electricity, shopping, school, hospital, entertainment, fitness centers, etc. Soft environmental improvement including optimizing market order, enhance market supervision and management, improving unreasonable market provisions, promoting high-efficient market operation, building talent management and training system, as well as establishing channels for communication and cooperation between enterprises.

Increase talent recruitment, strengthen independent innovation, and improve continuous competitiveness of industrial cluster. Entrepreneurs shall bring new ideas to management and system, including reform and innovation of organizational system, management system and human resource system. They shall focus on creating an enterprise cultural atmosphere to train, attract and retain talents. Enterprises shall pay more attentions on vocational education to improve knowledge and quality of workers. Meanwhile, great efforts in implementing talent strategies and introducing advanced talents and management experiences are needed, so that talents can be trained and retained permanently. Furthermore,

enterprises can enhance technological innovation through various ways, for example, increasing investment to technological development, establishing technological development institutes with universities and scientific research institutes, etc.

Implement regional information share and reinforce enterprise competition and cooperation. Disordered and vicious competition is a big problem of industrial cluster. Accelerating the construction of resource share and public service platform is the only one solution to this problem. It can overcome transaction difficulties caused by incomplete information and lower information search cost to a certain extent. Nowadays, Chinese enterprises in a region pay more attention to competition rather than harmonious development and copy from each other instead of create new products. Such vicious competition is distressing. Therefore, enterprises focus on mutual cooperation (e.g. Joint-funded R&D center, enterprise cluster or enterprise alliance) when compete with each other. A regional coordination development mechanism shall be established to create a multi-win structure.

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