Analysis on the Industrial Linkage Effect of High-tech Manufacturing Industry in Fujian Province

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Abstract: This research comprehensively examines the forward and backward correlation effect of high-tech manufacturing industry in Fujian Province by using the Input and Output Extension Data. The results show that the influence coefficient of high-tech manufacturing industry in Fujian Province is higher than 1, which demonstrates a strong backward correlation effect and a strong driving effect on other national economic industries. In the analysis of the forward correlation effect, the sensitivity coefficient of low-energy high-tech manufacturing is lower than high-energy high-tech manufacturing. Thus, the research argues that the development of energy-consuming manufacturing industry cannot be controlled blindly in order to promote the further development of other national economic industries.

1. Introduction

Manufacturing is one of the important industries that determine the comprehensive strength and international competitiveness of the country. As a leading technology industry to promote the high-quality development of manufacturing industry, high-tech manufacturing industry is the development direction of the future industry. On March 5, 2019, at the second session of the 13th National People's Congress, Premier Li Keqiang of the State Council mentioned in the government work report that "the growth rate of high-tech industry and equipment manufacturing industry is obviously faster than that of general industries". If we can effectively improve the upstream and downstream of high technology manufacturing industry correlation effect, it will drive the common development of other related industries in the national economy. As an important starting point of the "Maritime Silk Road", Fujian Province is currently in a deep-water zone with industrial structure adjustment and transformation. How to further promote the development of high-tech manufacturing industry in Fujian Province, and how it will drive and affect other industries, become the focus of current concern. Thus, this research intends to use the newly compiled extension Table of Fujian's input-output Table to make a deep research on the development of this industry as well as industrial linkage effect. Besides, it can be used as a reference for the industrial optimization and upgrading of Fujian and the sound development of national economy.

2. Research on the Definition of High-tech Manufacturing Industry

As for the classification and definition of high-tech manufacturing industry, in the latest revised Classification of High-tech Industry (Manufacturing) (2017) (hereinafter referred to as Classification (2017)), the National Bureau of Statistics defines this industry as the following 6 types. It includes pharmaceutical manufacturing, aerospace, spacecraft and equipment manufacturing, electronic and communication equipment manufacturing, computer and office

equipment manufacturing, medical equipment and instrumentation manufacturing, information chemicals manufacturing, etc.

It should be noted that the classification of the National Bureau of Statistics in 2017 is based on Classification of High-tech Industry (Manufacturing) (2013). The revision continues the classification principles, methods and framework of 2013. According to the correspondence between the old and new national economic industries, only the structure and corresponding industrial codes of high-tech industrial (manufacturing) classification are adjusted, but the original (manufacturing) classification is not substantially adjusted or changed. The standard of defining high-tech manufacturing industry is still R&D investment intensity. In other words, manufacturing industry with relatively high R&D investment is regarded as high-tech manufacturing industry. However, in recent years, there have been some controversies about this standard in the academic circles in China. It is believed that only relying on R&D investment intensity is inevitable to be insufficient. For example, Zhou Guofu (2016) believed that the current statistical scope of the National Bureau of Statistics on the classification of high-tech manufacturing is not completely in line with reality; "Railway transportation and urban rail transit equipment manufacturing" related to high-speed rail technology is not included in the statistical scope of high-tech industry. Internationally, at present, the most representative is the definition standard of OECD and the US Department of Commerce. OECD defines high-tech industry according to the index of "R&D investment intensity"; However, the US Department of Commerce chooses two indexes: "scientific and technical personnel investment" and "R&D investment intensity" to define high-tech industry.

Based on this, this research, enlightened by the research of domestic and foreign official departments and scholars, combines the development idea of low-carbon green economy and the situation of Fujian, and plans to use two indexes to measure high-tech manufacturing industry: "R&D investment intensity" and "scientific and technical personnel investment intensity". Furthermore, it further distinguishes high-tech manufacturing industry based on "energy consumption intensity", with the following criteria:

Manufacturing industry with "R&D investment intensity" or "scientific and technical personnel investment intensity" above the average is selected as high-tech manufacturing industry; Manufacturing industry with "energy consumption intensity" lower than the average is selected as the low-energy-consumption manufacturing industrial, and the opposite is the high-energy-consumption manufacturing industry. According to the statistical yearbook data of Fujian Province in 2018, the calculation results are as follows:

Table 1 Classification of High-tech Manufacturing Industrial in Fujian Province[1]

The primary classification	**Secondary classification**	**R&D investment intensity**	**scientific and technical personnel investment intensity**	**energy consumption intensity**
low energy consumption High-tech	27 Medicine manufacturing industry	High	High	Low
	29 Rubber and plastic production industry	High	High	Low
	34 General-purpose equipment manufacturing industry	High	High	Low
	35 Specialized facility manufacturing	High	High	Low

[1]According to GB / T 4754-2017 "Classification of National Economic Industries", "41 Other Manufacturing Industrial" is mainly "Daily Goods Manufacturing". In the statistical yearbook of Fujian Province in 2018, the added value of other manufacturing industrial only account for 0.572% of the added value of manufacturing industry, so this research will not make specific analysis on it temporarily.

manufac turing	industry			
	36 automobile manufacturing	High	High	Low
	37 Manufacturing of Railage, Marine traffic, Air transport and other transport equipment	High	High	Low
	38 Electric machinery and equipment manufacturing industry	High	High	Low
	39 Manufacturing industry of communication equipment, computers and other electronic equipment	High	High	Low
	40 Manufacturing industry of instruments and meters, and machinery for culture and office	High	High	Low
High energy consum ption High-tec h manufac turing	26 Chemical feedstock and chemical manufacturing industry	High		High
	28 Chemical fiber manufacturing industry	High		High
	31 Extracting and dressing of ferrous metal mines	High		High
	32 Extracting and dressing of non-ferrous metal ores	High		High

It can be seen from Table 1 that Fujian's high-tech manufacturing industry includes 13 categories, of which there are 9 categories of low-energy-consumption high-tech manufacturing and 4 of high-energy-consumption high-tech manufacturing. At present, Fujian's industry is speeding up to the high-end. Among them, the high-tech manufacturing industry with low energy consumption grows rapidly and its proportion continues to increase. In 2017, the added value of high-tech industry with low energy consumption above designated size was 284.635 billion yuan, an increase of 6.21% over the previous year, which accounted for 26.28% of the added value of manufacturing above designated size in the province; Among the other three categories, high-tech manufacturing with high energy consumption accounted for 12.18%; The manufacturing with high energy consumption and low technology accounted for 13.71%; Other industries accounted for 47.78%.

3. Analysis of Industrial Linkage Effect

For the selection of analysis methods for industrial linkage effect, it is a common practice at home and abroad to conduct analysis based on input-output technology. It is believed that there are innumerable forward and backward links between any one industry in the national economy and other industries. With the development of input-output technology, scholars use the matrix of total demand coefficient $\mu'(I-A)^{-1}$, i.e. $\sum_{i=1}^{n}\tilde{b}_{ij}$ for backward linkage and $(I-A)^{-1}\mu$, i.e. $\sum_{j=1}^{n}\tilde{b}_{ij}$ for forward linkage. Among them, it is Leontief inverse matrix $(I-A)^{-1}$, i.e. the matrix of total demand coefficient $\tilde{B}=(I-A)^{-1}=I+B$. A is the direct consumption coefficient matrix, and B is the complete consumption coefficient matrix, and the corresponding consumption coefficients are:

$a_{ij}=\frac{z_{ij}}{q_j}$ $(i,j=1,2,\ldots,n)$, a_{ij} is the direct consumption of unit product produced by sector j-th to products of sector i.

$$b_{ij} = a_{ij} + \sum_{k=1}^{n} a_{ik}a_{kj} + \sum_{k=1}^{n}\sum_{s=1}^{n} a_{is}a_{sk}a_{kj} + \sum_{k=1}^{n}\sum_{s=1}^{n}\sum_{t=1}^{n} a_{it}a_{ts}a_{sk}a_{kj} + \ldots \qquad (i, j = 1, 2, \ldots, n) \tag{1}$$

3.1 Influence Coefficient. Influence coefficient refers to the degree of influence on the output of various sectors of the national economy when the final demand of an industrial sector changes.

$\sum_{i=1}^{n} \tilde{b}_{ij}$ represents the sum of the pulling effects of changes in the unit final product of the j-th sector to various sectors of the national economy, which reflects the influence of changes in the unit final product of the j-th sector on the national economy. In order to compare the pulling effects of each sector, the backward coefficient is standardized. Even if the value of the sector with medium pulling effect is 1, the calculation formula of the influence coefficient is as follows:

$$\delta_j = \frac{\frac{1}{n}\sum_{i=1}^{n} \tilde{b}_{ij}}{\frac{1}{n^2}\sum_{j=1}^{n}\sum_{i=1}^{n} \tilde{b}_{ij}} \tag{2}$$

δ_j reflects the degree to which the unit final demand of the j-th sector adds to the demand of various sectors of the national economy. When $\delta_j = 1$, it means that the pulling effect of the j-th sector on society has reached the average level of each sector; When $\delta_j < 1$, it means that the pulling effect is lower than the average level of each sector; When $\delta_j > 1$, it means that the pulling effect is higher than the average level of each sector, and its effect is stronger.

Based on the input-output Table (42 sectors) of Fujian, Table 2 is the influence coefficient calculated of 6 low-energy-consumption high-tech manufacturing and 2 high-energy-consumption high-tech manufacturing.

Table 2 Influence Coefficient of High-tech Manufacturing Sectors in Fujian Province

The primary classification	The secondary classification	Influence coef.
low energy consumption High-tech manufacturing	◎Manufacturing industry of communication equipment, computers and other electronic equipment	1.21488925
	◎Transport and communication facilities industry	1.15099364
	◎Specialized facility manufacturing industry	1.13731002
	◎Manufacturing industry of instruments and meters, and machinery for culture and office	1.10871950
	◎General-purpose equipment manufacturing industry	1.09086433
	◎Electric machinery and equipment manufacturing industry	1.07806045
High energy consumption	◎Ferrous metal smelting and extrusion	1.16479415

High-tech manufacturing	◎Chemical manufacturing industry	1.13558979

It can be seen from Table 2 that the influence coefficients of high-tech manufacturing industry in Fujian are all greater than 1. This shows that compared with other industries, the influence coefficient of high-tech manufacturing industry is generally higher, with a strong backward linkage effect. Meanwhile, the backward linkage effect of high-tech manufacturing industry with high energy consumption is slightly higher than that with low energy consumption. Among the high-tech manufacturing industry with low energy consumption, the manufacturing of communication equipment, computer and other electronic equipment have the largest influence coefficient, with 1.21488925. This shows that this industry has the strongest backward linkage effect on other industries, and other industries have strong dependence on this industry and can give priority to development.

3.2 Sensitivity Coefficient. The sensitivity coefficient can reflect the degree to which an industry sector is affected by changes in the final demand of other industry sectors. The larger the coefficient is, the more likely the industry is to be affected by the change of the final demand of other industrial sectors, with a stronger forward linkage effect. After Jones proposed the distribution coefficient in 1976, it is generally believed that the forward coefficient should be calculated by using the complete distribution coefficient instead of the matrix of the matrix of total demand coefficient. The formula is as follows:

$$\theta_i = \frac{\frac{1}{n}\sum_{j=1}^{n}\tilde{g}_{ij}}{\frac{1}{n^2}\sum_{i=1}^{n}\sum_{j=1}^{n}\tilde{g}_{ij}},(i = 1, 2, 3...., n) \tag{3}$$

Among them, $\tilde{g}_{ij}$ is the element of the complete reaction coefficient matrix $(\mathrm{I}-\mathrm{H})^{-1}$, and θ_i reflects the promotion degree of the unit added value of the i-th sector to the output of each sector. Table 3 is the reaction coefficients of 6 industrial sectors in Fujian calculated based on the input-output table.

Table 3 Sensitivity Coefficient of High-tech Manufacturing Sectors in Fujian Province

The primary classification	The secondary classification	Sensitivity coef.
low energy consumption High-tech manufacturing	◎Manufacturing industry of communication equipment, computers and other electronic equipment	0.5340661
	◎Transport and communication facilities industry	0.5111363
	◎Specialized facility manufacturing industry	0.5204226
	◎Manufacturing industry of instruments and meters, and machinery for culture and office	0.4950431
	◎General-purpose equipment manufacturing industry	1.378714
	◎Electric machinery and equipment manufacturing industry	0.3608665
High energy	◎Ferrous metal smelting and extrusion	1.6117971

consumption High-tech manufacturing	◎Chemical manufacturing industry	1.6429204

It can be seen that the reaction coefficient of high-tech manufacturing industry with high energy consumption in Fujian is much higher than that with low energy consumption, and all of them are above 1.6. This shows that the forward linkage effect of the industry with high energy consumption is quite high. Though its energy consumption is high, it is an important basic sector in the national economic industry, and provides strong support for the development of other national economic industries. In the industry with low energy consumption, except the reaction coefficient of communication equipment, computer and other electronic equipment is higher than 1, the other coefficients are all around 0.5, with a low reaction. This shows that in the aspect of forward linkage effect, these industries are not closely related to the downstream industries.

4. Conclusions and Recommendations

Through the calculation of three indexes, this study first selects the high-tech manufacturing industry with low energy consumption. This industry should meet the requirements that R&D investment intensity is higher than the average level, R&D personnel investment intensity is higher than the average level and energy consumption intensity is lower than the average level. Then, it uses the input-output table of Fujian in 2015 to calculate the influence coefficients and reaction coefficients of these industries. Moreover, by combining them with the output scales of each industry, the research studies the forward and backward linkage effects of high-tech manufacturing industry on Fujian economy. The conclusions and suggestions are as follow:

4.1 Give priority to the development of communication equipment, computer and other electronic equipment manufacturing industries. These industries in Fujian Province are the industries with the highest influence coefficient and reaction coefficient among all high-tech manufacturing industries with low energy consumption, which have strong forward and backward linkage effects. Their output is not only demanded by other national economic sectors, but also has a strong pulling effect on other sectors. Thus, Fujian Province should give priority to promoting the development of these industries, and give more preferential policies and dividends.

4.2 Conditionally restrict the development of high energy-consuming manufacturing. According to the research, it is concluded that the metal smelting and rolling processing industry and the chemical industry in the high-tech manufacturing industry of Fujian are all high energy-consuming manufacturing industries. However, its influence coefficient and reaction coefficient are both high, with a strong forward and backward linkage effects on other industries and a strong supporting role in the development of the national economic industry. Thus, one-size-fits-all emission measures should not be conducted for all high-consuming manufacturing industries. Instead, through methods of furthering eliminating technological transformation, enterprise merger and reorganization, we should withdraw a number of manufacturing industries with hopeless transformation and upgrading, low-end and low efficiency, high energy consumption and low technology, and encourage the development of medium and high-end manufacturing industries.

4.3 Encourage high-quality growth of high-tech manufacturing industry with low energy consumption. With the development of green economy, high tech with low energy consumption has become the focus of global manufacturing competition. To improve the competitiveness of Fujian's manufacturing industry, we should continue to promote technological innovation and develop advanced high-tech industries. Also, we should introduce high-quality foreign investment and encourage more enterprises to cooperate and exchange with these transnational corporations in technological development, so as to bring in some advanced science and technology. On the one hand, it can quickly promote the development of some related industries. On the other hand, it can enhance industries competitiveness.

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