Research on the Measurement of Manufacturing Servitization Level in Fujian Province Based on Big Data and Input-Output Table

Dandan Wu* and Qingjin Lin
School of International Business, Xiamen University Tan Kah Kee College, Fujian Province, China, wdandan@xujc.com
College of Business and Economics, the Australian National University, Australia

*Corresponding author e-mail: u6482487@anu.edu.au

Abstract. Under the background of a new round of adjustment and upgrading cycle of global value chain (GVC), manufacturing servitization is one of the important measures to improve the position of value chain. Therefore, this paper bases on the classification of the GVC status of the manufacturing industry in Fujian Province, using its latest data of the input-output table, through the matrix operation analysis of the complete consumption coefficient, concluding the servitization level of manufacturing in Fujian Province is fairly low, among which the manufacturing service input in the high position of GVC is slightly lower than that in the low position of GVC.

Keywords: Big Data; Manufacturing Servitization; Complete Consumption Coefficient

1. Introduction
Research shows that the total revenue of the service industry accounts for 1/4 of that in the Global 500 manufacturing enterprises, and 19% of them are manufacturing enterprises, whose service revenue is more than half of the totality [1]. In fact, China is a power in manufacturing, but there are less than 1% of service-oriented manufacturing enterprises, so the level of manufacturing servitization is a significant factor affecting the upgrading of its value chain.

2. Domestic and foreign literature review
2.1. The definition of manufacturing servitization
The concept of servitization was first proposed by two scholars called Vandermerwe and Rada, respectively, they thought the servitization of manufacturing was that enterprises need to work according to the customer's demand, providing customers with "packages" that include goods, support, self-service and knowledge [2]. After that, some scholars like White et al. and Reiskin et al. developed the concept [3], the servitization of manufacturing was the service elements of the input and supply in manufacturing enterprises, in which consumers participate, all parties realize value-added in
this process.

2.2. Research status of the manufacturing servitization

At present, some scholars research on the manufacturing servitization is mainly based on the national level, while less focus on the regional ones. On the one hand, from the prospective of industry relevance level, Liu (2018) studied the relationship between the two industries of manufacturing and service in Fujian Province and analyzed its operation mode [4]; On the other hand, from the perspective of micro enterprises, according to the internal data of listed enterprises, Chen (2018) used the analysis of business scope to measure the servitization level of manufacturing enterprises in Fujian province [5]. To sum up, the research on the servitization level of regional manufacturing input is deficient. So this paper bases on the previous studies of scholars, intends to use the domestic and foreign relatively scientific input-output analysis method to measure its manufacturing servitization.

3. The classification of GVC status and service in manufacturing industry

3.1. The classification of GVC status in manufacturing industry

The GVC-status index of the high-status manufacturing industry is larger than 0, indicating the industry is in the upstream stage of GVC (including the design of analysis and development, brand design, and the component parts of the production process), with stronger added-value capacity; Conversely, the GVC-status index of the low-position manufacturing industry is less than 0, showing that the industry is in the downstream stage of GVC, with weaker added-value capacity. The calculation formula is as follows:

\[
\text{The mean value of GVC status} = \frac{\sum \text{Annual GVC status index}}{\text{Total number of years}}
\]

| High Status Industry | Mean | Low Status Industry | Mean |
|----------------------|------|---------------------|------|
| Other manufacturing industries, recycling | 0.19 | Metal ware | -0.02 |
| Food, drink, tobacco | 0.16 | Motor vehicles, trailers, semi-trailers | -0.06 |
| Basic metals | 0.16 | Coke, gasoline products, nuclear energy | -0.07 |
| Textiles, leather, footwear | 0.1 | Chemical raw materials & chemicals | -0.08 |
| Other transportation equipment | 0.06 | Rubber & plastic products | -0.09 |
| Other non-metallic mineral products | 0.09 | Wood and cork products | -0.03 |
| Mechanical equipment | 0.04 | Pulp paper, paper products, printing | -0.15 |
| | | Electronic machinery and instruments | -0.21 |
| | | Computer, electronic and optical equipment | -0.33 |

Table 1. The mean value of GVC status in manufacturing sectors

Source from: Research on International Division of Labor Status of China’s Manufacturing Industry under GCV

According to the status classification calculated in Table 1, we conclude that the total numbers of the high-status manufacturing industries (GVC ≥ 0) in Fujian province are shown below: Food and tobacco, textiles, clothing, footwear and etc.; And there are 8 low-status manufacturing industries (GVC < 0), which are: wood processing products and furniture, paper printing and etc.

3.2. The classification of service in manufacturing industry

From the perspective of service function, it can be divided into productive and consumer services.
Consumer services are to meet the final needs of consumers, and providing independent services directly to consumers [6]. Producer service is a kind of intermediate input, which plays an important role in providing production services for goods and services. According to this, this paper classifies metal products, machinery and equipment repair services, transportation and etc. as productive services, but for wholesale and retail, residential service repair and etc. as consumer services.

4. An empirical analysis on the servitization level of manufacturing industry in Fujian Province

This paper analyzes the integration and interaction degree of various departments and services in Fujian manufacturing industry by the measurement of the manufacturing servitization level of high and low status based on the data of 42 departments of the current input-output table.

4.1. Complete consumption coefficient based on the input-output table

The direct consumption coefficient is to calculate the direct consumption of 1 unit output of department j to the products of department i, which is obtained by dividing the service input of the industry by the total input; The complete consumption coefficient is used the direct consumption and department j through the sum of the direct consumption of the other departments to department i.

| Table 2 | the expression of Value input-output |
| --- | --- |
| Intermediate input | Intermediate product | Final product | Total output |
| | D1 | D2 | ⋯ | Dn | Sum | fi | q1 |
| D1 | x11 | x12 | ⋯ | x1n | Σxij | f1 | q1 |
| D2 | x21 | x22 | ⋯ | x2n | Σxij | f2 | q2 |
| ⋯ | ⋯ | ⋯ | ⋯ | ⋯ | ⋯ | ⋯ | ⋯ |
| Dn | xn1 | xn2 | ⋯ | xnn | Σxij | fn | qn |
| Sum | Σx1 | Σx2 | ⋯ | Σxn | ΣΣxij | Σfi | Σq1 |
| Initial Input | Depreciation of fixed assets | d1 | d2 | ⋯ | dn | Σd_j |
| Labor remuneration | v1 | v2 | ⋯ | vn | Σv_j |
| Net Product Tax | s1 | s2 | ⋯ | sn | Σs_j |
| Earning surplus | m1 | m2 | ⋯ | mn | Σm_j |
| Value added | v1 | v2 | ⋯ | vn | Σv_j |
| Total Input | q1 | q2 | ⋯ | qn | Σq_j |

In general, for more comprehensive and specific analysing the servitization level in manufacturing industry, this paper decided to use the measurement of complete consumption coefficient. The calculation formula of complete consumption coefficient is as follows:

\[
\text{Servitization}_{ij} = a_{ij} + \sum_{k=1}^{n} a_{ik} a_{kj} + \sum_{l=1}^{n} \sum_{k=1}^{n} a_{il} a_{sk} a_{kj} + \cdots \quad (1)
\]

In the above formula, \(\text{Servitization}_{ij}\) represents the servitization level of manufacturing industry j, and the first one \(a_{ij}\) represents the direct consumption of the department j to the service department i. The second item represents the first time of indirect consumption of the industry j to the service sector i through the sector k, similarly, the third item is the second round of direct consumption, by parity of reasoning, the item \(n + 1\) is the nth round of indirect consumption.

4.2. The analysis conclusion of the manufacturing input servitization

Through the calculation, it is found that for every unit of output increase in the high-status manufacturing industry, 0.3234 units of productive services and 0.1496 units of consumer services are
needed; And for each unit of output increase in low-status manufacturing industry, 0.3269 units of productive services and 0.1563 units of consumer services are input. So the service-oriented input of high-status manufacturing industry is slightly lower than that of low-status ones, regardless of the input of productive service or consumer service [7].

According to the result of industry segmentation, the top three inputs of productive services in the high-status manufacturing industry are waste products, non-metallic mineral products, metal smelting and calendering products, and the top three inputs of consumer services are waste products, general equipment and special equipment.

**Table 3** the Servitization level of the manufacturing subdivision of department in Fujian Province

| The subdivision of department | Productive services | Consumption services |
|------------------------------|---------------------|----------------------|
| **High Status**              |                     |                      |
| Food and tobacco             | 0.2418              | 0.1224               |
| Textile                     | 0.2845              | 0.1464               |
| Textile clothing, shoes, leather and its products | 0.2780 | 0.1364 |
| Nonmetallic mineral products | 0.4673              | 0.1672               |
| Metal smelting and rolling products | 0.4588 | 0.1813 |
| General equipment            | 0.3682              | 0.2011               |
| Special equipment            | 0.4050              | 0.1967               |
| Transportation equipment     | 0.3503              | 0.1726               |
| Other manufactured products  | 0.3111              | 0.1608               |
| Waste                       | 0.5518              | 0.2570               |
| **Low Status**               |                     |                      |
| Wood products and furniture  | 0.2632              | 0.1718               |
| Paper printing, culture, education and sports goods | 0.3623 | 0.1572 |
| Petroleum, coking products and nuclear fuel products | 0.3854 | 0.1567 |
| Chemical products            | 0.3724              | 0.1668               |
| Metal products               | 0.4758              | 0.1773               |
| Electrical machinery and equipment | 0.3371 | 0.1585 |
| Communication equipment, computers and other electronic equipment | 0.2625 | 0.1491 |
| Instrumentation              | 0.2853              | 0.1488               |

The above results show that the overall service input of metal products and petrochemicals is relatively high, whether it is productive service or consumer service, which plays a positive role in promoting the GVC status index of manufacturing industry. But now, due to the relatively insufficient input in scientific research and technology in Fujian province, which leads to the total service input of communication equipment, computers and other electronic equipment, instruments and meters is relatively low.

5. **Conclusion**

This paper takes Fujian Province as an example, studies the development level of manufacturing servitization in southeast coastal areas of China, based on the calculation of both the big data background and input-output table, which makes up for the lack of research on the measurement of manufacturing servitization level at the national and industry levels.

In general, the manufacturing industry with high value chain status has more abundant capital and technology, as well as more servitization input. However, it is converse in Fujian Province, which shows that the servitization level of manufacturing industry is very low. And from the perspective of the subdivision of department, the manufacturing industry with high servitization level plays a relatively significant role in the GVC. Conversely, the manufacturing industry with low servitization level plays a relatively insignificant role in the global value chain.
Acknowledgements
This paper is the research results of the educational and scientific research project of young and middle-aged teachers called "Structural Decomposition Analysis of Economic Growth and Energy Consumption in Fujian Province (JAS170785)".

Reference
[1] A. E. Karlik, I. A. Maksimtsev and E. A. Iakovleva, "Modern architecture of global value chains and value chain management of Russia," 2016 XIX IEEE International Conference on Soft Computing and Measurements (SCM), St. Petersburg, 2016, pp. 518-520.
[2] C. Yanjuan and X. Xiaofei, "Research on Appraisal System of Software Industry Competitiveness Based on Global Value Chain," 2010 International Conference on E-Business and E-Government, Guangzhou, 2010, pp. 3050-3053.
[3] D. Arruda and N. H. Madhavji, "Towards a big data requirements engineering artefact model in the context of big data software development projects: Poster extended abstract," 2017 IEEE International Conference on Big Data (Big Data), Boston, MA, 2017, pp. 4725-4726.
[4] J. L. Aron and B. Niemann, "Sharing best practices for the implementation of Big Data applications in government and science communities," 2014 IEEE International Conference on Big Data (Big Data), Washington, DC, 2014, pp. 8-10.
[5] S. Cai, Q. Wang and Z. Huang, "Research on the strategic decision-making model of manufacturing servitization," 2014 11th International Conference on Service Systems and Service Management (ICSSSM), Beijing, 2014, pp. 1-6.
[6] W. Liu, "The impact of technology-sourcing outward FDI in the upgrading of global value chain," 2011 International Conference on E-Business and E-Government (ICEE), Shanghai, China, 2011, pp. 1-4.
[7] X. Jiang, S. Li and J. Li, "The study on the influencing factors on knowledge transfer in Servitization of Manufacturing," 2011 International Conference on Computer Science and Service System (CSSS), Nanjing, 2011, pp. 2799-2802.