Research on evaluation of intensive economic benefits of equipment manufacturing enterprises

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Abstract. Intensive economic benefit is the result that the total factor productivity is improved by improving the utilization efficiency and combination quality of asset elements and human elements, and the increased output exceeds the total input of asset elements and human elements. In order to analytical study of smart manufacturing level and intensive economic benefit, by taking Liaoning Equipment Manufacturing Enterprise as the research object this paper establishes production function model and total factor productivity model of relationship between input and output of Liaoning Equipment Manufacturing Enterprise. Meanwhile by establishment grows model of total factor productivity it realizes measure of smart manufacturing level and intensive economic benefit of Liaoning Equipment Manufacturing Enterprise. Final by contrastive analysis total factor productivity and increase economic efficiency of contribution rate of equipment manufacturing enterprise this paper puts forward feasible countermeasures and suggestions to increase total factor productivity and realize intensive management of Liaoning Equipment Manufacturing Enterprise.

1. Introduction

Intensive The intensive management of equipment manufacturing enterprises is a kind of production and operation management mode that enterprises rely on improving the level of production technology, improving the utilization degree of labor resources, material resources, capital and other production resources to achieve the best combination of production factors and produce customized products at the lowest cost [1-2]. The intensive level is a measure of the intensive operation degree of an enterprise, it refers to the proportion of the relative growth of the industrial output value or product output of the enterprise by improving the total factor production efficiency. Intensive economic benefit (IEB) is the output effect that enterprises increase and the quantity of output exceeds the total input of production factors by increasing the total factor productivity (TFP). On the one hand, the improvement of the utilization efficiency of production factors reduces the input of all production factors consumed per unit product; on the other hand, the optimization of human and asset resources and intelligent production increase the efficiency of total factor production and increase the value of total output [3]. This index fully reflects the combined utilization effect and optimal allocation benefit of the production resources invested by the equipment manufacturing enterprise [4].

Throughout the research on the intensive operation and economic benefits of equipment manufacturing enterprises by relevant experts at home and abroad, the first is that the higher the proportion of industrial output value or product quantity growth depends on the improvement of labor productivity, the higher the degree of intensive operation of enterprises [5]; Second, it advocates the
comprehensive improvement of labor productivity and capital output rate as the main standard of enterprise intensive management [6-7]; Third, it advocates the comprehensive utilization and quality dynamic index system of labor productivity and other production factors as the judgment standard of intensive management degree [8].

The advantages of these evaluation methods are strong intuition and operability, but these research processes also have some shortcomings to a certain extent: First, it only reflects the utilization effect of production factors from the perspective of single index of production consumption, but it ignores the integration effect of all production factors such as human resources and assets, thus lacking comprehensiveness; Second, it does not reveal the level of economic benefits of intensive management from the perspective of optimal allocation of resources; Third, the comprehensive utilization of production factors of equipment manufacturing enterprises is not closely linked with the ability of sustainable development, so it is lack of dynamic.

Based on the research views of domestic and foreign scholars, intensive economic benefit calculation is to analyze the change of total factor production efficiency to reveal its level. Therefore, based on the establishment of production function model, this study establishes the total factor production efficiency model and the total factor production efficiency growth rate model, and then establishes the intensive economic benefit model. Then it can realize the scientific measurement of enterprise total factor efficiency and intensive economic benefits, and it will provide technical support for improving the level of intensive operation and intensive economic benefits of Liaoning equipment manufacturing enterprises.

2. Analysis method of enterprise intelligent manufacturing level and intensive economic benefit

With the improvement of total factor production efficiency of enterprises, it will inevitably lead to the improvement of enterprise's intensive economic benefit, which is closely related to the relative increase of total output or the relative saving of total input factors [9]. Therefore, only by calculating the growth rate of total factor production efficiency can we realize the intensive economic benefits of enterprises and the analysis process of intelligent manufacturing level [10].

2.1. Total factor production efficiency model

Total factor production efficiency is the ratio of the total output of an enterprise to the total input of all production factors such as assets and human resources in a certain period of time [11]. The calculation formula is as follows:

\[ TEP = \frac{Q}{M + bp} \]  

In Equation (1), the TFP is the total factor production efficiency; Q is the total output in a certain period; P is the input of asset elements; M is the input of human factors; b is the ratio of asset elements and human resources in the process of production, that is converting asset elements into human resources according to a certain equivalent [4]. The calculation formula is as follows:

\[ b = \frac{\alpha M^1}{\beta P^1} \]  

In Equation (2), the \( M^1 \) and \( P^1 \) are the average value of human factors and asset factors of all evaluation samples in a certain research period; \( \alpha \) is the output elasticity coefficient of asset elements, and \( \beta \) is the output elasticity coefficient of human factors. By establishing production function model of sample enterprises, \( \alpha \) and \( \beta \) can be obtained.

2.2. Construction of production function model

The production function is the technical relationship between the quantity and combination of production factors such as assets and human resources and the quantity of output under certain production technology conditions [12]. The production function model of sample enterprises can be
established by regression analysis of sample statistical data with least square method. The mathematical model of production function is as follows:

\[ Q = A^\alpha P^\beta M^\gamma \]  

(3)

In Equation (3), the Q is the output quantity; A is the level of technological progress, with the advent of industry 4.0 era, a more reflects the enterprise production organization, management level, technological innovation and intelligent production capacity, which is named as intelligent manufacturing level; P is the input of assets; M is the amount of manpower input [6]; \( \alpha, \beta \) is the output elasticity coefficient of assets and human factors.

2.3. Intensive economic benefits

The intensive economic benefit is the increased output due to the improvement of total factor production efficiency. Therefore, as long as the total factor productivity growth rate is calculated, the intensive economic benefit analysis process can be completed [13]. The calculation formula of intensive economic benefit is as follows:

\[ IEB = Q - Q / (1 + g) \]  

(4)

In Equation (4), IEB is the intensive economic benefit; Q is the output; g is the growth rate of total factor production efficiency, through the comparison of total factor production efficiency in two different periods, we can get the conclusion [8]. The calculation formula is as follows:

\[ g = \Delta TFP / TFP_0 \]  

(5)

In Equation (5), \( \Delta TFP \) is the added value of total factor production efficiency in the current period; TFP0 is the total factor production efficiency of the previous period.

3. Case analysis

3.1. Total factor production efficiency model

This paper takes 10 equipment manufacturing enterprises as the research object, taking the relevant cross-sectional data of the above years as the evaluation sample, the operating income of each enterprise is taken as the total output (Q), the average amount of assets as the asset input factor (P), and the average number of employees as the human input factor (M), the relevant data of the previous year are shown in columns 2-4 of Table 1, and the relevant data of the previous year are slightly different.

3.2. Establishment of production function model for Liaoning equipment manufacturing enterprises

According to the principle of Cobb -Douglas production function created by C. W. Cobb and Paul H. Douglas [14], relevant data in Table 1 were input into regression analysis software, the production function model of Liaoning equipment manufacturing enterprise is obtained.

\[ Q = e^{4.083} P^{0.589} M^{0.536} \]  

(6)

Because the complex correlation coefficient (R) of the model is 0.970, it shows that the total output (Q) has a strong correlation with assets (P) and labor (M); At the same time, the significance test index (F) of the model is 58.387, it is much higher than the critical value \( F_{0.01}(2,7) = 9.547 \), and the Sig. of production function model is 0.000, which fully shows that there is a highly significant relationship between output (Q) and asset factor input (P) and labor factor input (M).

3.3. Analysis of production function of sample enterprises

According to the production function model (6), The asset factor output elasticity \( \alpha \) of sample enterprises is 0.643, it shows that under the condition of constant comprehensive technical efficiency,
when the input of asset element (P) increases 1%, the total output scale (Q) will increase 0.643%; The output elasticity $\beta$ of human factors is 0.482, which indicates that when the input of human factors (m) increases by 1%, the total output (q) will increase by 0.482%; because of this $\alpha + \beta = 1.125$, it shows that under the condition of constant comprehensive technical efficiency, when both the asset element (P) and the human element (M) increase the input by 1%, the total output (Q) will increase by 0.125%, it shows that the production function model is a model of increasing output scale, it also fully shows that Liaoning equipment manufacturing enterprises have the characteristics of intensive operation.

3.4. Analysis of total factor production efficiency of sample enterprises

According to the models (1)-(2), the total factor production efficiency of all sample enterprises is calculated, as shown in column 5 of Table 1.

| Order No. | Output Quantity (million) | Capital Investment (million) | Labour Input (person) | Total Factor Efficiency (million/person) | Intensive Economic Benefits (million) |
|-----------|--------------------------|------------------------------|-----------------------|------------------------------------------|--------------------------------------|
| 1         | 1714.80                  | 2905.10                      | 3176                  | 0.31                                      | 453.44                               |
| 2         | 308.76                   | 1063.39                      | 771                   | 0.19                                      | 110.58                               |
| 3         | 287.45                   | 693.80                       | 677                   | 0.23                                      | 112.33                               |
| 4         | 1077.41                  | 2038.23                      | 819                   | 0.44                                      | 323.11                               |
| 5         | 11481.23                 | 22638.02                     | 9732                  | 0.41                                      | 5538.19                              |
| 6         | 1583.16                  | 3463.62                      | 2268                  | 0.31                                      | 621.13                               |
| 7         | 458.69                   | 2312.09                      | 1069                  | 0.37                                      | 774.20                               |
| 8         | 169.77                   | 354.30                       | 399                   | 0.16                                      | 158.13                               |
| 9         | 4003.71                  | 4461.36                      | 9813                  | 0.30                                      | 985.25                               |
| 10        | 9592.78                  | 19647.17                     | 21378                 | 0.26                                      | 2332.01                              |

According to column 5 of Table 1, it can be seen that: (1) the enterprise with the highest total factor efficiency is sample 4 (0.44 million/person), the second is sample 5 (0.41 million/person), their total factor efficiency is above 40 million/person, it shows that these enterprises have high efficiency in the use of assets, human resources; (2) The enterprises with higher total factor efficiency are sample 7 (0.37 million/person), sample 6 (0.31 million/person) and sample 1 (0.31 million/person), their total factor productivity is between 30-40 million/person, it shows that these enterprises are in a good condition in the aspects of asset factor, human factor utilization efficiency; (3) The total factor productivity of general enterprises is sample 9 (0.30 million/person),sample 10 (0.26 million/person) and sample 3 (0.23 million/person), their total factor productivity is between 20-30 million/person, it shows that these enterprises are in a poor state in the aspects of asset factor, human factor utilization efficiency, corresponding measures should be taken to optimize the allocation of production factors; (4) The enterprises with low total factor efficiency are sample 2 (0.19 million/person) and sample 8 (0.16 million/person),their total factor productivity is below 20 million/person, it shows that these enterprises have great problems in the utilization efficiency of assets, human resources, we must optimize the allocation of production factors to improve the efficiency of total factor production.

3.5. Intensive economic benefit analysis of sample enterprises

The input and output data of 10 sample enterprises in the previous year are taken as samples, by taking logarithm of input-output cross-section data, then the correlation coefficient of the production function of the previous year is calculated by the least square method, the production function model of sample enterprises in the previous year is obtained:

$$Q = e^{1.09}P^{0.644}M^{0.513}$$  \hspace{1cm} (7)

The complex correlation coefficient (R) of the model is 0.984, it shows that the total output (Q) has a strong correlation with assets (P) and labor (m); At the same time, the significance test index (F) of
the model was 107.055, far greater than the critical value $F_{0.01}(2,7)=9.547$, and the Sig. of production function model is 0.000. It fully shows that output ($Q$) is highly significant with asset factor input ($P$) and labor factor input ($M$).

Application model (4), calculate the intensive economic benefits of 10 sample enterprises (as shown in column 6 of Table 1. According to the data in this column, it can be seen that: (1) The enterprise with the highest intensive economic benefit is sample 5 (5538.19 million), the second is sample 10 (2332.01 million); (2) The enterprises with higher intensive economic benefits are sample 9 (985.25 million), sample 7 (774.20 million), sample 6 (621.13 million), sample 1 (453.44 million) and sample 4 (323.12 million); (3) The enterprises with low intensive economic benefits are sample 8 (158.13 million), sample 3 (112.33 million) and sample 2 (110.58 million).

3.6. Study on the countermeasures of enterprise management

According to the data in columns 5 and 6 of Table 1, it can be seen that: (1) Sample 5, sample 7, sample 6, sample 1 and sample 4 are the enterprises with high total factor production efficiency and high intensive economic benefits, On the basis of maintaining the utilization efficiency of the existing asset elements and human elements, the five enterprises should strengthen the digital and intelligent construction of enterprises through technology updating and upgrading, and then improve the intelligent manufacturing ability of enterprises [15]; (2) The total factor production efficiency is medium, however, the enterprises with high intensive economic benefits are sample 10 and sample 9 respectively. On the basis of maintaining the leading level of existing production organization, management level, the two enterprises are urgent to optimize the allocation of assets and human resources to improve the utilization efficiency, so as to improve the total factor production efficiency and intensive economic benefits [16]; (3) The total factor production efficiency is low (or lower), but the enterprises with lower (or low) intensive economic benefits are sample 3, sample 2 and sample 8 respectively. These three enterprises not only need to strengthen the digital and intelligent construction of enterprises to improve their intelligent manufacturing capacity, but also need to optimize the allocation of asset elements and human elements to improve their utilization efficiency to improve their total factor production efficiency, and ultimately improve their intensive economic benefits [17].

4. Peroration

Using the input and output data of enterprises to establish the production function model can not only realize the comprehensive analysis of sample enterprises' intelligent manufacturing capacity, total factor production efficiency and intensive economic benefits, but also draw important research conclusions: (1) It is of great practical significance to assign the level of technological progress of production function model to the level of intelligent manufacturing for the analysis of digital and intelligent development of enterprises; (2) The comparative analysis of enterprise intelligent manufacturing capability and total factor production efficiency is used to provide important technical support for enterprises to optimize the allocation of asset elements and human factors, and to improve the intelligent manufacturing capability; (3) The results show that it is feasible and practical to use the growth rate of total factor production efficiency to measure the intensive economic benefits, which will provide a scientific basis for improving the effect of enterprise intensive management.

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