The evolution pattern of Input and output of Chinese forest products industry

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Abstract. Based on the data of China Statistical Yearbook of Industry and China Statistical Yearbook, this paper analyzes the evolution characteristics of the input and output of China's forest product industry. The results show that from 2000 to 2018, the capital factor input of China's forest product industry showed a trend of increasing year by year on the whole, while the labor input stabilized after 2008, and the paper industry even decreased. Before 2016, the total revenue of the main business of forest product industry showed a trend of annual growth, and then the growth rate declined or even declined. After 2011, the profit margin of assets in the forest product industry fluctuated and declined, and the total labor productivity increased year by year from 1999 to 2016, but the growth rate slowed down greatly after 2014. In addition, the granger causality test method is introduced to find that: for wood processing industry and wood furniture manufacturing industry, in general, there is a significant causal relationship between output scale and output quality, that is, there is a mutually reinforcing mechanism of action; The relationship between the two is not significant in the paper industry.

1. Introduction
Since the 21st century, thanks to the low cost of labor, land, raw materials and other factors, China's forest product industry has developed at a high speed. China has become the world's largest wood product processing and production exporter. Guan Zhijie and Xu Yan (2018), the international market share of paper and paper products also increased rapidly [1-2]. However, after 2003, often encounter the European Union and the United States and other developed countries and regions of anti-dumping countervailing investigation, the global financial crisis in 2008 and the subsequent debt crisis in Europe, the United States in 2008 began to implement the US Lacey Act Amendment, through the EU Due Diligence Legislation act and other external shocks in 2010, and also face development such as Vietnam, Indonesia, Malaysia, after pressure after China's participation in the international industrial division of labor [3-4]. It is worth investigating how the forestry industry develops under the dangerous situation of "front and rear attack". In view of this, this article will analyze the evolution of the input and output of the wood processing industry, the wooden furniture manufacturing industry, and the paper industry from 2000 to 2018, which will help to understand and grasp the evolution of the input and output of the wood industry [5]. In addition, in order to explore the causal relationship between the output scale and output quality of the three sub-sectors of the forestry industry, and to clarify whether "be bigger and stronger" or "be stronger and stronger" to provide empirical evidence, we will introduce Granger causality test (Granger causality test) method is used to conduct empirical
tests to examine the mechanism of mutual promotion between the output scale and output quality of the industry, and to provide a scientific basis for improving the relevant policies of the wood industry.

2. Research design

2.1. Overview of Granger Causality Test

In economics, it is often necessary to determine whether the study of causality is X to Y, Y to X, or bidirectional causality. The test method proposed by Granger is based on the following idea: if the past information of the variables X and Y is included, the prediction effect of the variable Y is better than the prediction effect of Y by the past information alone, that is, The variable X helps explain the future change of the variable Y, and the variable X is considered to be the Granger cause of the variable Y. Considering the follow time series model:

\[ Y_t = \gamma + \sum_{m=1}^{p} \alpha_m Y_{t-1} + \sum_{m=1}^{p} \beta_m X_{t-m} + \epsilon_{1t} \quad (1) \]

\[ X_t = \gamma + \sum_{m=1}^{p} \alpha_m X_{t-1} + \sum_{m=1}^{p} \beta_m Y_{t-m} + \epsilon_{2t} \quad (2) \]

Among them, the lag order p can be determined according to the "information criterion" or "sequential t rule from large to small". Taking equation (1) as an example, test the null hypothesis "H0= \beta 1= \beta 2=...= \beta p=0", that is, the past value of X does not help predict the future value of Y. If the null hypothesis H0 is rejected, then X is called Y's "Granger cause". Taking formula (2) as an example, the above method can check whether Y is Granger's of X. It is worth noting that Granger causality is not a true causality, but a dynamic correlation. It shows whether a variable has "prediction ability" for another variable, and is a necessary condition for the existence of causality between variables. Of course, even if Granger causality does not equal actual causality, it does not hinder its reference value. Because in economics, the Granger causality in the statistical sense is also meaningful, and it can still play some role in economic prediction.

In actual operation, (X,Y) is often used to form a binary VAR(Vector Autoregression representation) system, and then use the 'Stata' command 'vargranger' in the framework of the VAR system to check Granger causality, or use the unofficial command 'gcause' to test. To test the above original hypothesis, use the F test, namely: \[ F = \frac{(\text{RSS}_R - \text{RSS}_{UR})/q}{\text{RSS}_{UR}((n-k))} \]. It follows the F distribution with degrees of freedom q and (n-k). Among them, RSS$_R$ is the sum of squared residuals estimated by the constrained model, and RSS$_{UR}$ is the sum of squared residuals obtained by the unconstrained model; n is the sample size, q is equal to the number of lag items X, that is, the number of parameters to be estimated in the constrained regression equation, and k is the number of parameters to be estimated in the unconstrained regression. If the F value calculated at the selected significance level $\alpha$ exceeds the critical value $F_\alpha$, the null hypothesis is rejected, so that the lag X term belongs to this regression, indicating that X is the Granger cause of Y. In addition, Granger causality test is only applicable to stationary sequences or unit root processes with cointegration. For unit root variables that do not have a cointegration relationship, they can only be differentiated first, and then Granger test is performed after a stationary sequence is obtained.

2.2. Data description

The data in this article comes from China Industrial Statistical Yearbook and China Statistical Yearbook from 2000 to 2019. The statistical objects are industrial enterprises above designated size, and those with main business income of more than 5 million yuan in 2011 and previous years are designated above designated size. Adjusted to 20 million yuan after 2011. According to the forestry industry, it mainly includes: wood processing and wood, bamboo, rattan, palm, straw products industry (referred to as "wood processing industry"); papermaking (including pulp companies) and paper products industry; wooden furniture manufacturing and bamboo and rattan furniture Manufacturing industry is a sub-industry of furniture manufacturing industry, referred to as "wooden
furniture manufacturing industry”. In view of the fact that only relevant data of the wooden furniture manufacturing industry and bamboo and rattan furniture manufacturing industry are available during 2012-2016, the total assets, total fixed assets, number of employees, main business income, and total profits of the two sub-sectors from 1999 to 2011. Based on the data from 2017-2018, the total value of the furniture manufacturing industry is multiplied by the "average value of the total value of the five sub-sectors on the five indicators respectively accounting for the total value of the five sub-sectors on the five indicators respectively accounting for the total value of the furniture manufacturing industry” for calculation and filling.

3. Results and discussion

3.1. Input of factors of production in China's forest product industry

It can be seen from Figure 1 and Table 1 that the fixed assets of the three sub-sectors of the forestry industry from 2000 to 2018 have been increasing year by year. The total fixed assets of the wood processing industry, wooden furniture manufacturing industry and paper industry in 2017 are respectively 8.31 times, 14.87 times, 5.32 times. The 2008 financial crisis still saw a sharp rise in the year, indicating that the financial crisis has no negative impact on the capital investment of China’s forestry enterprises above designated size, which may also stem from the rigidity or sustainability of fixed asset investment. That is, the good economic outlook before the financial crisis and the optimistic market expectations stimulated forestry companies to expand their production scale. After the financial crisis in 2008, they could not stop investing in fixed assets because of shrinking market demand, otherwise the pre-investment will evolve into a huge "sunk cost". After 2010, the rapid growth of fixed asset investment has occurred again. The main reason is that after the financial crisis, the Chinese government launched the "4 trillion economic stimulus plan" in December 2009. The new round of rapid growth in productive demand and real estate has stimulated A new round of consumer demand for wood products has stimulated Chinese forestry enterprises to further expand fixed asset investment to expand production capacity. This shows that the economic stimulus plan has a certain stimulating effect on the development of China's forestry industry.

In terms of labor input, before the financial crisis, the labor input of Chinese forestry enterprises was similar to that of capital elements, maintaining a rapid growth rate, and it really broke out in the third year of WTO accession (2003), reflecting the importance of WTO accession for the development of forestry industry. The promotion effect also confirms to a certain extent the extensive growth model of "high input and high output" of Chinese enterprises. However, after the financial crisis in 2008, fixed assets still grew at a fast rate, while the growth rate of labor input slowed down significantly. In the nine years to 2016, the number of employees in wood processing industry and wood furniture manufacturing industry fluctuated frequently with a small increase. Paper industry has been declining since its peak in 2010. On the one hand, this result reflects that the asset intensity of Chinese forestry enterprises is constantly increasing, because after the increasing labor cost and quality pressure, the investment of technology and equipment improvement or upgrading becomes the inevitable choice for forestry enterprises to cope with the fierce competition in the market, leading to the relative growth rate of labor demand decreasing. On the other hand, after the implementation of the policy of eliminating backward production capacity in 2010 and the stricter environmental protection policies (such as environmental protection supervision) after 2013, a large number of enterprises in the pulp and paper making and paper products manufacturing industry with relatively small scale and backward environmental protection measures have been eliminated or closed down, and the employment scale has naturally been reduced.
Figure 1. Total input of fixed assets.

Table 1. Number of employees.

| Year | Wood processing industry | Wooden furniture manufacturing | Paper industry |
|------|--------------------------|-------------------------------|----------------|
| 2000 | 50.04                    | 17.71                         | 113.41         |
| 2005 | 83.33                    | 46.67                         | 130.14         |
| 2010 | 142.29                   | 73.16                         | 157.91         |
| 2011 | 128.68                   | 69.68                         | 146.75         |
| 2012 | -                        | -                             | -              |
| 2013 | 138.06                   | 73.51                         | 140.35         |
| 2014 | 142.3                    | 77.26                         | 138.12         |
| 2015 | 140.78                   | 76.64                         | 134.95         |
| 2016 | 139.33                   | 78.11                         | 127.11         |
| 2017 | -                        | -                             | -              |
| 2018 | -                        | -                             | -              |

3.2. Evolution analysis of China's forest product industrial output scale
Based on the research of Cao Jinfei and other scholars (2019) and the data availability, this paper measures the output scale of China's forest product industry with the income from main business.
Figure 2. Evolution of main business income.
Table 2. Average value of main business income.

| Year | Wood processing industry | Wooden furniture manufacturing | Paper industry |
|------|--------------------------|-------------------------------|---------------|
| 2000 | 0.24                     | 0.23                          | 0.32          |
| 2005 | 0.32                     | 0.45                          | 0.54          |
| 2010 | 0.63                     | 0.72                          | 0.99          |
| 2011 | 1.07                     | 1.16                          | 1.67          |
| 2012 | 1.21                     | 1.25                          | 1.75          |
| 2013 | 1.35                     | 1.30                          | 1.83          |
| 2014 | 1.47                     | 1.35                          | 1.98          |
| 2015 | 1.50                     | 1.40                          | 2.05          |
| 2016 | 1.62                     | 1.50                          | 2.22          |
| 2017 | 1.58                     | 1.42                          | 2.24          |
| 2018 | 1.56                     | -                             | 2.05          |

It can be seen from Figure 2 and Table 2 that before 2016, the total revenue of the main business of the three subdivided industries showed a trend of increasing year by year. Similarly, two years after China’s accession to the WTO, the main business income of the three subdivided industries began to grow rapidly, once again confirming the significance of China’s accession to the WTO for China's economic growth. The 2008 financial crisis only led to a decline in the growth rate of main business income in 2009, but the growth rate remained relatively high. With the implementation of the “four trillion stimulus plan”, the growth rate of main business income began to accelerate again. Before 2016, the average main business income of China’s forestry industry enterprises also increased, and there was a huge increase in 2011, mainly due to the increase in terminal demand caused by the economic stimulus plan, inflation and the elimination of backward production capacity in 2010, leaving high-quality enterprises the result of. In the past three years, China’s economic growth has
slowed and the global market has been sluggish, which has caused the total (average) growth of the
main business income of the three sub-sectors to almost stagnate. The Chinese forestry industry must
strengthen technological innovation, product innovation, organizational structure or operating model
innovation, Marketing innovation, etc., in order to compete for market share in the global market
similar to "stock competition", in order to open up space for further growth.

3.3. Evolution characteristics of China's forest product industrial output quality

Drawing on the research of Scholars such as Su Shiwei and CAI Ting (2018), Wang Yebin and Xu
Xuefang (2019), total profit margin (the ratio of total profit to total assets) and total labor productivity
(the ratio of main business income to the number of employees) were designed to represent the output
quality of China's forest product industry. First, before 2016, the total profit of forestry enterprises
above the scale has been growing year by year. Before 2013, the total profits of timber processing
industry and wooden furniture manufacturing industry both grew rapidly, but the high growth rate of
paper industry only remained until 2010, and another explosive growth occurred in 2017. Second,
before 2011, the profit margin of the wood processing industry and the wood furniture manufacturing
industry basically showed a trend of increasing year by year, indicating that the profitability of the
enterprises in the two industries has been continuously enhanced and even avoided the negative impact
of the financial crisis. The peak in profit margins on paper industry assets came in 2010. Since 2011,
the profit margin of assets of the three subsectors has fluctuated and declined. In particular, the profit
margin of assets of the timber processing industry has almost halved. While the total profit keeps
increasing, the profit margin of assets declines, which indicates that China's forest product industry has
overcapacity and the utilization capacity of assets needs to be improved. In addition, forestry industry
enterprises must strive to innovate or introduce effective ways to increase profitable energy, strengthen
technological innovation, product innovation and marketing innovation, strengthen differentiated
competition strategies, enhance the ability to create value for customers and allow customers to
perceive and accept, and help develop new Markets, penetration of existing markets, and enhancement
of pricing power can transform the growth model and increase the profitability of enterprises.

![Total profit graph](image)

**Figure 3.** Total profit.
Figure 4. Profitability of assets.

It can be seen from Figure 5 that the total labor productivity of the forest product industry increased year by year from 1999 to 2016, indicating that the production efficiency and development quality of the forest product industry have been continuously improved. Of course, the "machine substitution movement", which is caused by rising labor costs and other factors, has led to an increasing level of automation and mechanization of enterprises, and the number of workers is fewer and fewer. The improvement is not necessarily due to the progress of the company’s internal management capabilities, production management capabilities, terminal marketing or sales capabilities, etc. This does not mean that the company will obtain higher gross profits due to increased production efficiency and lower costs. Forestry industrial enterprises An example is the decline in asset profitability. In addition, the slow increase in the overall labor productivity in the three sub-sectors after 2014 indicates to a certain extent that the latecomers’ production efficiency dividends due to borrowing from advanced enterprises and the “machine substitution movement” production efficiency dividend have disappeared. Forest industry enterprises in China should focus on driving force source or in digging a new improve production efficiency, so as to maintain and enhance market competitiveness in the fierce "stock competition".
3.4. Test of causality between output scale and output quality

As mentioned above, the premise that the Granger causality test results are reliable is that there is a unit root variable of the cointegration relationship. The Stata code vecrank is used to test the cointegration relationship of main business income, total profit, asset profit rate and labor productivity. It is found that there is at least one cointegration relationship for the time series data of 4 variables. Next, the VAR notation corresponding to the Stata code vecsoc used to perform the cointegration test is used to determine the lag order of the Granger test, and it is most reasonable to determine the lag order of 3. Finally, using the code gcause for Granger causality test, the results show that: First, for the wood processing industry, the output scale can promote profitability, but it cannot help the growth of labor productivity of all employees; total profit and total Labor productivity will promote the expansion of industrial output scale. Secondly, as far as the wooden furniture manufacturing industry is concerned, the scale of output can promote the growth of total profit and full labor productivity, but it cannot increase the profitability of assets; both profitability and full labor productivity can promote the expansion of industrial output scale. Third, as far as the paper industry is concerned, the scale of output can only promote the improvement of the labor productivity of all employees, and cannot improve the profitability of the industry; neither the profitability nor the productivity of all employees can promote the expansion of the output scale of the industry.

4. Conclusions

This paper analyzes the evolution characteristics of China's forestry industry input and output, and finds that: from 2000 to 2018, the capital input of China's forestry industry generally showed a year-on-year growth trend, while labor input stabilized after 2008, and the paper industry Even reduced. Before 2016, the total income of the main business of the forestry industry showed a year-on-year growth trend, and then the growth rate declined or even declined. After 2011, the asset profit margins of the forestry industry all exhibited the characteristics of declining fluctuations. The labor productivity of all employees showed a trend of increasing year by year from 1999 to 2016, but after 2014, the growth rate slowed down extremely, indicating that as a latecomer With reference to
the production efficiency dividends generated by advanced enterprises and the production efficiency dividends of the "machine substitution movement", China's forestry industry should devote itself to exploring new drivers of profitability and production efficiency. In addition, the Granger causality test is introduced to test the causal relationship between the output scale and output quality of the industry. The results show that: For the wood processing industry and the wooden furniture manufacturing industry, in general, the output scale and there is a significant causal relationship between the output quality, that is, there is a mechanism of mutual promotion; but the relationship between the two is not significant in the paper industry.

Table 3. Test results of causal relationship between output scale and output quality

| Causal relationship | Subdivision industry | Lag phase | F-value(P-value) | Outcome |
|---------------------|----------------------|-----------|-----------------|---------|
| sale → profit       | Wood processing industry | 3         | 3.13(0.082)     | reject  |
|                     | Wood furniture manufacturing industry | 3         | 0.47(0.713)     | accept  |
|                     | paper industry        | 3         | 1.45(0.293)     | accept  |
|                     | Wood processing industry | 3         | 10.68(0.003)    | reject  |
| sale → profit1      | Wood furniture manufacturing industry | 3         | 4.73(0.030)     | reject  |
|                     | paper industry        | 3         | 2.67(0.111)     | accept  |
|                     | Wood processing industry | 3         | 0.52(0.681)     | accept  |
| sale → tfp          | Wood furniture manufacturing industry | 3         | 6.70(0.011)     | reject  |
|                     | paper industry        | 3         | 6.58(0.012)     | reject  |
|                     | Wood processing industry | 3         | 4.14(0.038)     | reject  |
| profit → sale       | Wood furniture manufacturing industry | 3         | 2.99(0.088)     | reject  |
|                     | paper industry        | 3         | 2.66(0.111)     | accept  |
|                     | Wood processing industry | 3         | 2.01(0.183)     | accept  |
| profit → sale       | Wood furniture manufacturing industry | 3         | 9.16(0.004)     | reject  |
|                     | paper industry        | 3         | 0.56(6.656)     | accept  |
|                     | Wood processing industry | 3         | 3.14(0.097)     | reject  |
| tfp → sale          | Wood furniture manufacturing industry | 3         | 5.91(0.016)     | reject  |
|                     | paper industry        | 3         | 0.25(8.60)      | accept  |

Note: sale, profit, profit1 and tfp are respectively revenue of main business, total profit, profit rate of assets and total labor productivity.

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