

Heterogeneity of Total Factor Productivity of Export Tobacco Enterprises Under the Link of Tobacco Production Scheduling

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Objectives: The production scheduling of tobacco enterprises belongs to the production arrangement level, that is, to the decision-making management level. **Production scheduling chain management** started relatively late in tobacco enterprises. **Methods:** By combining TFP and production scheduling chain through scheduling coordination function, they can achieve the same goal of organic link. This can enable tobacco enterprises to develop products with excellent quality and stable performance, so as to improve the export volume and create considerable economic benefits. **Results:** The TFP (total factor productivity) of enterprises from the perspective of heterogeneity to test the applicability of the new trade theory to China's agricultural export enterprises. It measures the TFP and its heterogeneity from the micro enterprise level, and shows that the average increasing rate TFP of China's agricultural export enterprises is 4.2%. At the regional level, the TFP growth rate in the western region is the highest. The TFP of state-owned enterprises is the lowest, with an average increasing rate of 6.6%. **Conclusion:** More attention should be paid to the active introduction of new factors to accelerate the establishment and development of a modern tobacco system. Moreover, advanced factors of the Internet, digitization, and intelligence should be combined to promote an in-depth integration of the producer services, advanced manufacturing industry, and modern agriculture to achieve free flow and effective allocation of various factors for technical progress.

Key words: tobacco enterprises; tobacco production scheduling chain; total factor productivity; heterogeneity

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With China's accession to the tobacco framework agreement, it has formed a great shock to China's tobacco industry. Due to various national conditions, China's tobacco industry has been in a state of protection and national planning and control. Management and production are basically step-by-step. In recent years, human beings have strengthened their understanding of the environment and their

own health. The competition in the tobacco industry has become larger and the market has been gradually liberalized. The competition in the same industry at home has gradually changed into the competition of tobacco enterprises at home and abroad. Firstly, the technology of cigarette production in foreign tobacco industry is generally ahead of that in domestic tobacco industry. Secondly, because the foreign

tobacco industry has been in the fierce market competition for a long time, its management level is high and its capital is abundant. When China's tobacco enterprises are facing greater competitive pressure, improving the management and production level has become an important means to deal with the competitive pressure.

In the 21st century, tobacco enterprises have experienced a series of reform, reorganization and reconstruction of new production plants. Rural tobacco users see tobacco use as a personal choice rather than a structural or policy-related issue.¹ Especially in the information age, management and production must comply with the law of marketization, expand internet tobacco purchase monitoring to reduce youth exposure.² Management and automatic production will be the focus of all work of tobacco enterprises. The main activity of tobacco enterprises is production, and production management is the most important part of enterprise management. The work of production management should finally be implemented to the production department. The production management of the production department is the main link to control the delivery date, quality and cost. The production planning and scheduling of production department plays a connecting role in enterprise production management. Reasonable planning and scheduling can improve the service level of enterprises, the production capacity of enterprises and deepen the understanding of enterprise production process mechanism and key data.

Productivity is the core driving force for long-term tobacco industry development, with factor input- turning to efficiency-

based growth. total factor productivity (TFP) includes the efficiency of resource development and utilization. It originates from efficiency improvement, technical progress, and scale effect. The current methods of measuring changes in TFP mainly include stochastic frontier analysis and data envelopment analysis (DEA). Rolf et al³ were the first to use the DEA method to measure Malmquist-TFP, use the Malmquist index to measure TFP, and decompose it into three driving factors to measure the TFP characteristics of OECD countries, involving the United States and Japan. By measuring the technical efficiency of multiple decision-making units in different periods, the change in the rates of technical efficiency and technical progress of the components of Malmquist TFP can be obtained. Since estimating the inter-period distance function leads to an infeasible result, Jesu's proposed the global Malmquist index.⁴ It is difference in enterprise trade behaviors using the difference in enterprise production efficiency. Enterprise heterogeneity is manifested in the differences in production technology efficiency, and the age of the new-new trade theory began.⁵⁻⁷ The reallocation of the resources of an enterprise results in the reallocation of resources between enterprises, leading to changes in total productivity. This finding was confirmed by Victoria who also pointed out that differences in cross-country productivity can be partially explained by differences in the mismatch of internal resources of enterprises.^{5,8-9} There are significant differences in the productivity of companies in an industry, and the productivity of an enterprise is positively correlated with its scale and profit.¹⁰ The TFP of manufacturing

enterprises is increasing, which is mainly due to the advancement of cutting-edge technology.¹¹⁻¹² Gao concluded that the export scale has a significant positive impact on an increase in TFP.¹³ Large-scale tobacco product export enterprises exporting to high-income countries have high TFP. The TFP of export enterprises has an inverted U-shape relationship with spatial agglomeration.¹⁴⁻¹⁵ Enterprises lead technological innovation and achievement transformation. Export enterprises are at the forefront of product update and iteration. According to the productivity heterogeneity enterprise model, export enterprises with high productivity have low marginal production costs. There are many studies on the TFP of manufacturing enterprises. Whether their conclusions apply to China's tobacco export enterprises is not known. Thus, from the perspective of enterprise heterogeneity, this study examines TFP to test the applicability of the new-new trade theory to China's tobacco product export enterprises.

METHODS

Model Building

TFP reflects the output level per unit of various input factors in the production process. That is the overall efficiency of converting inputs into outputs. We construct a production frontier of two periods of observations and measure the TFP index. When a new period of data is added, only the frontier of the last period needs to be changed.¹⁶ A DEA-Malmquist index model is constructed to measure the overall TFP of China's tobacco export enterprises. The benchmark production technology is defined as follows:

$$T_c^i = \left\{ (x, y) \in R_+^{N+P} \mid x \leq \sum_{i=1}^I \lambda_i^t x_i^t, \right. \\ \left. y \geq \sum_{i=1}^I \lambda_i^t y_i^t, \lambda_i^t \geq 0, i=1, L, I \right\}$$

(1)

The benchmark production technology for period $t+1$ is defined similarly as follows:

$$T_c^B = \text{conv}\{T_c^i, T_c^{i+1}\}$$

(2)

Based on this, the distance function of the output direction is defined as follows:

$$D_c^B(x, y) = \min(\phi > 0 \mid (x, y/\phi) \in T_c^B) \quad (3)$$

The TFP index is defined as follows:

$$M_c^B(x_i^t, y_i^t, x_i^{t+1}, y_i^{t+1}) = \frac{D_c^B(x_i^{t+1}, y_i^{t+1})}{D_c^B(x_i^t, y_i^t)} \quad (4)$$

The TFP index can also be decomposed into changes in production efficiency and technology as follows:

$$\begin{aligned} M_c^B(x^t, y^t, x^{t+1}, y^{t+1}) &= \frac{D_c^{t+1}(x^{t+1}, y^{t+1})}{D_c^t(x^t, y^t)} \times \\ &\left\{ \frac{D_c^B(x^{t+1}, y^{t+1})}{D_c^{t+1}(x^{t+1}, y^{t+1})} \times \frac{D_c^t(x^t, y^t)}{D_c^B(x^t, y^t)} \right\} \\ &= \frac{TE_c^{t+1}(x^{t+1}, y^{t+1})}{TE_c^{t+1}(x^t, y^t)} \times \\ &\left\{ \frac{D_c^B(x^{t+1}, y^{t+1} / D_c^{t+1}(x^{t+1}, y^{t+1}))}{D_c^B(x^t, y^t / D_c^t(x^t, y^t))} \right\} \\ &= EC_c \times \left\{ \frac{BPG_c^B(x^{t+1}, y^{t+1})}{BPG_c^B(x^t, y^t)} \right\} \\ &= EC_c \times BPG_c \end{aligned} \quad (5)$$

Due to the TFP and heterogeneity characteristics of tobacco product export enterprises, the scale of an enterprise is the key internal cause of technical efficiency progress. The larger the scale, the more

conducive it is to the refined internal division of labor and the promotion of technical discovery and improvement. First, based on the first 24 chapters of the customs database, enterprises exporting tobacco products were screened, and non-productive enterprises whose names contain keywords such as "trade" and "import and export" were excluded from the research sample. Second, enterprises above the designated scale in China's industrial enterprise database from 2000 to 2009 were used as the research sample. Finally, the industrial sales value, active number of employees, and paid-in capital were selected as the output index, labor factor input index, and capital factor input index, respectively.

TFP Measurement and Heterogeneity Analysis of Tobacco Product Export Enterprises

During sampling, the TFP of China's tobacco product export enterprises continued to increase steadily, with an overall increase rate of 13.63%. The growth rate of the technical progress of enterprises was 108.51%, with the highest growth of 35.30% in 2004. The average value of scale efficiency was 0.928, with a minimum of 0.76 in very few years. The return to scale of enterprises was in a decreasing trend, indicating that the overall return to scale of enterprises decreased, and the efficiency was low. Continuous input of traditional production factors is experienced a continuous decrease in marginal returns. Therefore, technical improvement is an inevitable choice for enterprises to increase production efficiency and enhance export benefits. When the production of the industry of an export enterprise is heterogeneous, the product vertical development shows high

maturity, and the production equipment is dedicated. Therefore, the fixed cost of production is high, especially the technical efficiency. When the production of the industry of an export enterprise is homogeneous, the production equipment is more versatile, making the increase in technical efficiency slow. From 2000 to 2009, the TFP of various industries of tobacco product export enterprises experienced an upward trend, and the growth rates of various industries were different. Among them, the tobacco manufacturing industry had the fastest TFP growth rate, with an average increasing rate 12.1%, followed by the food processing industry and the tobacco and sideline food processing industry, with average annual rates of 6.6% and 7.9%, respectively. The tobacco manufacturing industry had the slowest development rate, with an average increasing rate of 5.8%. This industry also had the slowest TFP growth rate, with an annual decline of 2.6%. Due to the heterogeneity of consumer demand, the price of the same product exported by the same enterprise to different countries is different, and even the price of the same product exported to the same market may vary greatly. There are more than 600,000 types of products in developed countries, and China has over 300,000 types of products, with fewer types of exported tobacco products. This is related to the insufficient production and technical capabilities of China's tobacco product export enterprises.¹⁷ Hallak defined the price difference of the same type of product as "intra-product complexity." Although China's inter-product complexity (EXPY) is high, the intra-product complexity is very low. Thus, although China exports high-tech products,

the quality of these products is not good enough.¹⁷ The technology of the tobacco manufacturing industry progressed rapidly from 2000 to 2009, with an average increasing rate 10.1%, which was 1.4% higher than the average value. The growth rate of technological progress of the tobacco manufacturing industry in the same period was 9.6%, which was slightly higher than the average value. During sampling, the average increasing rate of the technical efficiency of tobacco manufacturing enterprises was 1.8%; the technical efficiency of tobacco and sideline food processing enterprises and food manufacturing enterprises were 2.6% and 2.2% higher than the average value, respectively; and the technical efficiency of tobacco manufacturing enterprises was 0.888, which was 8.6% less than the average. The production of the tobacco industry has low heterogeneity, and the production equipment in the industry is highly versatile. In addition, due to the restriction of administrative monopoly in the industry, the export prices of tobacco export enterprises are highly consistent, so the industry's TFP progress is slow. Under administrative monopoly, the property of tobacco production technology is dedicated, resulting in high barriers to production industries, and the production factors are mostly restricted to flowing within the industry, making it difficult to achieve technical exchanges and improvement between industries. The tobacco manufacturing industry has a relatively high growth rate of technical progress, which is closely related to the fact that its industry is almost a perfectly competitive market, and the free flow of production factors promotes technical improvement. The rapid and free flow of factors within the industry and between

enterprises increases the efficiency of factor allocation, thus increasing productivity. Tariffs can be used to adjust the industry differences in the TFP of export enterprises. For tobacco product industries with higher heterogeneity, reducing import tariffs induces export enterprises to improve technology and increase their product quality and export prices, whereas in tobacco product industries with small quality differences, reducing import tariffs makes export enterprises lower their export prices.

RESULTS

Enterprise TFP Analysis Based on Regional Heterogeneity

Regional financial development level, industrial structure, and property rights protection level are important factors that affect the TFP of export enterprises. Due to natural constraints of geographical distribution, TFP experienced regionally differentiated growth. The eastern region shares complete infrastructure and related supporting services, having the industrial synergy effect and making it easy to form industrial clusters. The TFP of tobacco product export enterprises in various regions of China is generally increasing, with an average increasing rate 0.4%. The TFP of western region has the fastest growth rate, which is 14.1% higher than the regional average; the eastern region has a slow TFP growth rate, which is 4.3% higher than the average growth rate and is 9.8% lower than that of the western region. The TFP of the central region experienced a relative declining trend, with an average annual decline of 15.6%. The trend of the TFP of China's tobacco product export enterprises is not consistent with the local economic development. With a huge market demand and advanced production

equipment, the eastern region has the ability and conditions to lead the production frontier, which continuously increase the TFP growth rate. Under the guidance of policies, tobacco product export enterprises in the western region experience rapidly increasing TFP and develop rapidly.

Analysis of TFP Heterogeneity of Enterprises with Different Types of Business Entity

The development of enterprises depends not only on the input of traditional production factors but also on technical progress and improvement. The production efficiency of an enterprise directly affects its export performance. Improving the TFP of China's tobacco product export enterprises is an inevitable way to achieve sustainable export development. Based on the type of business ownership, China's private enterprises had the highest export volume, reaching 48.735 billion U.S. dollars in 2017 and surpassing the exports of other types of enterprises. From the perspective of the heterogeneity characteristics of the TFP of other types of entities, China's domestic-funded enterprises had the highest TFP of 1.0309, of which joint-stock companies had the highest TFP of 1.0784, followed by enterprises invested by Hong Kong, Macao, and Taiwan with TPF of 1.0112, of which wholly-owned Hong Kong, Macao, and Taiwan enterprises had the highest TFP of 1.0186; foreign-invested enterprises had an average increasing rate TFP of 0.81%, and the enterprises suffered from low production inefficiency during the sample period. From 2000 to 2009, the TFP of collective holding enterprises grew the most, which was 6.2% higher than the average value; the TFP of state-owned

enterprises experienced a downward trend, with annual reduction rate 6.6%. The productivity of state-owned enterprises was mainly due to their lowest factor allocation efficiency has become the lowest. The productivity of private enterprises was in the middle, whereas their factor allocation efficiency was the highest. This proves once again that private enterprises are the most active economic entity in China.

The analysis of the efficiency of technical progress indicates that the technical progress of collective holding enterprises grew rapidly, with an average increasing rate 11.8% from 2000 to 2009; the average increasing rate of state-owned holding enterprises was 0.5%, which was 6.6% lower than the average value. From 2000 to 2009, average increasing rate of the technical efficiency of state-owned enterprises dropped by 7.1%, which was lower than the average of the industry. The production efficiency of different export enterprises in different markets was different. In 2017, the export volume of China's collectively-owned tobacco export enterprises increased by 4.6%, and the private enterprises increased by 6.6% to 48.74 billion US dollars; in comparison, the growth rate of state-owned enterprises was 2.8%, and that of foreign-invested enterprises fell by 4.2% year-on-year. This also shows that high-efficiency and high-quality product exports are more market-recognized and profitable. The technical progress of tobacco product export enterprises originates from the improvement of production technology achieved from the transition from traditional agriculture to modern industrialization, including the inter-industry substitution effect produced by the

transition from agriculture to industry, the improvement of efficiency in allocating technological factors among different industries, and the accumulation of technological factors (progress) within the industry, which help cultivate new competitive advantages for China's tobacco export enterprises.

DISCUSSION

Regardless of the heterogeneity characteristics of enterprises, the scale of enterprises is the main factor affecting exports. China has a logical chain of "low labor productivity–low profits–high export propensity." The lower the productivity of enterprises, the more they export.¹⁸ Su held a different view and further distinguished the export status, the type of ownership, and the scale of enterprises. They found that the TFP of private enterprises increased the most, followed by foreign-funded enterprises, whereas the productivity of state-owned enterprises decreased. From the perspective of the eastern, the productivity of enterprises in the western region grows the most, but the gap between regions is narrowing.¹⁹ This viewpoint is closer to that in this study and is more consistent with Melitz's theoretical.⁷ Similar views propose that trade liberalization, transportation infrastructure, and urban labor participation rate have a positive impact on heterogeneous export enterprises. The transportation infrastructure in the eastern region does not play as the transportation infrastructure in the central and western regions significantly promotes it.²⁰⁻²¹

Based on China's industrial enterprises above the designated scale and the DEA-Malmquist productivity index method, the overall TFP of China's tobacco product export enterprises and their heterogeneity

characteristics are measured at the micro-enterprise level. The average increasing rate of the overall TFP of China's tobacco product export enterprises was 4.2%, showing a slowly increasing trend with small fluctuations. Tobacco manufacturing enterprises had the highest growth rate of TFP, with an average increasing rate 12.1%. From the perspective of types of business entity, state-owned enterprises had the lowest TFP, with an average decreasing rate 6.6%. tobacco product export enterprises generally experience diminishing returns to scale. To further improve the production efficiency of exported tobacco products, the inter-industry technology spillover can be shared to form new competitive advantages for export enterprises.²² TFP is an important driving force for achieving innovation and development. We propose that enterprises should further open up to the outside world to absorb advanced management experience and adjust the industry differences in TFP of export enterprises through differentiated tariffs. The independent technical innovation of China's local enterprises should be strengthened to further build the brands of regional tobacco products exported.²³ More attentions should be paid to the active introduction of new factors to accelerate the establishment and development of a modern tobacco system. Moreover, advanced factors of the Internet, digitization, and intelligence should be combined to promote an in-depth integration of the producer services, advanced manufacturing industry, and modern agriculture to achieve free flow and effective allocation of various factors for technical progress.

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