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# ANALYSIS OF SEASONAL AND CYCLICAL VARIATION OF THE BRAZILIAN CELLULOSE PRICE IN THE USA MARKET FOR THE PERIOD OF 1997 TO 2018

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**Resumo**

*Análise sazonal e cíclica do preço da celulose brasileira no mercado dos EUA no período de 1997 a 2018.* Este artigo objetiva o estudo e análise da sazonalidade do preço da celulose brasileira que é exportada para os Estados Unidos da América como suporte para a definição de estratégias e tomadas de decisão das empresas brasileiras frente ao mercado externo no segmento. Os dados referentes ao período de 1997 a 2018, sobre quantidade e valor de exportação utilizados no estudo foram obtidos junto a plataforma ALICE-WEB, e em seguida deflacionados tendo o mês de abril de 2018 como período base. Os resultados do estudo apresentaram uma instabilidade nos preços da celulose brasileira no mercado dos Estados Unidos, com presença de quatro ciclos com durações não periódicas, e um quinto ciclo iniciando com tendência de recuperação nos preços. A sazonalidade dos preços tende a ser maior no segundo semestre de cada ano, com um aumento dos mesmos mais especificamente no mês de novembro.Com isso, a exportação de celulose brasileira para os Estados Unidos deve ser feita, sempre que possível, no segundo semestre, onde os preços estão mais altos, e desta forma armazenar a produção dos demais meses, e procurar mercados alternativos para a venda tendo em vista uma melhor lucratividade para as empresas.
*Palavras–chave*: comércio internacional; sazonalidade; pasta química de madeira; competitividade.

**Abstract**

*Analysis of seasonal and cyclical variation of the Brazilian cellulose price in the USA market for the period of 1997 to 2018.* The aim of this work was to analyse the seasonality in the price of the Brazilian pulp that is exported to the United States of America in order to support setting strategies and on the decision-making processes of the Brazilian companies in the international market framework. Data from the period between 1997 and 2018, related to the quantity and the value of exportation used in this work, was collected from the ALICE-WEB platform and then deflated using the month of April of 2018 as a base period. The results of the study show an instability in the prices of Brazilian pulp in the United States market, presenting four cycles with a non-periodic length and another fifth cycle that begins with a tendency of price recovery. The seasonal price movement tends to be greater during the second semester of each year, increasing mostly in the month of November. Therefore, the exportation of Brazilian pulp to the United States must be carried out, whenever possible, in the second semester, when the prices are higher, and stock the production from other months as well as look for alternative markets, having in mind a higher profitability for the companies.
*Keywords:* international trade; seasonality; chemical wood pulp; competitiveness.

## INTRODUCTION

The most significant sectors of the aggregate of worldwide exports of forest products, in descending order, are the segments of cellulose, sawn wood, paper and cardboard, wood panels, wood for industrial purposes and wood for energy (COELHO JUNIOR *et. al.*, 2013).

Brazil is a world highlight both in pulp production, being the second largest pulp producer in the world, with approximately 18.8 million tons in 2016, and in exports, 12.9 million tons were destined for export, with potential for growth, as the Ministry of Agriculture, Livestock and Supply projects an increase in pulp exports of 36.4 to 63.9% by 2027/2028 (IBÁ, 2017).

The main destinations for Brazilian cellulose exports are the USA, Canada and China, which are respectively the world's leading producer with 48.5 million tons, the third producer with 17 million tons and the fourth producer

with 16.8 million tons (IBÁ, 2017). Pulp consumption is directly related to paper consumption, which in turn is linked to world population growth, income and education (SOARES *et. al.*, 2009).

The cellulose pulp used in industry is of different types, and the present study deals with chemical pulps of wood, with soda or sulfate, semi-bleached or bleached, from non-coniferous wood (ALICE WEB, 2018).

Despite the high investment amounts for pulp production, one of Brazil's main competitive advantages, both in domestic supply and in exports, are the forest technologies used in processing, the reduced rotation time and the high productivity of plantations (COELHO and COELHO, 2013).

The study of analysis of time series of price is of great importance for pulp producing companies, helping in the search strategy for competitive advantage (CARDOSO *et al.*, 2013). In this way, knowing the seasonal behavior and price cycles is fundamental in defining strategies aiming to obtaining or increasing competitive advantage, not only by increasing productivity or reducing costs, but also considering product commercialization aspects (SOARES *et al.*, 2015).

At the same time, the study of this topic in specific markets is essential so that strategies can be developed market by market.

Perceived seasonality in agribusiness has been the object of study since the 1960s (SOARES *et. al*., 2015). However, specifically in the forest-based sector, research is still incipient, with emphasis on the work of Santana *et al.,* (2010), who studied the historical behavior of the production and local and international trade of wood in the state of Pará, Santana *et al.* (2018) who researched the seasonal behavior, occurrence of cycles and price trends of Brazil nuts exported by Brazil, and Oliveira and Waquil (2015) who evaluated the dynamics of commercialization, through prices, of yerba mate in Rio Grande do Sul.

In view of the importance of the topic, as well as the need for studies in the forestry area, the hypothesis of the present study is that the price index for pulp that leaves Brazil for the United States of America presents a seasonal and cyclical behavior.

The general objective of the study is to analyze the seasonality and cycles of the price of Brazilian cellulose exported to the United States of America from January 1997 to April 2018, as support for the definition of strategies and decision-making by companies in this field.

## MATERIAL AND METHODS

One of the main ways of analyzing time series arises with the investigation of their decomposition in terms of their principal components. The components of variation in a time series are trend, seasonality and cycles. Best known in academia as a structural approach to modeling and analyzing time series (LAMOUNIER, 2007).

### Theoretical framework

Cycles refer to rising and falling movements, at a regular interval of time during a given period, around an average level of the variable of interest (LAMOUNIER, 2007). Seasonality, on the other hand, is systematic (monthly assessment), but not necessarily regular, and is analyzed through economic time series that are caused by economic or non-economic phenomena (WALLIS and THOMAS, 1971).

The reason for the seasonality of the forest sector, for the most part, is due to demand, that is, there is greater demand at certain times of the year for a product, which leads to the occurrence of seasonal cycles (FUNCHAL, 2017). As cellulose is an export product, the seasonal study of the importing country is important.

For the planning of pulp production by companies, analysis of competitiveness, cost reduction, sales strategies, among others, it is important to analyze time series, as it makes it possible to understand price behavior over a certain predetermined period, knowing its seasonality and cycles (CARDOSO, *et al.*, 2013).

As a result of the favorable aspects, there is great competitiveness in the international pulp market. Therefore, Brazilian companies in the segment participate as price takers, that is, they have little power to influence price formation, thus becoming more exposed to the instability of this variable (SOARES *et al.*, 2015).

Seasonality is understood as the set of movements or fluctuations with a period equal to or less than 12 months, systematic, but not necessarily regular, occurring in a time series, resulting from natural, economic, social and/or institutional causes (WALLIS and THOMAS, 1971).

In the case of time series, cycles can be understood as movements of rise and subsequent fall of a variable, around an average or trend, without the need to present periodic behavior, that is, that the duration periods are equal (LAMOUNIER, 2007). Cycles are characterized by long waves, with certain regularity, around a trend line, and it is important to identify the inflection points, duration and frequency of each cycle (FREDO and MARGARIDO, 2008).

The practical and applied study of time series is based on the premise that it is stationary, with its parameters, such as mean and variance, stable over the analyzed period. Therefore, if there is a break in the series, this premise is violated and the parameters, if they do not incorporate this information, may become biased.

**Data source**

With regard to the source of data for the simulations, it should be noted that: those referring to the quantity and value of exports, for the purpose of carrying out this study, were collected in the ALICE-WEB system, which presents monthly information on foreign trade.

The selected product was "Chemical pulp of non-coniferous wood, with soda or sulfate, semi-bleached", registered by the Mercosur Common Nomenclature (MCN), code 4703.29.00. The period selected for data collection was due to the availability of the system, that is, from January 1997 to April 2018, totaling 256 months of observations.

All export values are presented in US dollars (US$) and were deflated by the ConsumerPrice Index (CPI) obtained from the Bureau of Labor Statistics (2018), with April 2018 as the base period. The unit price of Brazilian cellulose in the US market was obtained by the fraction of gross actual revenue, already deflated, by the quantity exported, according to equation 1:

$$Pu = \frac{Rb}{Q} x\ 1000 * (1)$$

With: Pu = cellulose unit price (US$/t); Rb = gross actual revenue (US$); Q = quantity being exported (t); *values were multiplied by 1000 to convert Kg into tons.

**Deseasonalization and Stationary Price Index**

In order to study the seasonal behavior of pulp prices that are traded in the United States of America market, it was initially necessary to calculate the stationary index for the period (August 1997 to April 2018), according to equation 2, allowing the observation of the variation of the pulp price in the period, around its average value.

$$IEt = Dij = \frac{Pt}{Gt} \quad (2)$$

With:IEt and Dij – Stationary index;Pt – Unit price;Gt – Moving Geometric Average of prices

After determining the Stationary Index, it was possible to calculate the Seasonal Price Index, according to equation 3, which shows the oscillation tendency of the variable.

$$Ej = \frac{Gj}{C} x\ 100 \quad (3)$$

With:Ej – Seasonal Index; Gj – Geometric average of prices for the jth month;C – Geometric Average of Stationary Indices.

Additionally, the Irregularity Index was calculated. This index is relevant because it allows the determination of the lower limit (through the product between the seasonal and irregularity indices) and the upper limit (through the ratio between the seasonal and irregularity indices) (HOFFMANN, 2006).

The ratio between the price and the seasonal index makes it possible to obtain the seasonally adjusted values of the historical price series, according to equation 4:

$$Pt(d) = \frac{Pt}{\varepsilon j} * 100\ (4)$$

With: Pt(d) – Seasonally adjusted price; Pt - Unit price (US$/t); εj - Stationary index.

Following the recommendation of Cardoso *et al.*(2013), since one of the objectives of the study is to compare the seasonal pattern in each cycle found, and these do not present the same period of duration, the indication of Hoffmann (2006) that the periods should have the same duration, was made more flexible, without interfering with the quality of the intended results.

**Cycle analysis**

The unit prices of the product were plotted on a graph, seeking a visual analysis of its variation, whose objective was to identify the occurrence of a break in the series and the division of the evaluated period into cycles. These breaks follow the cyclical behavior described by Castro and Sousa Neto (2013), with repeated oscillations over four phases, namely: prosperity (peak), recession (contraction), depression (bottom) and growth (expansion). They come from combinations of factors that affect the economy.

To confirm the breaks in the time series, the Chow test was used, which tests the null hypothesis that the coefficients of the equation are the same between two periods, against the alternative that the coefficients are different in the two subperiods (CHOW, 1960). Thus, it is possible to show whether there has been a change in the behavior of Brazilian cellulose prices exported to the United States of America. Based on this, the monthly geometric rate was calculated for the break periods in the series identified as significant by the Chow test. Data were tabulated in an Excel spreadsheet and in the R 3.4.4 software.

**Test of equality of two variances**

According to Spearman's Correlation Coefficient, after the stationary indices are sorted in ascending order within each period, their correlation coefficients are determined and it is verified if these coefficients are statistically different from zero at a significance level of 5%.

To compare variations in the value of the stationary index between months with variations within months, Hoffman (2006) proposed an analysis of variance according to Table 1:

Table 1: Analysis of Variance
Tabela 1: Análise de Variância

| Causes of Variation (C.V.) | Freedom Degrees (F.D.) | Sum of Squares (S.S.) | Mean Squares (M.S.) | "F[4]" |
|---|---|---|---|---|
| Months (seasonality) | 11 | $\frac{1}{n-1}\sum_i \left(\sum_j d_y\right)^2 - \frac{1}{12(n-1)}\left(\sum_i \sum_j d_g\right)^2$ | S.S./F.D. | $\frac{M.S.Months}{M.S.Residue}$ |
| Residue | 12 (n – 2) | $\sum_i \sum_j d^2{}_y - \frac{1}{n-1}\sum_i \left(\sum_j d_y\right)^2$ | S.S./F.D. | $\frac{M.S.Months}{M.S.Residue}$ |
| Total | 12 (n - 1) - 1 | $\sum_i \sum_j d_y{}^2 - \frac{1}{12(n-1)}\left(\sum_i \sum_j d_g\right)^2$ | - | - |

Source: Hoffman (2006)

**RESULTS**

**Evaluation of cycles and price behavior**

The price of Brazilian pulp in the US market showed high instability, with the clear presence of four cycles of different lengths and the beginning of a fifth cycle with a tendency for prices to recover.

The pulp market does not have regular historical cycles, which prevents, according to Cardoso *et. al.* (2013), the formulation of strategies for the sector, since the price of Brazilian pulp on the world market presents non-periodic cycles, characterized by intense fluctuation and unpredictability of high and low periods.

Cycles are characterized by repeated oscillations of: peak, contraction, bottom and expansion (Figure 1).

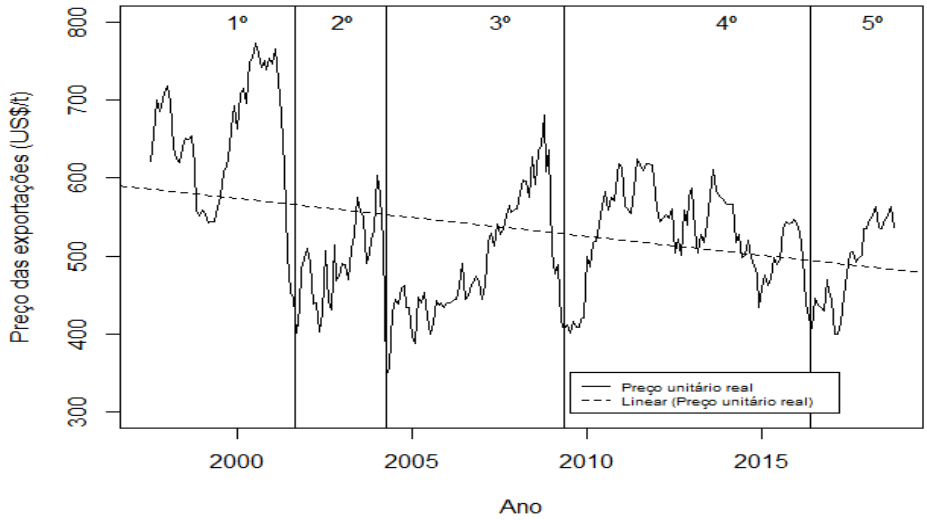


Figure 1: Variation in the unit price of chemical pulp from non-coniferous wood exported to the United States of America.
Figura 1: Variação do preço unitário da pasta química de madeira de não coníferas exportada para os Estados Unidos da América.
Source: The authors, 2019.

On average the duration of the cycles was 59 months, the first cycle contains 56 months (January/1997 to August/2001) but not accounted for in the average due to lack of the beginning of the cycle; the second with 31 months (September/2001 to March/2004); the third with 61 months (April/2004 to April/2009); the fourth cycle lasts 84 months (May/2009 to May/2016); and the fifth cycle, not yet completed, therefore not used in the calculation of the average, with 26 months.

**Stationary variation pattern**

It is possible to observe a large oscillation in the pattern of stationary variation found for the prices of Brazilian pulp exported to the United States (Figure 2), and the price instability makes it very difficult to define strategies for companies in the segment (SOARES *et. al.,* 2015.

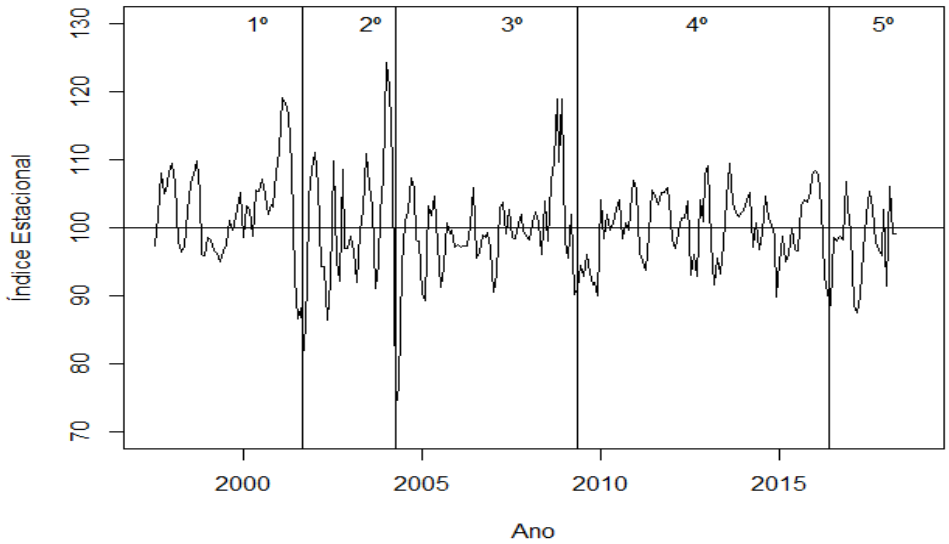


Figure 2: Stationary price index of non-coniferous wood cellulose exported to the US.
Figura 2: Índice estacional do preço da celulose de não coníferas exportadas para os EUA.
Fonte: Os autores, 2019.

**Seasonal variation pattern**

It can be seen that the variation pattern of the Seasonal Index (SI) was different for the cycles found in the study for the five periods (Figure 3): total period of analysis (January 1997 to April 2018), Cycle 1 (P1 - January 1997 to August 2001), Cycle 2 (P2 - September 2001 to March 2004), Cycle 3 (P3 - April 2004 to April 2009), Cycle 4 (P4 - May 2009 to May 2016 ), Cycle 5 (P5 - June 2016 not finished).

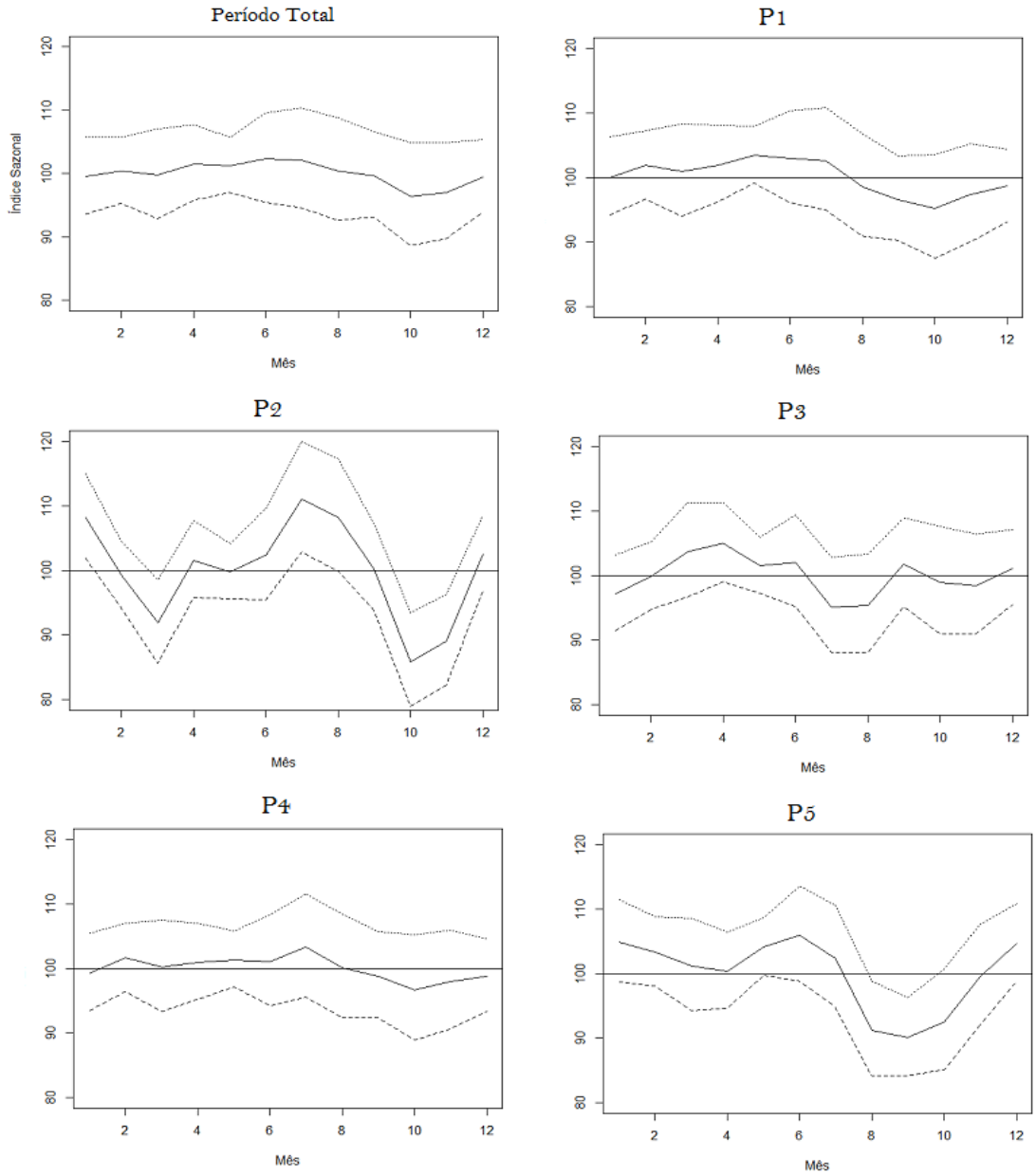


Figure 3: Seasonal variation in the price of non-coniferous wood cellulose exported to the US in the analysis periods.
Figura 3: Variação sazonal do preço da celulose de não coníferas exportadas para os EUA nos períodos de análise.
Source: The authors, 2019.

The highest average Seasonal Indices, that is, the highest prices in the American market, observed for the total period were in November (102.33). With regard to the lowest values of average Seasonal Indices and, consequently, prices of pulp traded with the United States for the total period, it was visualized in the month of March (96.45). The

amplitude of variation for the entire period was 5.88, considered low, which was expected, as extreme values are smoothed by the calculation method.

It is possible to observe that for the first period (P1) the highest seasonal index and, consequently, the sale price, of pulp in the US market was 110.04 in January/2001, while the lowest seasonal index was 82.00 in month of August/2001; for the second period (P2), 124.71 (higher SI) in December/2003 and 73.80 (lower SI) in March/2004; for P3, 118.96 (higher SI) in September/2008 and 76.83 (lower SI) in April/2004; for P4 109.59 (higher SI) in July/2013 and 88.63 (lower SI) in May/2016.

The ANOVA results demonstrate a positive and high ordinal Spearman correlation coefficient between the different periods analyzed, showing that prices throughout the year, for all periods, present practically the same trend (Table 2).

Table 2 - Analysis of the variance of the values of the stationary indices related to the prices received for pulp exported to the USA (1997 - 2018)

Tabela 2 - Análise da variância dos valores dos índices estacionais relativos aos preços recebidos pela celulose exportada para EUA (1997 - 2018)

| Origin of variations | Sum of squares | Freedom Degrees | Square mean | F |
|---|---|---|---|---|
| Months (Stationarity) | 341417.3627 | 11 | 31037.94207 | 0.326438 |
| Residue | 2472202.232 | 244 | 10131.97636 | |
| Total | 2813619.595 | 255 | | |

Source: The authors, 2019.

## DISCUSSIONS

It should be noted that it is not possible to state that the 1st cycle began in January 1997, but within the collected data it can be verified that it presents export prices of Brazilian cellulose in the North American market in expansion already followed by a moment of fall, a trend that changed from January 1999, the same period in which the floating exchange rate policy was adopted in Brazil.

In a study comparing the influence of the exchange rate on pulp and sawn wood exports, Almeida *et al.* (2009) concluded that there is little influence of exchange rate fluctuations on pulp exports, because the mills normally have good economic and financial capacity and can sustain exchange rate losses in the short term. As a result, in the middle of the 1st cycle, prices began to recover, followed by a systematic fall at the end of the 1st cycle, that is, between January and August 2001.

The drop in prices that ended the 1st cycle can be explained by the maintenance of high inventories of the product, combined with the drop in world demand due to the economic instability in the period (SOARES *et. al.*, 2015).

From that moment on, a certain instability was observed in the prices of pulp exported to the United States, with constant moments of decline and recovery, which lasted until March 2004 (2nd cycle). The reduction in prices in the 2nd cycle may be related to the large increase in pulp production capacity in the world, which resulted in greater supply (CARDOSO, *et. al*., 2013).

The 3rd cycle is marked by small variations in prices, but with a very clear tendency for prices to rise. According to Soares *et. al.* (2015), the increase in demand for eucalyptus wood, due to the growth in production and exports of the Brazilian industry based on reforestation, was not accompanied by an increase in cultivation in the same proportions. The upward trend in prices lasted until September 2008, when it began a sharp drop, closing the 3rd cycle in April 2009.

The drop in pulp prices exported to the USA at the end of the 3rd cycle can be explained by the economic crisis of 2008 and 2009. As explained by Rocha *et. al.* (2015), the national production and exports of the industry that uses eucalyptus-based wood decreased considerably, which led to a reduction in the use of the raw material. However, Brazilian pulp production in the same period increased, which can be explained by the fact that the USA ceased to be the main importer of the product in this period, becoming China (FIGUEIREDO *et al.*, 2016). The same authors claim that the amount of Chinese imports of pulp produced in Brazil went from 3.8% in 1997 to 33.7% in 2015.

Still as a result of the 2008 world crisis, there was a reduction in demand, causing prices to plummet (VERVLOET and GARCIA, 2010).

From May 2009 to May 2016, prices of the cellulose exported to the United States of America began a period of great instability (4th period), with constant variations around the trend line.

In an analysis carried out in 2011 with data that ended in December 2010, Cardoso *et al*., stated that the 4th cycle was still ongoing and, therefore, could continue expanding, provided that key factors, such as the worsening of the world crisis, didn't close it (CARDOSO *et al.*, 2013).

The same authors also verified as characteristics of the cycles a gradual increase in the price of semi-bleached Brazilian hardwood pulp in the American market, and, after its maximum level, instead of a gradual decrease, what occurred was an abrupt drop. However, the same behavior was not observed for the 4th cycle, since it is possible to observe a systematic downward trend in prices, which, apparently, have been recovering since mid-2016.

As of June 2016, a period of price recovery begins, with small variations, demonstrating a price trend towards a possible recovery in the coming months, which would indicate the beginning of a new cycle. The price recovery trend is also perceived in the accumulated twelve months of 2017, when the price of long pulp fiber per ton, exported from Brazil to the USA, jumped from US$ 990 to US$ 1,190 (CARDOSO *et al*., 2013). However, new studies must be carried out to prove the hypothesis of a new cycle (5th cycle).

In the long run, observing the entire series, a downward trend can be seen in the actual price of Brazilian cellulose in the US market, corroborating the observations of Cardoso *et al.* (2013). In keeping with this trend, companies should seek greater efficiency in costs to maintain profitability in that market, as this is one of the few factors over which companies have some control.

The high instability of the stationary variation is represented by the amplitude of variation of the stationary index (difference between the highest and lowest value), which was 50.37. Amplitude very similar to that found by Soares *et. al.* (2015) when analyzing the same product exported to China, which was 49, and by Cardoso *et al.* (2013) when studying pulp exported to the United States (50), or even plywood exported to the United States (DREYER, 2017). The highest index occurred in December 2003 (124.17), and the lowest occurred in March 2004 (73.80), that is, both during the 2nd cycle, with a short time interval between them, three months.

The 5th cycle, still starting, recorded the highest coefficient of variation (5.18%), indicating that important factors are occurring in this period and causing this high instability. It is relevant in subsequent works to look for the factors that caused it, enabling the support of strategies, because, from the moment the causes are known, they can eventually be anticipated, preventing losses or maximizing profits.

The analysis of the Seasonal Index corroborates Cardoso *et al.* (2013), when stating that the prices of pulp exported to the USA present behavior similar to that described by José Penido and Antonio Maciel Neto, respectively presidents of the board of directors of Fibria and Suzano Papel e Celulose at the time, that is, prices start the year high, followed by a fall in the first months, then there is a phase of growth, stabilization and, finally, new growth until reaching the highest values in the year.

Thus, it can be said that the months of the second semester are the best for the commercialization of pulp with the EUA, with higher prices in average terms, as observed by Soares *et al.* (2015) and Cardoso *et al*. (2013) for the Chinese and North American markets, respectively.

The results of the analysis of the seasonality of the price of Brazilian pulp that is exported to the US can be useful to companies in the segment when making a decision. The fact that the highest prices are concentrated in the second semester indicates that efforts to sell the product in this market should be concentrated, whenever possible, in these periods.

In addition, the differences in the results found compared to those presented by Soares *et. al.* (2015), confirm the complexity for defining strategies in organizations that operate in both the North American and Chinese markets. Thus, the ideal is to develop specific strategies for each market.

The global pulp market is currently going through a period of rising prices, as a result of high Chinese demand, but also due to the economic recovery in the United States and Europe. According to Bacha, this price increase cycle that started in 2017 should continue until 2019 (CARDOSO *et. al*., 2013).

## CONCLUSIONS

- The results demonstrate that the price of Brazilian pulp exported to the United States of America presents a cyclical behavior, however, without a clearly defined period.
- Through the study of seasonality, it is possible to conclude that the value received by the product, on average, is higher in the second half of the year. Thus, the ideal situation would be for companies that export pulp to the United States to be able to concentrate their sales efforts in the second half of each year, as long as it is possible

to store part of the production in periods of lower prices for sale in months with superior prices, since such behavior was also verified by Cardoso *et al.* (2013).

- With this, it is possible to use the seasonality analysis to support the trade strategies of pulp companies in Brazil with other trading partners, aiming at increasing competitiveness.
- The results also indicate the importance of carrying out studies on price seasonality as a support for the definition of strategies by the business sector. However, due to the high variation of data, more information on supply and demand for the product must be gathered in the decision-making process.

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