Advances in Management & Applied Economics, Vol. 13, No. 5, 2023, 83-106
ISSN: 1792-7544 (print version), 1792-7552(online)
https://doi.org/10.47260/amae/1355
Scientific Press International Limited

Research on the Impact of Producer Service Quality on Export Technological Complexity of Manufacturing Enterprise

Huizheng Liu[1*], Xueting Lu[2] and XiuShan Bai[3]

Abstract

Based on the world Input-output data, Chinese industrial enterprise data and customs data from 2000 to 2013, this paper examines the effect of producer service quality on export technology complexity and its transmission mechanism. The results show that improving the quality of producer service inputs can significantly increase the export technological complexity of manufacturing enterprises, which is consistent with the endogenous and robustness test.

The heterogeneity study finds that the quality of producer services has a significant effect on the export technological complexity of capital-intensive and technology-intensive manufacturing enterprises, but has no significant effect on the export technological complexity of labor-intensive manufacturing enterprises. The quality of domestic-sourced producer services has a significant positive effect on the export technological complexity of manufacturing firms, while the effect of foreign-sourced producer services is not significant. From the perspective of influence mechanism, the improvement of enterprise R&D innovation level and export product diversity will strengthen the positive correlation between the quality of input producer services and enterprise export technology complexity.

Keywords: Productive service quality, Export technology complexity, Manufacturing Industry.

[1] Professor, Beijing University of Technology, School of Economics and Management, Beijing, 100124, China.*Corresponding author.

[2] Postgraduate, Beijing University of Technology, School of Economics and Management, Beijing, 100124, China

[3] Beijing Institute of Economic and Social Development, Beijing, 101160, China

Article Info: Received: April 18, 2023. Revised: May 8, 2023.
Published online: May 25, 2023.

1. Introduction

China has become the largest manufacturing country in the world, but the development of manufacturing industry still faces the problem of "big but not strong, all but not excellent". According to the data of the National Information Center, the similarity of China's export products with relevant countries is constantly improving. In the field of high-end manufacturing, China is in direct competition with developed countries such as Europe, America, Japan and South Korea in the international market, while in the field of low-end manufacturing, it faces fierce competition from developing countries such as Southeast Asia and South Asia in cost advantages, and the export market space is constantly squeezed. International market competition is not only the competition of market share, but also the competition of product technical level. The technical level of export products has become one of the decisive factors of international division of labor and international trade interests. Under the background that the original labor cost advantage and resource endowment advantage are gradually weakening, it is of great significance to improve the complexity of manufacturing export technology for solving the development problems of manufacturing industry and realizing the high-quality development of manufacturing industry.

Producer service industry generally has the characteristics of strong professionalism, high technology content, active innovation and remarkable driving effect (Huang Fan Hua and Hong Yinxing 2020), and has gradually become an important force leading the transformation and upgrading of manufacturing industry and high-quality development (Heuser and Mattoo, 2017). In March 2021, the Opinions on Accelerating the High-quality Development of Manufacturing Service Industry jointly issued by the National Development and Reform Commission and other 13 departments pointed out that "Manufacturing Service Industry is a producer service industry oriented to manufacturing industry... It is necessary to accelerate the development of manufacturing service industry and lead the transformation, upgrading and quality improvement of manufacturing industry with high-quality service supply." Therefore, it is urgent to answer the following questions: will the quality of productive services in manufacturing input affect the technical complexity of manufacturing export? If so, what is its influencing mechanism? Furthermore, which type of manufacturing enterprises have more significant influence on the technical complexity of export by the quality of productive services? Is there any difference in the influence effect of producer services from different sources? Answering the above questions will help to clarify the impact of the quality of producer services on the complexity of export technology, and provide decision support for enhancing the international competitiveness of China's manufacturing industry and promoting the high-quality development of manufacturing industry.

2. Literature review

The research of this paper is mainly related to the following four types of literature: The first type of literature is related to the investment in productive services. Productive service input refers to the services invested in the manufacturing process (Yang Renfa and Wang Qingqing, 2018), which is mainly measured by the total consumption coefficient of productive services in the manufacturing industry. In recent years, with the development of producer services and the deepening of industrial integration, the research on the impact of producer services input on manufacturing industry has gradually increased. The relevant literature mainly discusses the role of producer services input on the global value chain status of manufacturing industry, manufacturing service and international competitiveness of manufacturing industry. Some scholars have found that by increasing the investment in productive services, the manufacturing structure can be continuously adjusted to a "softening" trend, and the "lock-in effect" can be freed from climbing to high value-added links at both ends of GVC, thus improving the division of labor status of China's manufacturing industry in GVC, and also effectively promoting the manufacturing industry to achieve the refinement of the whole industrial chain (Yu Mingyuan and Fan Aijun, 2019, Nozomi, 2018). The theoretical analysis of (Yang Renfa and Liu Qinwei 2019) points out that the input of producer services promotes the status of manufacturing global value chain through technological innovation effect, financing ability effect and human capital effect. Xia Jie Chang and Yao Zhanqi (2019) theoretically expounded the mechanism of domestic and imported producer services investment in promoting the service-oriented manufacturing industry in China, and empirically found that both domestic and imported producer services investment can promote the service-oriented manufacturing industry, but imported producer services investment plays a greater role. Macpherson (2008) conducted a 12-year follow-up study on manufacturers in New York State to explore the changes in the use of external producer services at the company level. The results show that the innovation and service utilization rate in three major regions of New York State have become consistent, and producer services can significantly promote the international competitiveness of manufacturing in New York State.

The second kind of literature is related research on the quality of productive service input. There is little literature in this field. At present, the core and foundation of the relevant literature to measure the quality of industrial development is its total factor productivity. Liu Jishuang (2020) regards the total factor productivity of producer services as a proxy variable of its quality, and calculates the change rate of total factor productivity and its decomposition index. Vinv Liu et al. (2020) use the weighted total factor productivity of input services as the proxy variable of quality, that is, calculate the total factor productivity of each service industry, and calculate the weighted total factor productivity of each manufacturing service input with the direct input coefficient and the full input coefficient as weights. Among them, the method of Vinv Liu et al. (2020) can not only reflect the production relations between industries, but also reflect the technical factors and cost factors, so it is more reasonable to measure the quality of productive service input with this method.

The third kind of literature is related research on the complexity of export technology. Scholars at home and abroad have done a lot of research, mainly including index calculation and analysis of influencing factors. Hausmann et al. (2007) model can ensure that some poor countries with small export volume are given enough weight (Rodrik, 2006), so this method is widely used in empirical research. The method is divided into two steps. In the first step, the RCA index of export products of various countries (regions) is calculated by using the export volume, and the per capita GDP of each country (region) is weighted and averaged to get the export technical complexity at the product level. In the second step, the export technical complexity of each product is weighted and averaged by taking the proportion of the export volume of a product in the total export volume of a country (region) as the weight to get the export technical complexity at the national level. In addition, considering the particularity of China's export trade, that is, the existence of a large number of processing trade may cause low quality problems in products with high export technical complexity (Assche and Gangnes 2010, Gao Xiang and Yuan Kaihua 2020), so some scholars revised the method of Hausmann et al. (2007). Among them, Xu (2010) uses the relative price index to adjust the level of product technical complexity, and based on this method, Sheng Bin and Mao Qilin (2017) further calculate the export technical complexity of enterprises adjusted by the price index; Cheng Dazhong (2017), proposed to calculate the RCA index with the export value of trade added, and then calculate the technical complexity of export at the industry and national level; Yu Juanjuan and Yu Dongsheng (2018) adopt the total factor productivity (TFP) of enterprises to adjust the technical complexity of export, and get the technical complexity index of export. Scholars have done a lot of research on the influencing factors of export technology complexity, such as economic growth (Huang Haixian et al., 2010), foreign direct investment (Liu Sheng and Gu Naihua, 2016), human capital and R&D investment (Zheng Zhanpeng and Wang Yangdong, 2017), knowledge capital (Liu Yingji, 2016], intellectual property protection (Li Junqing and Miao Ersen, 2018), digital trade (Yao Zhanqi, 2021), uncertainty of economic policy (Hu Yuanhong and others, 2021), investment in productive services (Liu Hui et al., 2020).

The fourth kind of literature is the related research on the influence of producer service input on the technical complexity of manufacturing export. At present, there are few related studies. Ling Dan (2020) hold that the input of producer services affects the technological complexity of manufacturing export through factor recombination effect, cost reduction effect and knowledge spillover effect, and use the input-output and manufacturing industry data from 2005 to 2014 for empirical test, and find that the input of producer services with low knowledge technology can promote the technological complexity of manufacturing export, while the input of producer services with high knowledge technology has no significant effect. Hui-Juan Li and Cai Weihong (2016). Based on the non-competitive input-output model, the empirical results show that offshore producer services can significantly promote the technological complexity of manufacturing export. For different types of manufacturing offshore productive services, the complexity of export technology can be significantly improved.

Scholars' research on the input of productive services and the technical complexity of manufacturing export provides an important reference for this paper, but there are still three problems to be discussed and improved. First, from the perspective of research, the existing research results mainly discuss its impact on the technical complexity of manufacturing export from the perspective of the scale of producer services investment. Under the background of the increasingly important input of producer services and the high-quality development of manufacturing industry, it is of great practical significance to investigate the impact of producer services on the technical complexity of manufacturing export from the perspective of input quality, which will promote the manufacturing industry to form new advantages and improve its international competitiveness. Second, from the research level, the existing literature on the impact of producer service input and manufacturing export technology complexity is mostly carried out from the industry level, ignoring the heterogeneous characteristics of enterprises; Thirdly, as far as the influence mechanism is concerned, the existing literature has not systematically studied how the quality of producer service input affects the export technology complexity of manufacturing enterprises.

In view of this, the possible marginal contributions of this paper are as follows:

(1) Using WIOD (2016) input-output table to calculate the total consumption coefficient of producer services in manufacturing industry, and weighting the total factor productivity of producer services with it to get the quality of producer services input by manufacturing industry, and avoiding the problem of estimation bias that may be caused by the heterogeneity of producer services.

(2) The influence of the quality of producer services input on the complexity of manufacturing export technology is discussed from the micro level, and the heterogeneity analysis is made from the sources of producer services input and the types of factor concentration of manufacturing enterprises, which is an important supplement to related research.

(3) Using the moderating effect model, this paper analyzes and empirically tests the influence mechanism of the quality of producer services input on the complexity of export technology from two ways: R&D innovation and export product diversity.

3. Theoretical mechanism and research hypothesis

The quality of productive service input may affect the export technology complexity of manufacturing enterprises through cost saving effect, knowledge technology spillover effect and value chain upgrading effect.

(1) Under the background of manufacturing transformation and upgrading and high-quality development, the demand for high-quality productive services is escalating (Xia Jie Changhe Xiaoyu, 2019). Therefore, the improvement of the input quality of productive services can improve the adaptability with the demand of manufacturing industry, which further increases the demand of manufacturing industry for productive services. The increase in demand can promote the formation of a larger market, which will lead to more enterprises entering the competition. In the end, the market will provide specialized productive services with higher efficiency, better quality and lower cost, which will reduce the transaction costs and production costs of manufacturing enterprises, so that enterprises can allocate the saved capital and resources to core business links with comparative advantages and cultivate core competitiveness.

(2) Productive services are rich in technology, information, human capital and knowledge (Ma Yingying and Sheng Bin, 2018). The improvement of the quality of productive services invested by manufacturing enterprises means that more advanced technologies, knowledge capital and other elements will be integrated into all aspects of manufacturing enterprises' production, which will promote enterprises to absorb and learn advanced technologies through technology spillover effect, thus enhancing the technical complexity of enterprises' export.

(3) The rising of manufacturing value chain refers to the dynamic process of upgrading the value chain from production and processing to high-end R&D design and brand marketing, and from traditional low-end manufacturing to high-end manufacturing (Sun Xiangxiang and Zhou Xiaoliang, 2018). The improvement of the quality of productive services invested in design, R&D and marketing of manufacturing industry can change the original production technology and process, realize process upgrade and product upgrade, increase the added value of products and promote the complexity of export technology. Based on the above analysis, hypothesis 1 is put forward.

Hypothesis 1: The quality of productive service input can promote the complexity of manufacturing enterprises' export technology.

R&D innovation is a process of transferring various production factors in an organization to carry out technological innovation to achieve product innovation (Ling Dan and Zou Mengting, 2020). By improving the level of R&D innovation, reorganizing production processes, innovating production models, and using more advanced production technologies, enterprises can produce products with high added value and high technical level, and enhance the technical complexity of their exports, so that their relative comparative advantages can be shifted to links with high domestic added value, and then they can gain more benefits in international trade. In this process, enterprises will invest more money and energy in product research and innovation, and the degree of specialization of enterprises will further deepen. In order to concentrate on the development of core technologies and save costs, enterprises will divest some internalized productive services and seek productive services with higher quality and lower cost in the market. At the same time, with the improvement of R&D innovation level, there will be a complementary effect of R&D, that is, in order to effectively use the invested high-quality production service inputs and intermediate products, manufacturing enterprises must improve their own R&D innovation ability, increase R&D investment, absorb and transform the production service inputs and the technology spillover of intermediate products to enhance the value of export products and promote the complex upgrading of export technology of enterprises (Han Yafeng and Fu Yunjia, 2018). Based on the above analysis, hypothesis 2 is put forward.

Hypothesis 2: The improvement of R&D innovation level of enterprises will strengthen the positive correlation between the quality of productive service input and the complexity of export technology of manufacturing enterprises.

Diversification of export products can reduce output volatility, achieve higher productivity growth, upgrade skills and technology, promote the complexity of export technology, and ensure sustainable economic growth and development (Naudé et al. 2010, Gnangnon 2020). With the improvement of the diversification of export products, enterprises are required to invest in different combinations of productive services to meet and support the diversified operation of products. Specifically, the increase in the diversity of export products means that enterprises will face a larger product market and more consumers, which requires enterprises to know the relevant laws and regulations, the product information of competitors in the market, and the demand of consumers for product specifications and quality when entering a competitive international market. This requires enterprises to invest in high-quality legal, information, management consulting and other productive services, promote the improvement and development of enterprise product specifications and production standards, and further enhance the international market occupation ability of Chinese manufacturing enterprises. In addition, the diversification of export products of enterprises will increase the complexity of productive services such as production, logistics and sales, thus reducing management efficiency (Wang Jian and Zhang Chi, 2020). Therefore, enterprises need to invest in high-quality productive services such as logistics, transportation, warehousing and brand management to promote the efficient development of product production procedures and management and marketing methods. At the same time, the improvement of product diversity also means that enterprises need to invest more productive services such as finance and insurance to ease the liquidity constraint of enterprise funds and provide continuous and stable financial support for manufacturing enterprises. Based on the above analysis, hypothesis 3 is put forward.

Hypothesis 3: The improvement of the diversification of export products will strengthen the positive correlation between the quality of productive service input and the complexity of export technology of manufacturing enterprises.

4. Model setting, variable measurement and data explanation

4.1 Model setting

In order to investigate the influence of the quality of productive services invested by manufacturing industry on the complexity of export technology, this paper constructs a panel econometric model:

$$ESI_{it} = \alpha_0 + \alpha_1 qpsmc_{ijt} + \beta X_{ijt} + V_i + V_t + \varepsilon_{ijt} \quad (1)$$

In the above formula, the subscript i stands for enterprise, j stands for industry and t stands for year. The explained variable ESI_{it} is the complexity of export technology of manufacturing enterprises, and $qpsmc_{ijt}$ is the quality of productive service invested by j in the industry where enterprise i is located in T period. X_{ijt} is the control variable, and V_i represents the fixed effect of enterprises and industries; V_t is a fixed year effect, and ε_{ijt} is a random disturbance term.

In order to further test whether the R&D innovation and the diversity of export products of enterprises are the channels through which the quality of productive service input affects the complexity of export technology of enterprises, the following test model is set:

$$ESI_{it} = \alpha_0 + \alpha_1 qpsmc_{ijt} + \alpha_2 tech_{it} + \alpha_3 tech_{it} \times qpsmc_{ijt} + \beta X_{ijt} + V_i + V_t + \varepsilon_{ijt} \quad (2)$$

$$ESI_{it} = \alpha_0 + \alpha_1 qpsmc_{ijt} + \alpha_2 ed_{it} + \alpha_3 ed_{it} \times qpsmc_{ijt} + \beta X_{ijt} + V_i + V_t + \varepsilon_{ijt} \quad (3)$$

In the above formula, $tech_{it}$ stands for enterprise's R&D innovation index and ed_{it} stands for enterprise's export product diversity index. In order to facilitate the explanation of the adjustment coefficient, this paper centralizes the indicators of producer service input quality, enterprise's R&D innovation and product export diversity.

4.2 Variable measurement

(1) Explained variable.

Complexity of export technology of manufacturing enterprises. Firstly, the method of Hausmann et al, (2007) is used to calculate the technical complexity of industry export, and then the method of Yu Juanjuan and Yu Dongsheng (2018) is used to adjust the technical complexity of industry export. The complexity of export technology can not only reflect the export competitiveness of the industry, but also reflect the technical efficiency difference of enterprises. The formula is as follows:

$$ESI_j = \sum_n \frac{(X_{nj} / X_n)}{\sum_n (X_{nj} / X_n)} . pcgdp_n \quad (4)$$

$$ESI_i = \frac{tfp_i}{tfp_j}.ESI_j \quad (5)$$

In the above formula, ESI_j represents the complexity of industrial export technology, X_{nj} is the industrial export volume of a country (region), X_n is the total export volume of a country (region), and $pcgdp$ is the per capita GDP of a country (region). ESI_i is the complexity of enterprise's export technology tfp_i and tfp_j respectively represent the productivity of enterprise i and the average productivity of its industry. The total factor productivity (TFP) of enterprises is estimated by ACF (Ackerberg et al., 2015).

(2) The core explanatory variable.

The quality of productive service input. Firstly, according to the method of (Cheng Dazhong, 2021), the departments with intermediate demand rate higher than 50% are defined as producer services. Secondly, the method of Vinv Liu, 2020) is used for reference to measure the quality of productive service input, which not only reflects the production relationship between industries, but also reflects the factors of technology demand and cost. Firstly, calculate the total factor productivity of each producer service industry. Drawing on the calculation method of Liu Hongkui and Xie Qian, 2017), the formula is as follows:

$$\ln T_{ist} = (\ln Y_{ist} - \ln \bar{Y}_{ist}) - \bar{\mu}_{ist}(\ln K_{ist} - \ln \bar{K}_{ist}) - \bar{\ell}_{ist}(\ln L_{ist} - \ln \bar{L}_{ist}) - \bar{\omega}_{ist}(\ln I_{ist} - \ln \bar{I}_{ist}) \quad (6)$$

$$\ln \bar{X}_{ist} = \frac{\sum_i \ln X_{ist}}{N}; \ln \bar{\theta}_{ist} = (\theta_{ist} + \frac{\sum_i \ln \theta_{ist}}{N})/2 \quad (7)$$

Among them, T_{ist} stands for total factor productivity; Subscripts i,s,t represent country, industry and time respectively; Y represents output; K represents the input of capital, L represents the input of labor, and I represents the input of intermediate goods. μ representing capital reward, ℓ representing labor reward, ω representing intermediate goods, respectively representing the share of value in output, where $\omega = 1 - \mu - \ell$. Parameters $X = \{Y, K, L, I\}$ and $\theta = \{\mu, \ell, \omega\}$ define the mean variable in formula (1), where n represents the number of countries. This paper uses the World Input-Output Database (WIOD 2016) to calculate the total factor productivity of countries and industries at the global level.

Secondly, calculate the direct and complete consumption coefficient of manufacturing industry about producer services, multiply it with the total factor productivity of producer services, and get the quality of producer services directly and completely invested by manufacturing industry. The specific calculation formula is as follows:

$$index_{sj}^d = a_{sj}t_s, index_{sj}^w = a_{sj}t_s + \sum_{s=1}^{n} b_{sk}a_{kj}t_s \quad (8)$$

$$qpsmd_j = \sum_{s \in S}^{d} index_{sj}^{d}, qpsmc_j \sum_{s \in S}^{w} index_{sj}^{w} \tag{9}$$

Among them, a_{sj} represents the direct consumption coefficient of j manufacturing industry about s producer services, ts represents the total factor productivity of s producer services, and $index_{sj}^{d}$ describes the quality of s producer services directly invested by j manufacturing industry. b_{sk} represents the complete consumption coefficient of s producer services in manufacturing industry, while $index_{sj}^{w}$ describes the quality of s producer services fully invested by j manufacturing industry. S stands for all producer service industries. Because the quality of fully invested productive service is composed of the quality of directly and indirectly invested productive service, and it is generated by the continuous iteration of the quality of directly invested productive service, which can better reflect the quality of productive service invested by manufacturing industry, this paper uses the quality of fully invested productive service $qpsmc$ as the core explanatory variable, and the quality of directly invested productive service $qpsmd$ as the robustness test.

(3) Control variables.

Referring to the research of Gao Xiang and Yuan Kaihua (2020), Li Junqing and Miao Ersen (2018), this paper selects the following control variables:

1) Total factor productivity (tfp) of enterprises. In order to avoid duplication with the productivity used in measuring the technical complexity of enterprises' exports, LP method (Levinsohn and Petrin, 2003) is used to estimate the productivity of enterprises.

2) Age of enterprise, the logarithm is taken after the difference between the current year and the year when the enterprise was established is +1.

3) Finance, the ratio of enterprise interest expense to total assets is +1, and then the logarithm is taken.

4) Klratio: the ratio of fixed assets to employees is logarithmic.

5) Herfindal index (hhi): calculated from the industry level (2 digits) according to the sales revenue of enterprises.

6) State, define enterprises with registration types of 110, 120, 130, 141, 142, 143 and 151 in the industrial enterprise database as state-owned enterprises. The other registered types are defined as non-state-owned enterprises. 1 for state-owned enterprises and 0 for non-state-owned enterprises.

(4) Regulating variable

1) Enterprise R&D innovation level: Hu Haoran (2021) pointed out that the production technology and R&D innovation ability of enterprises are relatively consistent, so this paper used Hu Haoran's (2021) method for reference to measure the overall technical level of enterprises. Firstly, refer to Lall (2000) to classify products according to the numerical value of product technology intensity, that is, products are divided into five categories: primary products, resource-based products, low-tech products, medium-tech products and high-tech products. And assign values to these five kinds of products with different technology intensity, and then take the export proportion of each product as the weight, and calculate the technical level of the enterprise by weighted average. The specific formula is as follows:

$$tech_{it} = \sum_{i} \frac{x_{ipt}}{x_{it}} . techintensity_{p} \tag{10}$$

In the above formula, i,p and t represent the enterprise, product and year respectively, x represents the export volume, and $techintensity$ represents the assignment of technology intensity for different product types (primary product is 0.1, resource-based product is 0.3, low-tech product is 0.5, medium-tech product is 0.7, and high-tech product is 0.9).

2) Diversity of export products: This paper uses the method of Wu Lichao et al. (2016) for reference to measure the export diversity of enterprises. Diversity index is a deformation based on Herfindal index. Because Herfindal index is a reverse measure index, its reciprocal form is selected to represent diversity index. The greater the value of this index, the lower the concentration of export products, and the greater the degree of product diversity. Conversely, the smaller the index value, the smaller the degree of diversity. The specific formula is as follows:

$$herfindal_{it}^{l} = \sum_{p} (\frac{x_{ipt}}{x_{it}})^{2}, ed_{it} = 1/ herfindal_{it}^{l} \tag{11}$$

In the above formula, ed stands for export product diversity index; i,p and t represent the enterprise, product and year respectively, and x represents the export volume.

4.3 Data Source and Description

The database used in this paper includes three groups: the first group is the World Input-Output Database (WIOD2016), which can be used to measure the quality of productive services invested by manufacturing industry; The second group is the China industrial enterprise database, from which the enterprise indexes such as industrial added value, input of intermediate products and number of employees involved in the calculation of control variables come. For key indicators missing in some years, refer to relevant literature to supplement:

(1) The lack of industrial intermediate input from 2008 to 2013 was supplemented by the estimation method of Zhu Peihua and Chen Lin (2020), "intermediate input = total output value*main business cost/main business income-total wages payable-depreciation in the current year+financial expenses";

(2) The missing wages and salaries in 2008 and 2009 were supplemented according to the average wages of registered employees by the National Bureau of Statistics;

(3) Lack of industrial added value from 2008 to 2013, supplemented with reference to the method of Nie Huihua (2012) "Industrial added value = total industrial output value-industrial intermediate input+value-added tax"; The index of gross industrial output value in 2004 is missing. Refer to the estimation method of Liu Xiaoxuan and Li Shuangjie (2008) "Industrial added value=sales income-beginning inventory+ending inventory-industrial intermediate input+value-added tax" to supplement the added value data in 2004. In addition, the database has been processed as follows:

Delete abnormal values and missing values.

1) The price has been adjusted on the basis of 2000.

2) Uniformly adjust the industry code of enterprises to the 2002 edition of National Economic Industry Classification (GB/T 4 754-2002).

The third group is the China Customs Trade Database and the World Bank WDI Database, which provide the import and export indicators involved in the calculation and GDP data of various countries respectively. Finally, referring to the practice of Yu (2015), the China Customs trade database and the industrial enterprise database are matched according to the information such as enterprise name, telephone number and postcode. After matching and data processing, an unbalanced panel data is finally formed, with a time span of 2000-2013. Because the industrial enterprise data in 2010 lacks relevant indicators needed for calculation, the data in 2010 is excluded.

Table 1: Descriptive statistics of main variables

Variable name	Meaning	Observed value	Average	Standard deviation	Minimum	Maximum
esi	Technical complexity of Export	318235	5.032	1.418	-10.47	12.41
qpsmc	Full-input productive service quality	318235	-1.581	0.280	-2.181	-1.012
tfp	Total factor productivity	318235	6.460	1.247	0.166	13.29
age	Age	318235	2.159	0.622	0	4.174
finance	Financing constraint	318235	0.010	0.0170	-1.251	1.486
klratio	Capital intensity	317722	3.778	1.362	-5.967	12.00
hhi	Herfindal index	318235	0.008	0.013	0.001	0.628
state	Enterprise nature	318235	0.0330	0.178	0	1
tech	R&D innovation	318235	0.002	2.284	-5.073	3.927
ed	Diversity of export products	318235	0.020	1.764	-1.017	95.10
qpsmc_d	Quality of productive service fully invested in China	318235	-1.839	0.287	-2.445	-1.299
qpsmc_i	Quality of Productive Service Fully Invested by Foreign Countries	318235	-5.487	0.329	-6.302	-4.127
usa_qpsmc	Quality of productive service fully invested by the United States	318235	-1.824	0.224	-3.029	-1.343
esi2	Technical complexity of export II	318235	5.236	1.090	-9.896	10.78
qpsmd	Quality of productive service directly invested.	318235	-2.968	0.267	-3.539	-2.191

Annotate: Variable esi, qpsmc, tfp, age, finance, klratio, dqpsmc, iqpsmc, usa_qpsmc, esi2, qpsmd take logarithms. Both tech and ed are centralized.

5. Empirical test and result analysis

5.1 Benchmark regression result

Table 2 reports the benchmark regression results of the influence of the quality of producer services input on the technological complexity of enterprises' exports based on the fixed effect model. In this paper, the clustering robust standard error expansion estimation at the enterprise level is adopted, and the fixed effects of enterprises, industries and years are controlled at the same time. In the first column, only qpsmc is added for regression, and its estimation coefficient is positive, which is significant at the significant level of 1%. Columns 2-7 are the regression results of gradually increasing control variables, which shows that the significance and sign of qpsmc estimation coefficient have not changed fundamentally, which fully proves the robustness of the theoretical assumptions of the model. From the complete results in the seventh column, the qpsmc estimation coefficient is positive at the significance level of 1%, which indicates that the quality of productive service input can improve the complexity of export technology of enterprises.

Table 2: Benchmark Regression Test Analysis

Variable name	esi (1)	esi (2)	esi (3)	esi (4)	esi (5)	esi (6)	esi (7)
qpsmc	0.2346***	0.2925***	0.2916***	0.2917***	0.2950***	0.2881***	0.2882***
	(12.73)	(20.29)	(20.22)	(20.24)	(20.49)	(19.10)	(19.11)
tfp		0.9728***	0.9737***	0.9737***	0.9736***	0.9735***	0.9734***
		(366.42)	(366.19)	(366.19)	(365.90)	(365.73)	(365.85)
age			-0.0362***	-0.0363***	-0.0350***	-0.0349***	-0.0337***
			(-5.40)	(-5.41)	(-5.23)	(-5.22)	(-5.03)
finance				0.0585	0.0406	0.0436	0.0438
				(0.60)	(0.42)	(0.45)	(0.45)
klratio					0.0303***	0.0304***	0.0303***
					(10.21)	(10.22)	(10.19)
hhi						-0.7875**	-0.7876**
						(-2.04)	(-2.03)
state							-0.0271*
							(-1.79)
Constant	5.4608***	-0.2580***	-0.2093***	-0.2098***	-0.3163***	-0.3071***	-0.3059***
	(86.37)	(-5.79)	(-4.64)	(-4.65)	(-6.77)	(-6.56)	(-6.53)
Fixed time	YES	YES	YES	YES	YES	YES	YES
Industry fixation	YES	YES	YES	YES	YES	YES	YES
Enterprise fixation	YES	YES	YES	YES	YES	YES	YES
Number of observed values	318,235	318,235	318,235	318,235	317,722	317,722	317,722
R_2	0.059	0.541	0.541	0.541	0.542	0.542	0.542

Annotate: *, * * and * * represent the significance levels of 10%, 5% and 1% respectively; The value in brackets is t value, the same below.

The control variables are analyzed by the regression results in the seventh column of Table 2, and the results are basically in line with expectations. The estimation coefficient of tfp of enterprises is significantly positive, which is the same as the existing research conclusions, that is, the improvement of TFP of enterprises can significantly promote the improvement of export technology complexity; The estimation coefficient of enterprise age is significantly negative, which indicates that the growth of enterprise age inhibits the improvement of export technology complexity. This may be because the enterprises established earlier have difficulties in industrial transformation, and organizational inertia causes the age of enterprises to become an internal obstacle to the upgrading of export technology and the improvement of export structure (Yu Juanjuan and Yu Dongsheng 2018). The estimation coefficient of financing constraint is not significant, which indicates that the change of financing constraint does not significantly affect the technological complexity of export. The estimation coefficient of capital intensity (klratio) is significantly positive, which indicates that the increase of capital intensity can enhance the technical complexity of enterprises' export. The reason is that capital accumulation is an important material basis for most enterprises to update equipment and technology research and development. The estimation coefficient of Herfindal index (hhi) is significantly negative, which is the same as the existing research conclusions, indicating that the higher the competition degree of the industry where the enterprise is located, the higher the complexity of export technology.

5.1 Heterogeneity test

Heterogeneity analysis based on manufacturing factor density. Different factor-intensive manufacturing enterprises may have different demands for the quality of productive service input, and different factor-intensive manufacturing industries may benefit from the technology spillover effect of productive service input quality differently. This paper draws lessons from the research of (Fan Maoqing and Huang Wei, 2014) and divides the manufacturing industry into three categories: labor-intensive, capital-intensive and technology-intensive. As shown in Table 3, for capital-intensive and technology-intensive manufacturing enterprises, the impact of producer service input quality on export technology complexity is significantly positive, but the impact on labor-intensive manufacturing enterprises is negative, but not significant.

Generally speaking, compared with labor-intensive manufacturing enterprises, capital-intensive and technology-intensive manufacturing enterprises usually have higher technology level and technology absorption capacity, and can benefit from the technology spillover effect of the quality of productive service input.

Based on the heterogeneity analysis of the sources of producer services, the World Input-Output Table (WIOD 2016) divides the inputs into two parts: domestic and foreign, so do different sources have different effects on the quality of producer services? If the effects are different, it will certainly provide useful reference for the import of producer services in China and the development of domestic producer services. The regression results show that the quality of productive service fully invested in China (qpsmc_d) can significantly improve the technical complexity of enterprises' exports, while the quality of productive service fully invested in foreign countries (qpsmc_i) has a negative impact on the technical complexity of enterprises' exports, but it is not significant. The possible reasons are China's manufacturing industry has long been accustomed to directly importing high-quality and high-tech intermediate inputs, which has a substitution effect on the R&D and innovation activities of enterprises, forming a continuous import dependence (Jason, 2015), lacking the motivation to carry out "substantive innovation" activities, making it difficult for enterprises to break through the "low-end lock-in" dilemma of global value chains, which is not conducive to the improvement of the technical complexity of enterprises' exports (Vinv Liu et al., 2020)

Table 3: Heterogeneity Test Analysis

Variable name	Labor-intensive	Capital intensive	Technology-intensive	Domestic sources	Foreign sources
	(1)	(2)	(3)	(4)	(5)
qpsmc	-0.0540	0.6211***	0.1409***		
	(-0.81)	(19.40)	(4.24)		
qpsmc_d				0.3306***	
				(22.53)	
qpsmc_i					-0.0012
					(-0.21)
tfp	0.9743***	0.9838***	0.9731***	0.9740***	0.9720***
	(231.52)	(195.71)	(210.77)	(366.22)	(363.66)
age	-0.0227**	-0.0290**	-0.0468***	-0.0335***	-0.0363***
	(-2.02)	(-2.22)	(-4.13)	(-5.00)	(-5.39)
finance	0.1679	-0.3881*	0.1702	0.0364	-0.0262
	(1.02)	(-1.95)	(1.09)	(0.37)	(-0.27)
klratio	0.0270***	0.0334***	0.0324***	0.0300***	0.0283***
	(5.93)	(6.13)	(6.06)	(10.11)	(9.47)
hhi	7.6446***	-0.9024	-4.4103***	-1.4439***	-2.7880***
	(5.28)	(-1.45)	(-6.52)	(-3.78)	(-6.57)
state	-0.0553*	-0.0053	-0.0248	-0.0258*	-0.0252*
	(-1.92)	(-0.19)	(-1.09)	(-1.71)	(-1.66)
Constant	-1.1764***	-0.6474***	-1.6174***	-0.3429***	-0.5767***
	(-12.76)	(-6.55)	(-17.46)	(-7.47)	(-12.58)
Fixed time	YES	YES	YES	YES	YES
Industry fixation	YES	YES	YES	YES	YES
Enterprise fixation	YES	YES	YES	YES	YES
Number of observed values	106,264	78,275	133,183	317,722	317,722
R_2	0.538	0.609	0.505	0.542	0.539

5.2 Mechanism test

Based on theoretical analysis, this paper uses the level of R&D innovation of enterprises and the diversity of export products as adjusting variables to verify the possible channels through which the quality of productive service input affects the complexity of export technology. The first and second columns of Table 4 respectively report the effects of enterprise R&D innovation level (tech) and export product diversity (ed) as moderating variables. The empirical results show that the interaction between producer service input quality and enterprise R&D innovation level (qpsmc*tech) and producer service input quality and export product diversity (qpsmc*ed) has significantly positive effects on enterprise export technology complexity at the level of 1%, which confirms the enterprise R&D innovation level.

Table 4: Mechanism Test Analysis

Variable name	esi	esi
	(1)	**(2)**
qpsmc	0.3464***	0.2948***
	(23.65)	(19.61)
qpsmc*tech	0.0210***	
	(12.14)	
tech	0.2919***	
	(59.41)	
qpsmc*ed		0.0089***
		(6.68)
ed		0.0379***
		(18.71)
Control variable	YES	YES
Fixed time	YES	YES
Industry fixation	YES	YES
Enterprise fixation	YES	YES
Number of observed values	317,722	317,722
R_2	0.646	0.544

5.3 Endogenous test

In the process of manufacturing enterprises' production and export, there may be a two-way causal relationship between the quality of productive services and the complexity of export technology. To a great extent, the complexity of export technology will be affected by the quality of productive service input. At the same time, enterprises with high export technology complexity may prefer to choose high-quality productive service inputs. Sample selectivity will also make empirical analysis endogenous. The instrumental variable method can effectively solve the above endogenous problems. Vinv Liu et al. (2020) hold that the service quality of American manufacturing inputs meets two conditions of effective instrumental variables:

1) Relevance: The United States is an important source country for China manufacturing enterprises to input services, especially in producer services such as R&D, information and technology.

2) Externality: The service input of American manufacturing enterprises mostly comes from their own countries, and they have little dependence on other countries. Therefore, this paper selects the quality of productive service fully invested by the United States and the lag period of the core explanatory variables as instrumental variables.

The first and second columns of Table 5 are the regression results using the quality of productive services fully invested by the United States and the lag period of the core explanatory variables as instrumental variables respectively; The third column is the regression result of using the quality of productive service fully invested by the United States and the lag of the first phase of the core explanatory variables as instrumental variables. In order to test the validity of tool variables, this paper carries out the under-recognition test and the weak tool variable test: the p values of Kleibergen-Paap rk LM test are both 0.0000, which obviously rejects the unrecognized hypothesis; The statistical values of Kleibergen-Paap Wald rk F are 64000, 6433.548 and 21000, respectively, which are significantly greater than the tolerable critical value of 10%, and the hypothesis of weak instrumental variables is rejected. The above tests show that the tool variables are reasonable and effective. The regression results in Table 5 show that the quality of producer services still significantly improves the technical complexity of manufacturing enterprises' exports, indicating that endogenous problems will not change the conclusion of this model.

Table 5: Endogenous Test Analysis

Variable name	esi	esi	esi
	(1)	(2)	(3)
qpsmc	0.1964***	0.1861***	0.1893***
	(0.013)	(0.014)	(0.013)
tfp	0.7929***	0.7923***	0.7923***
	(0.001)	(0.001)	(0.001)
age	0.0261***	0.0328***	0.0328***
	(0.002)	(0.003)	(0.003)
finance	0.0279	0.1897*	0.1901*
	(0.068)	(0.099)	(0.099)
klratio	0.0679***	0.0725***	0.0725***
	(0.001)	(0.001)	(0.001)
hhi	-0.2168	-0.8864***	-0.8496***
	(0.222)	(0.314)	(0.309)
state	0.0642***	0.0688***	0.0688***
	(0.007)	(0.010)	(0.010)
Constant	0.0868***	-1.0227***	-1.0266***
	(0.019)	(0.026)	(0.025)
Individual fixation	Yes	Yes	Yes
Industry fixation	Yes	Yes	Yes
Fixed year	Yes	Yes	Yes
Number of observed values	317,722	172,169	172,169
R_2	0.670	0.676	0.676
Annotate: The standard error is reported in brackets.			

5.4 Robustness test

In order to test the robustness of the benchmark regression results, we use the methods of eliminating extreme values and replacing the original explanatory variables and explained variables to re-test. The first column of Table 6 is the result of robustness test of the explained variables after censoring, that is, the outliers of 5% before and after the complexity of export technology of enterprises are eliminated and then the benchmark regression test is carried out again. The second column is the measurement method of changing the export technical complexity index of enterprises. The method of Sheng Bin and Mao Qilin (2017) is used to adjust the export technical complexity of products by price, and then the export technical complexity (esi2) of enterprises is calculated. In the benchmark regression, we use the quality of productive service fully invested by the manufacturing industry, and here we use the quality of productive service directly invested by the manufacturing industry (qpsmd) for robustness test. The regression result is the third column. The regression analysis results in Table 6 are basically consistent with the benchmark results, which shows that the above empirical results are robust and credible.

Table 6: Robustness Test Analysis

Variable name	esi	esi2	esi
	(1)	(2)	(3)
qpsmc	0.2679***	0.1488***	
	(27.44)	(9.94)	
qpsmd			0.0758***
			(13.47)
tfp	0.8264***	0.4882***	0.8253***
	(338.30)	(185.36)	(337.25)
age	-0.0054	-0.0283***	-0.0063
	(-1.12)	(-4.28)	(-1.32)
finance	0.1243*	0.0902	0.0870
	(1.73)	(0.94)	(1.21)
klratio	0.0209***	-0.0021	0.0197***
	(9.73)	(-0.72)	(9.10)
hhi	-0.8335***	-1.2393***	-2.3795***
	(-2.89)	(-3.35)	(-7.29)
state	-0.0111	-0.0363**	-0.0092
	(-0.93)	(-2.47)	(-0.76)
Constant	0.5477***	2.5629***	0.3717***
	(15.83)	(55.38)	(10.98)
Enterprise fixation	Yes	Yes	Yes
Industry fixation	Yes	Yes	Yes
Fixed year	Yes	Yes	Yes
Number of observed values	317,722	317,722	317,722
R2	0.650	0.250	0.647

6. Conclusion and enlightenment

In this study, using the world input-output database from 2000 to 2013, China industrial enterprise data and customs data, we investigated the influence of the quality of productive services invested by manufacturing enterprises in China on the export technical complexity of enterprises, and explored its internal mechanism, and got the following main conclusions: First, the improvement of the quality of productive services can significantly enhance the export technical complexity of manufacturing enterprises during the sample period; Secondly, the quality of productive service input has a significant positive effect on the improvement of export technical complexity of capital-intensive and technology-intensive manufacturing enterprises, but has no obvious effect on the export technical complexity of labor-intensive manufacturing enterprises; Thirdly, from the source of producer service input, the quality of producer service input in China has a significant promotion effect on the improvement of export technology complexity of manufacturing enterprises, while the promotion effect abroad is not significant; Fourth, the innovation of enterprise R&D and the improvement of export product diversity will strengthen the role of the quality of productive service input in improving the technical complexity of manufacturing enterprises' exports.

Based on the research conclusion of this paper, the following suggestions are put forward. First, we should optimize the supply quality of producer services, improve the adaptability of producer services to manufacturing demand, and adapt, lead and create new manufacturing demand with high-quality supply. At the same time, we should treat imported productive services rationally and scientifically realize their influence on China's manufacturing enterprises. Only in this way can we promote the formation of a strong domestic and international market and stabilize the new development pattern of "double circulation". Specifically, it is necessary to speed up the development of producer services such as scientific and technological research and development, professional science and technology, support the technological innovation of manufacturing industry, and solve the realistic dilemma of "being controlled by people" in some areas of China's manufacturing industry; Accelerate the development of information services, logistics, transportation, warehousing and other producer services, promote the integration and sharing of information resources, and improve the integrated operation level of manufacturing and logistics; Accelerate the development of producer services such as finance and insurance, give better play to the role of the capital market, and constantly innovate service models to ensure the stable and efficient development of manufacturing. Second, the transformation and upgrading of labor-intensive manufacturing industries need to improve policy support, strengthen policy guarantee, increase government subsidies, accelerate the integration and evolution of producer services and labor-intensive manufacturing industries, and promote the export competitiveness of labor-intensive manufacturing enterprises. Third, the government should build a policy chain and a service chain to support the innovation ability of manufacturing enterprises. Specifically, it can encourage and support enterprises' R&D innovation activities by issuing preferential policies such as R&D innovation subsidies, tax relief and talent introduction. Encourage enterprises to promote personalized design and diversified production, implement product diversification strategy, and cultivate new business models such as customized consumption.

Funding Statement

This work was sponsored in part by General Project of the National Social Science Foundation of China "Research on the Impact Mechanism of Global Value Chain Reconstruction on the High Quality Development of Export Trade" (21BJL136)

References

[1] Huang Fanhua and Hong Yinxing (2020). The impact of producer services on China's participation in the international cycle-based on the position of the global value chain division of manufacturing. Economic trends (12),pp.15-27.

[2] Heuser C. and Mattoo A. (2017). Services trade and global value chains. World Bank Policy Research Working Paper (8126).

[3] Yang Renfa and Wang Qingqing (2018). Productive service input, technological innovation and international competitiveness of manufacturing industry. Journal of Shanxi University of Finance and Economics,40(09), pp.62-75.

[4] Yu Mingyuan and Fan Aijun (2019). Embedding of producer services and enhancing the international competitiveness of China's manufacturing industry. Contemporary Economic Science, 41(02), pp.88-96.

[5] Nozomi, Zhang Xinjue, and Li Yang (2018). An empirical study on the dynamic and coordinated development of manufacturing and producer services in China. Economic Research, 53(03), pp.79-93.

[6] Yang Renfa and Liu Qinwei (2019). Producer service input and manufacturing global value chain status: impact mechanism and empirical test. World Economic Research, (04), pp.71-82+135.

[7] Xia Jiechang and Yao Zhanqi (2019). The impact of intermediate investment in producer services on the service of China's manufacturing industry. social science front (05), pp.102-110.

[8] Macpherson A. (2008). Producer service linkages and industrial innovation: Results of a twelve-year tracking study of New York State manufacturers. Growth and Change, 39(1), pp. 1-23.

[9] Liu Jishuang and Ye Ting (2020). Ren Baoquan. Quality evaluation and dynamic trend research of producer services in China. Journal of Changzhou University (Social Science Edition), 21(03), pp.55-65.

[10] Vinv Liu, Zhou Lingyun, and Li Jing (2020). Service quality of production input and enterprise innovation-analysis based on production outsourcing model. China Industrial Economy (08), pp. 61-79.

[11] Hausmann R, Hwang J and Rodrik D. (2007). What you export matters. Journal of economic growth, 12(1), pp.1-25.

[12] Rodrik D. (2006). What's so special about China's exports?. China & World Economy, 14(5), pp.1-19.

[13] Assche A. V. and Gangnes B. (2010). Electronics Production Upgrading: Is China Exceptional? Applied Economics Letters, 17(5), pp.477-482.

[14] Gao Xiang and Yuan Kaihua (2020). Cleaner production environment regulation and technological complexity of enterprises' export-micro evidence and influence mechanism. International Trade Issues, (02), pp.93-109.

[15] Xu B. (2010). The sophistication of exports: Is China special? China Economic Review, 21(3), pp. 482-493.

[16] Sheng Bin and Mao Qilin (2017). Does the liberalization of import trade affect the technical complexity of China's manufacturing exports. World Economy, 40(12), pp.52-75.

[17] Cheng Dazhong, Wei Ruqing, and Zheng Lekai (2017). Dynamic changes and international comparison of the export complexity of China's service trade-based on the perspective of trade added value. International Trade Issues, (05), pp.103-113.

[18] Yu Juanjuan, and Yu Dongsheng (2018). Government Subsidies, Industry Competition and Technical Complexity of Enterprises' Export. Financial Research, 44(03), pp.112-124.

[19] Huang Xianhai, Chen Xiaohua, and Liu Hui (2010). Measurement of industrial export complexity and analysis of its dynamic evolution mechanism-an empirical study based on the export of metal products in 52 economies from 1993 to 2006. Management World (03), pp.44-55.

[20] Liu Sheng and Gu Naihua (2016). The impact of foreign direct investment on the technical complexity of China's manufacturing exports. Journal of capital university of economics and business, 18(02), pp.11-18.

[21] Zheng Zhanpeng and Wang Yangdong (2017). International technology spillover, human capital and export technology complexity. Economist (01), pp.97-104.

[22] Liu Yingji (2016). Empirical analysis of the impact of knowledge capital on the technical complexity of manufacturing export. World Economic Research (03), pp. 97-107+136.

[23] Li Junqing, and Miao Ersen (2018). Intellectual property protection under incomplete contract conditions and the technical complexity of enterprise export. China Industrial Economy (12), pp.115-133.

[24] Yao Zhanqi (2021). Digital Trade, Industrial Structure Upgrading and the Complexity of Export Technology-Multiple Mediating Effects Based on Structural Equation Model. Reform (01), pp.50-64.

[25] Hu Yuanhong, Dai Yixin, and Sun Sheng (2021). Study on the Impact of Economic Policy Uncertainty on the Technical Complexity of Manufacturing Export. Soft Science, 35(08), pp.14-22.

[26] Liu Hui, Chen Xiaohua, and Jiang Mobing (2020). The best choice of embedding producer service resources in manufacturing production-from the perspective of upgrading the technical complexity of intermediate inputs. Financial Research, 46(07), pp.154-168.
[27] Ling Dan, Gui Sen, and Liu Huiling (2020). Study on the Impact of Intermediate Input in Producer Services on the Technical Complexity of Manufacturing Export. Journal of Beijing University of Posts and Telecommunications (Social Science Edition), 22(03), pp.48-56.
[28] Hui-juan Li, and Cai Weihong (2016). The impact of intermediate investment in offshore producer services on the technological complexity of China's manufacturing exports. World Economic and Political Forum (03), pp.122-141.
[29] Xia Jiechang, and Xiao Yu (2019). Producer service industry: development trend, existing problems and high-quality development policy ideas. Journal of Beijing Technology and Business University (Social Science Edition), 34(04), pp. 21-34.
[30] Ma Yingying, and Sheng Bin (2018). Servitization of manufacturing industry and the complexity of export technology: a study based on the perspective of trade added value. Industrial Economic Research, (04), pp.1-13+87.
[31] Sun Xiangxiang, and Zhou Xiaoliang (2018). Research on the impact of service industry opening on the rising efficiency of manufacturing value chain-an empirical analysis based on threshold regression. International Trade Issues, (08), pp.94-107.
[32] Ling Dan, and Zou Mengting (2020). Financial Support, R&D Innovation and Export Complexity-Based on the Analysis of China High-tech Industry Value Chain. Technical Economy, 39(11), pp.77-86.
[33] Han Yafeng, and Fu Yunjia (2018). Independent research and development, import of intermediate products and technical complexity of manufacturing export. Economic Jingwei, 35(06), pp.73-79.
[34] Naudé W, Bosker M, and Matthee M. (2010). Export Specialisation and Local Economic Growth. World Economy, 33(4), pp.552-572.
[35] Gnangnon S. K. (2020). Export product diversification and tax performance quality in developing countries. International Economics and Economic Policy, 17(7).
[36] Wang Jian, and Zhang Chi (2020). Research on product diversification decision-making supporting the improvement of R&D capability. Science Research, 38(11), pp.2008-2019.
[37] Ackerberg D. A., Caves K., and Frazer G. (2015). Identification properties of recent production function estimators. Econometrica, 83(6), pp.2411-2451.
[38] Cheng Dazhong (2021). Accelerate the high-quality development of producer services-based on the perspective of economic cycle optimization and value chain status promotion. People's Forum Academic Frontier (05), pp.28-40.
[39] Liu Hongkui, and Xie Qian (2017). Productivity effects of emerging economies participating in global value chains. Financial Research, 43(08), pp.18-31+121.

[40] Hu Haoran (2021). Cleaner production environment regulation and China enterprises' added value upgrading. International Trade Issues (08), pp.137-155.
[41] Lall S. (2000). The Technological structure and performance of developing country manufactured exports, 1985-98. Oxford development studies,28(3), pp. 337-369.
[42] Wu Chao, Zhang Xinyue, and Guan Yue (2016). Measurement and dynamic analysis of the diversity of trade products in China. Research on Quantitative Economy, Technology and Economy, 33(07), pp.40-58.
[43] Zhu Peihua, and Chen Lin (2020). Industrial added value and total factor productivity estimation-based on the quasi-Monte Carlo experiment of China manufacturing industry. China Industrial Economy (07), pp.24-42.
[44] Nie Huihua, Jiang Boat, and Yang Rudai (2012). Current situation and potential problems of industrial enterprise database in China. World Economy, 35(05), pp.142-158.
[45] Liu Xiaoxuan, and Li Shuangjie (2008). Measurement and comparison of relative efficiency of manufacturing enterprises and its exogenous determinants (2000-2004). Economics (Quarterly) (03), pp.843-868.
[46] Yu M. (2015). Processing trade, tariff reductions and firm productivity: Evidence from Chinese firms. The Economic Journal,125(585), pp.943-988.
[47] Fan Maoqing, and Huang Wei (2014). Research on the Evolution of China's Trade Industrial Structure Based on the Decomposition of Global Value Chain. World Economy,37(02), pp.50-70.
[48] Jason (2015). Import behavior, enterprise R&D and processing trade dilemma. World Economic Research (09), pp.22-36+127.