Research on Quantitative Measurement and Feature Analysis of Industrial Overcapacity

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Based on the production function method, this paper examines Chinese industry under the different stages of Chinese economic development. The study involves selected indicators of the gross value of industrial output, fixed capital stock, labor input, and energy input. In addition, the panel data fixed effects model is used to measure the capacity utilization of Chinese industries, and analyze the main features of the excess capacity. Finally, according to the research results, this paper puts forward some suggestions to solve the contradictions between overcapacity.

Keywords: Excess Capacity, Capacity Utilization Rate, Feature Analysis

Introduction

Since 2008, influenced by the international financial crisis, the international market demand has been weak, with many Asian developing countries showing a trend of slow economic growth. Scale expansion and over-investment make the growing industrial capacity of developing countries in Asia problematic. Serious overcapacity will lead directly to product price weakness, affect investment efficiency, and harm the quality of economic growth¹. Therefore, this research quantitatively measures the capacity utilization, and analyzes features of excess capacity to improve productivity.

Overview of excess capacity

Many scholars have analyzed the measurement of excess capacity. Lee et al. used the fundamental price theory to re-examining the optimum capacity of the US lodging industry². Khadim et al. used two computer software packages to estimate the maximum sustainable yield of the L. calcarifer fishery from Pakistani waters which indicates that the fishery is over-exploited³. Wang Y used the data envelopment analysis method to measure the level of overcapacity⁴. He L measured the capacity utilization of China's 36 industrial sectors using the panel cointegration method⁵. Yang Z B et al. used the transcendental logarithmic production function to measure the excess production index of China's industrial sector⁶. The foregoing studies have focused on the measure of production capacity and excess capacity but have paid less attention to the characteristics of excess capacity. This paper will further explore the relative insufficiency measure of excess capacity in China and conduct an in-depth analysis of the features of overcapacity at different stages of economic development.

Empirical analysis

Measuring methods and models

Production function method is a method of parameter estimation. The most widely used form of the production function method is the C–D function, which is calculated using capital and labor input indicators. Energy is also an important input to the industrial sector⁷-⁸. Therefore, this paper adopts the modified C–D function:

$$Y_t = f(K_t, L_t, E_t)e^{-\mu} = AK_t^\alpha L_t^\beta E_t^\gamma e^{-\mu} \quad \ldots (1)$$

Where $Y_t$ is the level of output, $A$ is the factor of technical progress, $t$ means time trend, $K_t$ is the input of capital, $L_t$ is the input of labor, $E_t$ is the input of energy elements, $\alpha$, $\beta$, $\gamma$, respectively, is the output elasticity of capital, labor and energy, satisfying: $\alpha + \ldots$
\[ \beta + \gamma = 1, \quad \text{and} \quad 0 \leq \alpha, \beta, \gamma \leq 1. \]

The actual boundary production function is:

\[ \ln Y^* - \ln E_t = \ln A + \alpha (\ln K_t - \ln E_t) + \beta (\ln L_t - \ln E_t) \quad \cdots (2) \]

In which \( Y^* \) is the theoretical maximum output level. Using the least squares estimation, we can get the average production function:

\[ \ln \bar{Y}_t / E_t = (a - \bar{u}) + \bar{u} \ln K_t / E_t + \bar{v} \ln L_t / E_t \quad \cdots (3) \]

According to the characteristics of the boundary production function, the boundary of the required production function is:

\[ Y_t = e^{\bar{u} K_t ^{\alpha} L_t ^{\beta} E_t ^{-\gamma}} \quad \cdots (4) \]

The above steps are used to calculate the theoretical capacity, and the capacity utilization formula (CU) = actual capacity / theoretical capacity.

**Indicators and data**

According to the standards published by the National Economic Classification, the Chinese industry can be divided into three categories: the mining industry, the production and supply of electric heating gas, and water, and manufacturing, with a total of 39 industrial sectors. And based on the character of the industry, manufacturing industry can be divided into light industry and heavy industry. Due to the value of small, short sequence, and statistical caliber inconsistencies, this paper ignores 4 industries. This paper selects the relevant data of Chinese industrial sector and remaining 35 industries from 2000 to 2014 to calculate the capacity utilization. The output indicators are measured by the gross industrial output value of each industrial sector. The industrial fixed capital stock data of different industries are constructed via perpetual inventory method. The labor inputs are measured by the average number of employees of industrial enterprises above a designated size. The energy inputs for each industrial sector are measured by the gross annual energy consumption per 10,000 tons of standard coal units.

**Model parameter estimation and calculation**

In this paper, using Eviews 8.0 software to test the data model of the panel, we determine the panel data model for the fixed-effect variable intercept model. According to the corresponding expression and the above model steps, we can get the frontier production. The frontier production function is used to estimate the theoretical capacity, and the formula CU= actual capacity / theoretical capacity is used to obtain the capacity utilization rate of China total industry and 35 industries in 2000-2014.

**Empirical results and feature analysis**

Internationally, it is generally thought that a capacity utilization rate of less than 75% (not included) represents serious excess capacity. Referring to existing research, this paper divides the capacity utilization rate into four nodes: 75%, 79%, 90%, and 100%, and defines the capacity utilization falling in the interval of (0, 75%) as serious overcapacity, [75%, 79%) as mild overcapacity, [79%, 90%) as a basic balance between supply and demand, (90%, 100%) as a lack of capacity.

**Analysis of overcapacity in China's whole industry area**

From the calculation, we get the frequency statistics of Chinese industrial capacity in 2000–2014, and get the trend of China's GDP growth rate and industrial capacity utilization (shown in Figure 1). From 2000 to 2014, there are 6 years of capacity utilization in the interval of [79%, 90%), 6 years of capacity utilization in the interval of [75%, 79%), 2 years of capacity utilization in the interval of (0, 75%), and 1 year of capacity utilization in the interval of (90%, 100%). Overall, China's industrial sector is in overcapacity during more than half of the years between 2000 and 2014, and the capacity utilization is low. As can be seen from Figure 1, the change of capacity utilization rate of the Chinese industrial sector is generally consistent with fluctuation of the economic cycle.

**Analysis on the features of overcapacity in industrial subsectors**

From the calculation, we rank the average utilization rate of 35 industrial sectors in China from 2000 to 2014 and get the average of capacity
utilization and the excess capacity of 13 overcapacity industries. As shown in Figure 2, there is a sharp distinction in capacity utilization among the 35 industries. In general, the capacity utilization of China's mining industry and the water and gas industry is low. There is a sustained excess capacity phenomenon. The capacity utilization is in a high-level state of long-term stability in most of the light industries, such as the manufacture of foods, and the manufacture of furniture. Heavy industries with advanced knowledge or technology have relatively high capacity utilization, such as the manufacture of electrical machinery and equipment, and the manufacture of communication equipment, computers and other electronic equipment. Combined with China's economic development cycle and capacity expansion period, 2000–2014 is divided into four stages. T, I, II, III and IV respectively, mean the periods of 2000-2014, 2000–2002, 2003–2007, 2008–2011, and 2012–2014. Since 2009, the range of overcapacity in China's industrial sectors has been gradually expanding. As can be seen from Table 1, there are 13 major industrial sectors in overcapacity, of which 11 major industrial sectors in a serious excess capacity. The characteristics of China's overcapacity industry are: 1) Overcapacity industries are concentrated in the heavy chemical industry and mineral resources industry, 2) the industries with excess capacity are mostly labor-intensive or capital-intensive industries with low efficiency of production factor allocation and long-term blind investment, and 3) overcapacity industries are mostly associated

![Fig. 2 — The average capacity utilization ranking of Chinese 35 industrial sectors in 2000-2014](image)

<table>
<thead>
<tr>
<th>Sector</th>
<th>T</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>The excess capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production and Supply of Water</td>
<td>71.57</td>
<td>88.95</td>
<td>70.79</td>
<td>66.02</td>
<td>62.87</td>
<td>strong</td>
</tr>
<tr>
<td>Production and Supply of Gas</td>
<td>72.04</td>
<td>58.65</td>
<td>64.44</td>
<td>86.45</td>
<td>78.86</td>
<td>strong</td>
</tr>
<tr>
<td>Extraction of Petroleum and Natural Gas</td>
<td>72.09</td>
<td>87.80</td>
<td>71.54</td>
<td>66.70</td>
<td>64.47</td>
<td>strong</td>
</tr>
<tr>
<td>Smelting and Pressing of Non-ferrous Metals</td>
<td>74.17</td>
<td>71.49</td>
<td>78.30</td>
<td>70.97</td>
<td>74.26</td>
<td>strong</td>
</tr>
<tr>
<td>Processing of Petroleum, Coking, Processing of Nuclear Fuel</td>
<td>74.73</td>
<td>94.43</td>
<td>78.82</td>
<td>65.07</td>
<td>61.10</td>
<td>strong</td>
</tr>
<tr>
<td>Mining and Processing of Nonmetal Ores</td>
<td>74.49</td>
<td>61.51</td>
<td>73.69</td>
<td>83.60</td>
<td>76.36</td>
<td>strong</td>
</tr>
<tr>
<td>Mining and Processing of Ferrous Metal Ores</td>
<td>74.62</td>
<td>78.34</td>
<td>67.31</td>
<td>76.44</td>
<td>80.65</td>
<td>strong</td>
</tr>
<tr>
<td>Smelting and Pressing of Ferrous Metals</td>
<td>77.53</td>
<td>71.31</td>
<td>85.00</td>
<td>74.05</td>
<td>75.94</td>
<td>strong</td>
</tr>
<tr>
<td>Manufacture of Non-metallic Mineral Products</td>
<td>77.78</td>
<td>75.40</td>
<td>81.53</td>
<td>75.93</td>
<td>76.38</td>
<td>strong</td>
</tr>
<tr>
<td>Mining and Washing of Coal</td>
<td>78.47</td>
<td>85.52</td>
<td>77.49</td>
<td>74.27</td>
<td>78.66</td>
<td>strong</td>
</tr>
<tr>
<td>Printing, Reproduction of Recording Media</td>
<td>78.69</td>
<td>74.68</td>
<td>82.04</td>
<td>78.97</td>
<td>80.39</td>
<td>weak</td>
</tr>
<tr>
<td>Manufacture of Textile Clothing, Footwear, and Caps</td>
<td>78.94</td>
<td>93.08</td>
<td>76.83</td>
<td>76.58</td>
<td>75.68</td>
<td>strong</td>
</tr>
<tr>
<td>Mining and Processing of Non-Ferrous Metal Ores</td>
<td>80.14</td>
<td>92.47</td>
<td>83.17</td>
<td>73.17</td>
<td>72.08</td>
<td>weak</td>
</tr>
</tbody>
</table>
with high pollution and high energy consumption. Environmental constraints are increasingly prominent\textsuperscript{9-10}.

**Conclusions and recommendations**

This paper uses production function method to calculate the capacity utilization of Chinese industrial sectors from 2000 to 2014 and analyzes the features of the excess capacity. The main results are as follows. (i) The change of capacity utilization rate of the Chinese industrial sector is generally consistent with fluctuation of the economic cycle. (ii) Capacity utilization differs significantly across 35 Chinese industrial sectors; Overcapacity mainly presents a structural characteristic. According to the research conclusions, this paper puts forward the following recommendations. Firstly, the state should construct and improve new institutional production market mechanisms, utilize price leverage, and optimize market resource allocation, thereby promoting economic health development and improving industry capacity utilization. Secondly, enterprises should continue to increase R&D investment, promote terminal application of the new-generation network technology, and form independent intellectual property rights of industrial technology system to achieve industrial transformation and upgrading.

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**References**