Analysis of the Dynamics of Prices for Pulp in the Markets Europe, America and China

Sushko O.P. [1,2][a]
[1]*Moscow State Technical University of Civil Aviation, Kronshtadtsky boulevard, 20, Moscow, Russia*
[2]*Plekhanov Russian Economic University, 11997, Stremyanny lane, 36, Moscow, Russia*
osushko@mail.ru

Keywords: Analysis of the structure of time series of pulp price indices, Primary and secondary trends, Seasonal fluctuations, Cyclic fluctuations, Differential analysis of pulp NBSK and BHKP index prices.

Abstract: Technical analysis of the structure of time series of pulp price indices of different types shows a complex dynamics structure, including primary and secondary trends, seasonal fluctuations, cyclic fluctuations of different duration, random changes. The dynamics of the average monthly index prices pulp NBSK and BHKP for Europe, the USA have positive trends over a long time, represented by various linear, logarithmic, power, polynomial equations. The overall increasing trend consists of primary in middle segments and secondary trends in short periods. The linear and non-linear trend equations for the time series of average monthly pulp NBSK prices for the period from 1999 to 2022 have high growth factors. Also in the dynamics of index prices of pulp NBSK and BHKP for Europe, the USA there are periodic fluctuations (seasonal, cyclical). The range of seasonal fluctuations in the price of pulp NBSK Europe does not exceed 4-5% of the price, and on BHKP less than 3%. Seasonal variations can be associated with the technological features of logging and pulping, as well as transportation logistics. The dynamics of NBSK and BHKP index prices include long and brief cyclical fluctuations. Short-term index price cycles have a period of 12-15 quarters (industry business cycles). The change in the period of short cycles occurs under the action of general industrial cycles. Long cycles are essentially endogenous and background processes, which stated in most cases as secondary trends, and can, enhance the phase of fall or growth of the business cycle. In addition, long waves can cause time stretching or shortening of a short cycle, which is why NBSK and BHKP business cycles cannot have the same interval, and as mentioned above, have a period of 12-15 quarters. Differential analysis of NBSK and BHKP index prices in the European and Chinese markets showed fairly consistent and synchronous dynamics of NBSK and BHKP price indices. However, the NBSK and BHKP price differences in Europe, America and China are present. The largest NBSK price indices presented in the USA market. NBSK Europa price indices differ from prices indices in the USA market by 32-98 USD. The price of NBSK in the Chinese market differs more significantly from the prices in the European and US markets.

1 INTRODUCTION

The topic of forecasting the market for timber products in natural and value terms remains relevant both during periods of positive situation, and even more so during periods of negative development and uncertainty. The latest European sanctions against Russia with the cessation of the supply of chemicals, machinery and equipment for the timber industry, the embargo on timber led to negative results in 2022. The difficult conditions for the activities of Russian timber producers were intensified by fluctuations in prices for timber products in the global and domestic markets in anticipation of a global economic recession (Pushkareva, L. 2021). The closure of Russia's timber trade with Europe has prompted increased trade with China, as it plays an important role in global trade and cooperation in the trade of wood products, pulp, paper, cardboard and paper products, influencing international trade in paper and related products around the world (Gaillard, P., Goude, Y., 2015). China is the world's main consumer of pulp (up to 70%) (Jun, H., 2019). Over the past years, its needs have remained the main and

[a] https://orcid.org/ 0000-0003-0865-6621

defining indicator of the global market. In the context of reorientation of sales markets and supply chain planning, it is important to understand the price situation for timber products (Belov, A.N., 2022).

2 HYPOTHESIS, PURPOSE, METHODS

In connection with the above, the purpose of conducting studies of the price dynamics for timber products is to determine the patterns of price movements, which provide the necessary information for making decisions of interested market participants and state authorities. The subject of the study was the price dynamics on pulp of various types in the Chinese market. The studies of price dynamics are based on both traditional statistical methods and special methods with elements of qualitative estimates.

China and USA), BHKP (Europe and China), presented in the form of time series, are comparable by territory, circle of covered objects, units of measurement, moment of registration, reliability. Therefore, the samples can be considered representative, and, therefore, the conclusions based on the study of this sample reflect the processes of the original population quite accurately. Fastmarkets FOEX PIX indices are used by financial institutions as reference prices, for example, in swap transactions and other financial hedging instruments against product price risks (Buongiorno. J., 2018). In addition to being used in hedging instruments, PIX indices can also be used as reference prices in conventional bilateral sales contracts, reference prices in domestic sales transactions. PIX weekly indices are calculated based on real sales prices traded during the reporting week.

Analysis of time series of pulp prices was carried out because of data with different intervals for full time series. Average annual pulp prices are needed to determine overall trends over time. A seasonality study required data at very short intervals, and analysis was performed on weekly pulp prices (Kallio, A.M.I., Solberg, B., 2018), (Solodky, M.O., 2013). Conversely, for comparison, synthesis and other studies, weekly and monthly prices are recalculated into quarterly data. The main part of the study was carried out with average quarterly prices for pulp. Monthly, quarterly, and annual mean PIX values per pulp are calculated as the direct arithmetic mean of the weekly PIX values for the period in question (Gordeev, R. 2020).

The study involves software products and software tools for data processing: MS Access, MS Excel, SPSS, Statistica, a software complex for data mining of the Enterprise BI class of the Forsyth analytical platform.

3 ANALYSIS RESULTS

The analysis of the structure of time series of cellulose price indices of different types shows a complex dynamics structure, including primary and secondary trends, seasonal fluctuations, cyclic fluctuations of different duration, random changes. The allocation of these components in the price series is because many factors affect any dynamic series at the same time. Some of them form a general trend in the development of the phenomenon, others form cyclic and seasonal fluctuations of the series, and others cause random deviations in dynamics. With different combinations of these factors, the dependence of series levels on time can take different forms.

The dynamics of the average monthly index prices NBSK and BHKP for Europe, the USA have positive trends over a long period, represented by various linear, logarithmic, power, polynomial equations. The overall increasing trend consists of primary in middle segments and secondary trends in short periods. Therefore, it is difficult to calculate the actual growth rate for the period from 1999 to the present period, however, the linear and non-linear trend equations for the time series of average monthly NBSK prices for the period from 1999 to 2022 have high growth factors (Fig. 1). Trend factors vary depending on the type of approximation of the time series of index prices, as well as depending on the number of series periods (weekly, monthly average, quarterly average and annual average) (Kailash, Ch.P., 2017).

Increasing trends in the average quarterly dynamics of pulp prices of different types of Europe and the USA were recorded according to data from 1999 to 2022. A characteristic feature of the trends in index prices NBSK and BHKP for Europe is the close coefficients of linear, logarithmic, power, polynomial equations.

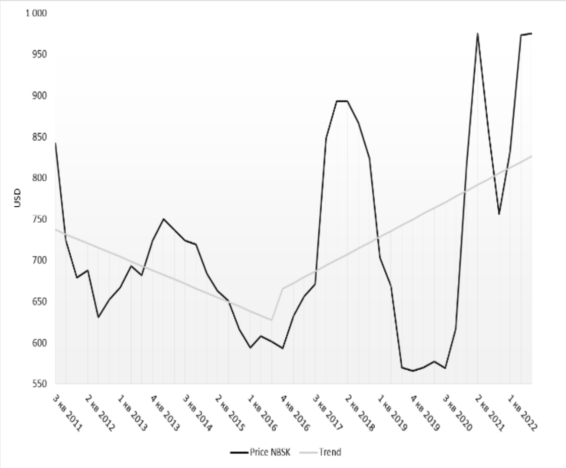

Figure 1: This caption has more than one line so it has to be set to justify.

In addition to the trend in the dynamics of index prices NBSK and BHKP for Europe, the United States has periodic fluctuations (seasonal, cyclical). The range of seasonal fluctuations in the price of pulp NBSK Europe does not exceed 4-5% of the price, and on BHKP less than 3%. Seasonal variations can be associated with the technological features of pulping and logistics of transportation.

The dynamics of NBSK and BHKP index prices include long and brief cyclical fluctuations. Short-term index price cycles have a period of 12-15 quarters (industry business cycles). The change in the period of short cycles occurs under the influence of general industrial cycles (1990-2001, 2001-2008, 2008-2014, 2014-2022). Long cycles are essentially endogenous (cumulative and stream components) and background (stream component) processes, which are stated in most cases as secondary trends, which we noted above. So, in the streaming component (for example, the price index or the dynamics of GDP), economic cycles (cumulative processes) are associated with such phenomena as investments in fixed assets of advanced industries in the economy. Consequently, long waves are superimposed on business cycles in NBSK and BHKP price dynamics for Europe, the US, and can amplify the fall or rise phase of the cycle and reflect on a larger drop or rise in price. Long waves can cause time stretching or shortening of the short cycle, which is why NBSK and BHKP business cycles cannot have the same interval, and as mentioned above, they have a period of 12-15 quarters.

The analysis of the consistency of the NBSK and BHKP index prices in the markets of Europe, America and China was carried out on the basis of a statistical check of time series (Tables 1 and 2), based on testing the Mann-Whitney test, designed to assess differences between the two samples, based on determining the correlation of time series of actual data (unrefined), as well as correlation of series cleared of periodic and trend components to confirm the validity of the consistency of the development of price dynamics.

Table 1: Descriptive statistics for average monthly NBSK Europe and CHINA prices for the period 2011-2022.

Descriptive statistics indcatiors	Time series of average monthly prices NBSK Europe	Time series of average monthly prices NBSK CHINA
Average	963,71	716,30
Standard error	16,03	10,15
Median	887	691
Fashion	809	725
Standard deviation	186,34	117,99
Sample variance	34724,53	13922,64
Excess	0,4495	-0,3995
Asymmetry	1,2704	0,7599
Interval	731	430
At least	766	558
At most	1497	988
Sum	130101	96701
Account	135	135
Maximum (1)	1497	988
Smallest (1)	766	558
Reliability level (95.0%)	31,72	20,08

The mathematical expectations of the analyzed time series of the average monthly prices for NBSK Europe and CHINA for the period 2011-2022 show the difference between the obtained t-critical one-sided and two-sided compared to test statistics (Table 2-3), therefore, there is no sufficient evidence to confirm the similarity and difference of time series.

Table 2: Double sample t-test for average monthly prices NBSK Europe/CHINA for the period 2011-2022.

Indicator	Value NBSK Europe	Value NBSK CHINA
Average	963,3136	715,0554
Dispersion	34956,27	13837,35
Observations	134	134
Pearson correlation	0,816158	
Hypothetical mean difference	0	

df	133	
t-statistics	25,30853	
P (T < = t) one-sided	5,38E-53	
t critical one-sided	1,656391	
P (T < = t) double-sided	1,08E-52	
t critical two-sided	1,977961	

Table 3: Double sample t-test for price variances for the period 2011-2022.

Average	963,31	715,09
Dispersion	34964,11	13829,28
Observations	134	134
df	133	133
F	2,528267638	
P (F < = f) one-sided	7,71967E-08	
F critical one-sided	1,331460032	

Testing the difference in the Mann-Whitney sample levels (calculated empirical criterion 2166.5) showed that the differences in the sample levels may not be considered significant.

The NBSK/NBSK index price correlation values obtained show a very strong and strong correlation in the Europe/USA and Europe/CHINA markets. The correlation of average annual NBSK prices in USA/CHINA markets is slightly smaller (Table 4).

The correlation between NBSK/BHKP prices in Europe and China is strong and very strong (Table 5).

Table 4: Correlation index price NBSK/ NBSK in Europe, America.

<table>
<tr><th rowspan="2">Interval dynamics</th><th colspan="2">Europe / USA</th><th colspan="2">Europe / CHINA</th><th colspan="2">US / CHINA</th></tr>
<tr><th>Factor Value</th><th>Interpretation</th><th>Factor Value</th><th>Interpretation</th><th>Factor Value</th><th>Interpretation</th></tr>
<tr><td>Weekly</td><td>0,985</td><td rowspan="4">Very strong</td><td>0,814</td><td rowspan="3">Strong</td><td>0,827</td><td>Strong</td></tr>
<tr><td>Average monthly</td><td>0,942</td><td>0,815</td><td>0,751</td><td>Strong</td></tr>
<tr><td>Quaterly average</td><td>0,945</td><td>0,819</td><td>0,697</td><td rowspan="2">Moderate</td></tr>
<tr><td>Average annual</td><td>0,928</td><td>0,876</td><td>Very strong</td><td>0,645</td></tr>
</table>

Table 5: Correlation of index prices between NBSK and BHKP time series in Europe, China

<table>
<tr><th rowspan="2">Interval dynamics</th><th colspan="2">NBSK / BHKP Europe (USD)</th><th colspan="2">NBSK / BHKP CHINA (USD)</th></tr>
<tr><th>Factor Value</th><th>Interpretation</th><th>Factor Value</th><th>Interpretation</th></tr>
<tr><td>Weekly</td><td>0,970</td><td rowspan="4">Very strong</td><td>0,839</td><td>Strong</td></tr>
<tr><td>Average monthly</td><td>0,971</td><td>0,945</td><td>Very strong</td></tr>
<tr><td>Quaterly average</td><td>0,978</td><td>0,839</td><td rowspan="2">Strong</td></tr>
<tr><td>Average annual</td><td>0,982</td><td>0,836</td></tr>
</table>

Differential analysis of NBSK and BHKP index prices in the European and Chinese markets was carried out. The dynamics of the NBSK and BHKP price indices in Europe, America and China are quite consistent and synchronous, as was confirmed above, but the price difference is present. The largest NBSK price indices are presented in the USA market. NBSK Europa price indices differ from prices indices in the USA market by 32-98 USD. The price of NBSK in the Chinese market differs more significantly from the prices in the European and US markets. In the dynamics of average annual prices NBSK China from 2011 to 2022, the difference with European prices varies between 142 - 468 USD. The difference in average annual BHKP prices for Europe and China is also significant 66-497 USD (Fig.2). The average annual price of NBSK is higher than BHKP in all regional markets, For Europe this difference varies from 2 to 188 USD, for China from 13 to 200 USD. There is also a larger difference in prices NBSK Europe/China and BHKP Europe/China for the period 2021-2022.

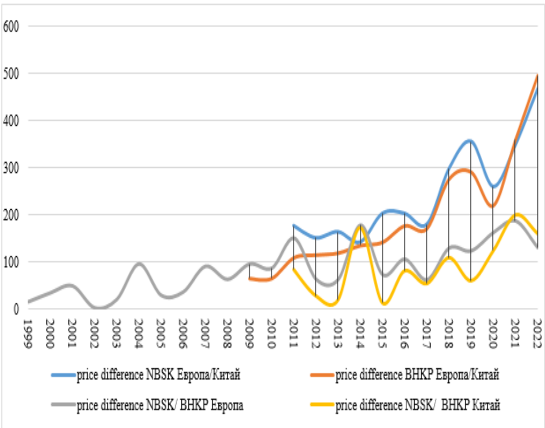

Figure 2: Difference between average annual price softwood and hardwood pulp, USD

Source: foex.fi.

The difference in Europe's average annual NBSK prices is 138-561 USD higher than China's, while BHKP is 31-569 USD higher (Fig. 3). The average quarterly price of NBSK is higher than BHKP in all regional markets. For Europe, this difference varies from 20 to 199 USD, for China NBSK is higher by 13-199 USD, for BHKP by 5-216 USD, but in some periods, the price of BHKP is higher than coniferous by 5-13 USD.

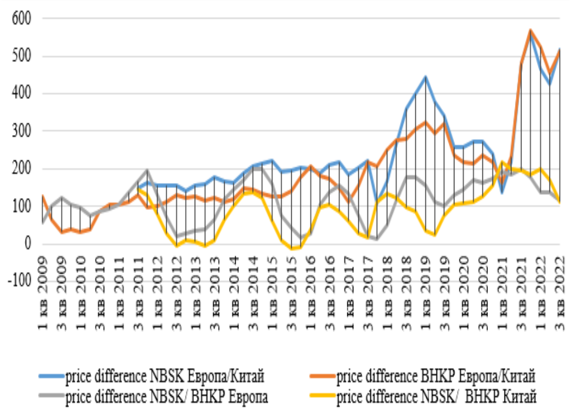

Figure 3: Difference between average quarterly softwood and hardwood pulp prices, USD

Source: foex.fi

The difference between the average monthly prices of NBSK and BHKP Europa and China was also analysed. However, if we analyse the average monthly prices of NBSK Europa and China, then the difference is more significant - from 80 to 612USD. The average difference is 247 USD. The difference in pulp prices in the markets of China, Europe and America can be caused by different supply conditions, differences in quality characteristics (Sushko, O.P., 2016).

4 CONCLUSIONS

Technical analysis of the structure of time series of cellulose price indices of different types shows a complex dynamics structure, including primary and secondary trends, seasonal fluctuations, cyclic fluctuations of different duration, random changes. The allocation of these components in the price series is because many factors affect any dynamic series at the same time. Some of them form a general trend in the development of the phenomenon, others form cyclic and seasonal fluctuations of the series, and others cause random deviations in dynamics. With different combinations of these factors, the dependence of series levels on time can take different forms (Sushko, O.P., 2015).

Correlation analysis of NBSK and BHKP price series in the markets of Europe, America and China shows that the time series of prices are comparable and do not have significant differences in qualitative and quantitative characteristics. Consequently, the NBSK and BHKP price change process in the European, American and Chinese markets has a consistency and unidirectional development of price dynamics. There is a price difference in the dynamics of the NBSK and BHKP price indices of the markets of Europe, America and China. The largest NBSK price indices are presented in the USA market. The price of NBSK in the Chinese market differs more significantly from the prices in the European and US markets.

REFERENCES

Belov, A.N., 2022. Quantitative assessment of the time trend in the price of softwood sawmill in the constituent entities of the Russian Federation. *Pricing stability is the basis of the forest use economy: Collection of articles*. Pushkino: All-Russian Research Institute of Forestry and Forestry Mechanization. 97-111.

Buongiorno. J., 2018. On the accuracy of international forest product statistics. *Forestry*, 91, 541–551.

Jun, H., 2019. Ensemble forecasting for electricity consumption based on nonlinear optimization. *Procedia Computer Science*, 162, 19-24.

Gaillard, P., Goude, Y., 2015. Forecasting Electricity Consumption by Aggregating Experts; How to Design a Good Set of Experts, Modeling and Stochastic Learning for Forecasting in High Dimensions. *Lecture Notes in Statistics*. 217. 95-115.

Gordeev, R. 2020. Comparative advantages of Russian forest products on the global market. For. Policy Econ. 119, 102286.

Kailash, Ch.P., 2017. Price movements in futures and spot markets: evidence from the s&p cnx nifty index. Review of Business and Economics Studies. T. 5. 1. 32-41.

Kallio, A.M.I., Solberg, B., 2018. On the Reliability of International Forest Sector Statistics: Problems and Needs for Improvements. Forests. 9, 407.

Pushkareva, L. 2021.The determinants of forest land prices. *Conference Series: Earth and Environmental Science, Ussurijsk*,,. 032117.

Sushko, O.P., 2016. Price dynamics of the market as a factor in the integrated production of timber products *Global challenges in the economy and industrial development (INDUSTRY-2016): Proceedings of a scientific and practical conference with foreign participation, St. Petersburg, March 21-23, 2016*, edited by A.V. Babkin. - St. Petersburg: Federal State Autonomous Educational Institution of Higher

Education "St. Petersburg Polytechnic University of Peter the Great". 521-526.

Sushko, O. P., 2015. Analysis and forecast of prices on pulp and paper production of Russian enterprises and world goods market. *Studies on Russian Economic Development.* Vol. 26, No. 4. 347-350.

Solodky, M.O., 2013. Futures market – important factor of price stabilization. *Economy of the agro-industrial complex*. 12 (230). 044-048.