

# CONCENTRAÇÃO MUNDIAL DE EXPORTAÇÕES DE PRODUTOS FLORESTAIS MADEIREIROS

*World's concentration of timber forest products exports*

*Concentración mundial de las exportaciones de productos  
forestales madereros*

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**Resumo:** A economia mundial passou por diversas mudanças e crises que podem ter alterado a dinâmica e a estrutura do mercado florestal após 2008. Assim, o objetivo deste estudo foi medir a concentração do mercado internacional dos principais produtos florestais entre 2009 e 2018. Utilizamos a Razão de Concentração [CR(k)], o Índice de Hirschman-Herfindahl (HHI), o Índice de Entropia de Theil (E) e o Coeficiente de Gini (G) para avaliar a concentração dos produtos florestais. Os resultados mostraram que os países americanos e asiáticos cresceram e assumiram posições de grandes exportadores de produtos florestais para os mercados europeus ao longo dos anos. O principal produto exportado foi "Papel e papelão", seguido por "Madeira serrada", "Celulose", "Painéis de madeira", "Madeira para fins industriais" e "Energia". A participação global do Brasil se destacou nos segmentos de papel e celulose. A concentração do mercado de produtos florestais foi classificada como baixa para CR4, moderadamente baixa para CR8, não concentrada e altamente competitiva para os índices HHI e Entropia. Além disso, o mercado foi classificado com desigualdade de muito forte a absoluta usando o índice de Gini, indicando que as exportações vêm de um pequeno número de nações. De forma geral, existe competitividade entre os países exportadores, o que favorece o desenvolvimento do setor e a entrada de novos players no comércio florestal madeireiro. As dinâmicas e implicações apresentadas são essenciais para a formulação de decisões estratégicas, políticas e investimentos determinantes para o desenvolvimento do setor.

**Palavras-chave:** Economia florestal. Concentração de mercado. Estrutura de mercado.

**Abstract:** *The world's economy has undergone several changes and crises that may have altered the dynamics and structure of the forestry market after 2008. Thus, the objective of this study was to measure the concentration of the international market of the main forest products between 2009 and 2018. We used the Concentration Ratio [CR(k)], Hirschman-Herfindahl Index (HHI), Theil Entropy Index (E) and Gini Coefficient (G) to evaluate the forest products concentration. The results showed that American and Asian countries have risen and taken positions of major forest products exporters to European markets over the years. The main exported product was "Paper and cardboard", followed by "Lumber", "Pulp", "Wooden panels", "Wood for industrial purposes" and "Wood for Energy". Brazil's global share stood out in the pulp and paper segments. The forest products market concentration was classified as low for CR4, moderately low for CR8, unconcentrated and highly competitive for HHI and Entropy indices. Furthermore, the market was classified with inequality from very strong to absolute using the Gini index indicating that exports come from a small number of nations. In general, there is competitiveness among exporting countries, which favors the development of the sector and the entry of new players into the timber forestry trade. The dynamics and implications presented are essential for formulating strategic decisions, policies and investments that will determine the sector's development.*

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**Keywords:** *Forest economy. Market concentration. Market structure.*

**Resumen:** *La economía mundial ha sufrido varios cambios y crisis que pueden haber alterado la dinámica y la estructura del mercado forestal después de 2008. Así, el objetivo de este estudio fue medir la concentración del mercado internacional de los principales productos forestales entre 2009 y 2018. Utilizamos el Ratio de Concentración [CR(k)], el Índice de Hirschman-Herfindahl (HHI), el Índice de Entropía de Theil (E) y el Coeficiente de Gini (G) para evaluar la concentración de los productos forestales. Los resultados mostraron que los países americanos y asiáticos han ascendido y tomado posiciones de principales exportadores de productos forestales a los mercados europeos a lo largo de los años. El principal producto exportado fue el "Papel y cartón", seguido de la "Madera aserrada", la "Pasta de papel", los "Paneles de madera", la "Madera para fines industriales" y la "Energía". La cuota global de Brasil destacó en los segmentos de "Pasta y papel". La concentración del mercado de productos forestales fue clasificada como baja para el CR4, moderadamente baja para el CR8, no concentrada y altamente competitiva para los índices HHI y Entropía. Además, el mercado se clasificó con desigualdad de muy fuerte a absoluta utilizando el índice de Gini que indica que las exportaciones proceden de un número reducido de naciones. En general, existe competitividad entre los países exportadores, lo que favorece el desarrollo del sector y la entrada de nuevos actores en el comercio forestal maderero. La dinámica y las implicaciones presentadas son esenciales para formular decisiones estratégicas, políticas e inversiones cruciales para el desarrollo del sector.*

**Palabras clave:** *Economía forestal. Concentración del mercado. Estructura del mercado.*

## **INTRODUCTION**

Forestry activities are one of the most important economic activities in the world and have increased in recent decades due to global trade demand (FISCHER 2009). This sector has become fundamental for the subsistence of 2.5 billion people and covers an area of 4.06 billion hectares of forest in addition to the progressive interest of several organizations. However, forest products distribution are unevenly in the world with the five richest countries in forest resources (Russian Federation, Brazil, Canada, United States of America and China) holding more than half of the total area (FAO 2016, 2021; Coelho Junior et al. 2023a).

Many conveniences were brought by globalization such as access to information, greater cultural interaction, economic opening, speed of investments transfer, and the expansion of international trade in goods and services at the end of the 20th century. The global booming caused the forestry sector to grow until 2007, but at a lower rate and decreased sharply in 2008-2009 due to the global economic crisis. Since then, the global trade in forest products has slowly recovered and in 2016 grew at a rate of three to six percent a year for seven years in a row. This was due to the economic growth that also continued over the years after 2016 due to global economic development and the increase renewable energy demand (FAO 2014a, 2016).

The main subcontinents to export forest products are the Western and Eastern Europe, North America and the developing Asia-Pacific region. These regions accounts for about 90% of the total global trade in forest products. Most international trade takes place between countries within each of these regions or between these four regions, indicating a industrial concentration of forest products (FAO 2014b),

In a broad sense, “industrial concentration” is understood as a process of increasing the control by large companies over an economic activity and is one of the most important components of competition between countries. There is an inverse relationship between concentration and competition where as market concentration increases, the degree of competition between countries decreases. This implies in an increase in market power of countries where the market is concentrated (POSSAS 1999, COELHO JUNIOR et al. 2019). Forest products market power of a nation can be represented by its share in the production and export of the forest-based industry. Concentration indicators are efficient instruments that measure and analyze the market structure and competitiveness of the countries involved (POSSAS 2002, RESENDE; BOFF 2002).

Studies on the concentration of the pulp and paper markets were done by Braga and Mascolo (1982), Leite and Santana (1998), Hilgemberg and Bacha (2001), Montebello (2006), Costa and Garcias (2009), Soares et al. (2010) and Coelho Junior et al. (2010). Noce et al. (2007) presented a study for the international lumber market. Furthermore, Noce et al. (2008) conducted study in the wood panel segment, while Silva et al. (2017) researched wood for energy generation. Nonetheless, only a single study was carried out to analyze the global concentration of all forest products together, which used data from 1961 to 2008 (COELHO JUNIOR et al. 2013). However, after 2008 the world economy has undergone several changes and crises that may have altered the dynamics and structure of the world forestry market, a fact that motivated the development of this article.

This study has the objective of measuring the concentration of the international market of the main forest products. Specifically, it seeks to estimate

the degree of concentration and inequality and the structure of the market in the period between 2009 and 2018.

## 2 –METHODOLOGY

The data used in this study is available on the FAO (Food and Agriculture Organization of the United Nations) database, on the FAOSTAT (FAO – Statistics Division) website. We used the monetary value (US\$) of annual exports for the period between 2009 and 2018. In addition, we considered countries that had annual exports greater than US\$1000.00.

Timber forest products were classified and aggregated into groups following FAO (2021), which were: Wood panels, Cellulose, Wood for energy, Sawn wood, Paper and cardboard and Wood for industrial purposes. We created a ranking of the main countries to analyze the world's forest products exports based on 2018. Furthermore, countries were observed by the aggregates of main forest products in 2018.

The concentration and inequality measures allowed us to analyze the market structure, competitiveness, and competition in forest product's exports. Such indicators aim to show the trends of economic agents in the world's market (MARION FILHO; DALLA 2010, RESENDE; BOFF 2002, SCHERER; ROSS 1990, TIROLE 1988, SANTOS JÚNIOR et al. 2022). The concentration ratio  $\left[ CR(k) = \sum_{i=1}^k S_i \right]$  calculated through the sum of the percentage values of the  $k$  countries with the highest export rates (BAIN 1959). We used the top four [CR(4)] and top eight [CR(8)] forest product's exporters countries to calculate the concentration ratio and classified according to Table 1.

Table 1 - Classification of the Concentration Ratio of the four [CR(4)] and eight [CR(8)] largest participants, with forest-based thermoelectric plants (Level 1 and 2)

Level of concentration	Four largest	Eight largest
Very high	$CR(4) > 75\%$	$CR(8) > 90\%$
High	$65\% \leq CR(4) < 75\%$	$85\% \leq CR(8) < 90\%$
Highly Moderate	$50\% \leq CR(4) < 65\%$	$70\% \leq CR(8) < 85\%$
Low Moderate	$35\% \leq CR(4) < 50\%$	$45\% \leq CR(8) < 70\%$
Low	$CR(4) < 35\%$	$CR(8) < 45\%$

Source: Bain (1959).

The Herfindahl-Hirschman Index  $\left( HHI = \sum_{i=1}^n S_i^2 \right)$  corresponds to the sum of the squared  $S_i$ , assigning a higher weight to the countries with more exports, varying between  $1/n$  and 1. The lower limit of the index is  $1/n$ , indicating a low concentration and representing homogeneity between the countries involved in the market. On the other hand,  $HHI = 1$  indicates a monopoly (COELHO JUNIOR et al. 2022, RESENDE 1994, SANTOS; SOUZA JÚNIOR 2016). The HHI has a limitation when performing intertemporal comparisons, due to the changes of "n" in time, varying the lower limit ( $1/n$ ). Due to this difficulty, Resende (1994) proposed the adjusted HHI  $\left[ HHI' = \frac{1}{n-1} (nHHI - 1) \right]$ , when  $n$  is greater than 1. Therefore, the  $HHI'$  ranges between 0 and 1, i.e., as it moves away from zero, there is a higher exports concentration. Accordingly, an  $HHI' < 0.1$  indicates a competitive market,  $0.10 \leq HHI' < 0.15$  indicates a non-concentrated market,  $0.15 \leq HHI' \leq 0.25$

indicates a moderate market concentration and  $HHI' > 0.25$  high market concentration (RESENDE; BOFF 2002).

The index proposed by Theil  $\left[ E = -\sum_{i=1}^n \ln(S_i) \right]$  measures the inverse of the

HHI. An unequal market, in which few countries export most of the items produced, implies a low entropy value. Thus, in cases where the Theil index equals zero, there is a monopoly market, i.e., with the maximum concentration. Whereas, in the Theil index upper limit, the “ $\ln(n)$ ”, companies have similar shares in export representativeness in the market, demonstrating a minimum market concentration (RESENDE; BOFF 2002, SANTOS JUNIOR et al. 2021). Similar to what was suggested for the HHI, Resende (1994) proposed an adjusted entropy index

$\left[ E' = -\frac{1}{\ln(n)} \sum_{i=1}^n S_i \ln(S_i) \right]$  in cases of intertemporal analyses. The market can be

classified as monopolistic when  $E' = 0$  and as perfect competition, when  $E' = 1$ .

The market inequality between nations was estimated using the Gini coefficient  $\left[ G = 1 - \frac{\sum_{i=1}^n (C_{ij} + C_i)}{n} \right]$ , Where  $n$  is the number of nations,  $C_{ij}$  the

cumulative share of exports in an ascending order and  $C_i$  is the participation of nation “ $i$ ”. This coefficient measures the degree of inequality in exports of forest products between nations, since a concentrated market implies high inequality between countries participating in economic transactions. The index ranges between 0 and 1, with  $G = 0$  indicating zero inequality in the market and  $G = 1$  meaning absolute inequality (COELHO JUNIOR et al. 2022, SANTOS JUNIOR et al. 2021).

### 3 – RESULTS AND DISCUSSION

Table 2 shows the exporting countries ranking evolution for the forest products, based on 2018, and their respective shares (%), for 2009, 2011, 2013, 2015, 2017 and 2018. In 2009, world exports of forest products were of US\$ 188.25 billion, which represents a reduction of 20% compared to the previous year as a reflect of the 2008 crisis. In 2018, the exported value was US\$ 262.43 billion, with an average increase of 4% per year compared to 2009. The forest products that contributed the most were paper and cardboard, cellulose and sawn wood. There was a recovery in the world economy and the number of countries involved in forest products trade remained the same (201 countries).

Coelho Junior et al. (2013) found that Canada was the largest exporter between 1961 and 2008, however, as of 2009, it lost this position to the United States, which remained in hegemony until 2018. Canada dropped to third place in 2009 giving its previous position to Germany but returned to the second position in 2010 and staying there for the rest of the period. Meanwhile, Germany stayed in third place of the rank from 2010 to 2018. From 1961 to 2018, Europe dominated the market significantly, representing around 50% of the exported value (FAO 2021). Nonetheless, American and Asian countries have risen in the market over the years taken positions of major European exporters. This fact is proven through the reduction of the negotiations of European countries, which reduced 6.34% per year since 2008. On the other hand, American and Asian countries grew 2.3% and 2.7% per year, respectively, until 2018.



Table 2 - Ranking evolution of forest products exporting countries in 2018 and their percentage shares (%), for and 2009, 2011, 2013, 2015, 2017 and 2018

<b>Countries</b>	<b>2009</b>	<b>2011</b>	<b>2013</b>	<b>2015</b>	<b>2017</b>	<b>2018</b>
United States	1 <sup>o</sup> (10.2)	1 <sup>o</sup> (10.2)	1 <sup>o</sup> (10.8)	1 <sup>o</sup> (11.0)	1 <sup>o</sup> (11.0)	1 <sup>o</sup> (10.7)
Canada	3 <sup>o</sup> (9.1)	2 <sup>o</sup> (9.1)	2 <sup>o</sup> (9.7)	2 <sup>o</sup> (9.5)	2 <sup>o</sup> (9.6)	2 <sup>o</sup> (9.7)
Germany	2 <sup>o</sup> (9.8)	3 <sup>o</sup> (9.2)	3 <sup>o</sup> (8.3)	3 <sup>o</sup> (8.2)	3 <sup>o</sup> (8.2)	3 <sup>o</sup> (8.6)
China	6 <sup>o</sup> (4.3)	6 <sup>o</sup> (5.2)	5 <sup>o</sup> (6.0)	4 <sup>o</sup> (6.7)	4 <sup>o</sup> (6.0)	4 <sup>o</sup> (5.8)
Finland	5 <sup>o</sup> (5.9)	5 <sup>o</sup> (5.8)	6 <sup>o</sup> (5.7)	6 <sup>o</sup> (5.3)	6 <sup>o</sup> (5.1)	5 <sup>o</sup> (5.6)
Sweden	4 <sup>o</sup> (7.5)	4 <sup>o</sup> (7.0)	4 <sup>o</sup> (6.5)	5 <sup>o</sup> (5.8)	5 <sup>o</sup> (5.5)	6 <sup>o</sup> (5.5)
Russia	7 <sup>o</sup> (4.1)	7 <sup>o</sup> (3.9)	7 <sup>o</sup> (4.0)	8 <sup>o</sup> (3.8)	7 <sup>o</sup> (4.3)	7 <sup>o</sup> (4.7)
Brazil	10 <sup>o</sup> (3.1)	9 <sup>o</sup> (3.2)	8 <sup>o</sup> (3.3)	7 <sup>o</sup> (3.8)	8 <sup>o</sup> (4.1)	8 <sup>o</sup> (3.8)
Indonesia	11 <sup>o</sup> (3.0)	10 <sup>o</sup> (3.1)	9 <sup>o</sup> (3.2)	9 <sup>o</sup> (3.4)	9 <sup>o</sup> (3.4)	9 <sup>o</sup> (3.2)
Austria	9 <sup>o</sup> (3.4)	11 <sup>o</sup> (3.0)	11 <sup>o</sup> (2.9)	11 <sup>o</sup> (2.7)	10 <sup>o</sup> (2.7)	10 <sup>o</sup> (2.7)
France	8 <sup>o</sup> (3.6)	8 <sup>o</sup> (3.4)	10 <sup>o</sup> (3.0)	10 <sup>o</sup> (2.8)	11 <sup>o</sup> (2.6)	11 <sup>o</sup> (2.6)
Poland	18 <sup>o</sup> (1.3)	18 <sup>o</sup> (1.4)	18 <sup>o</sup> (1.6)	16 <sup>o</sup> (1.5)	16 <sup>o</sup> (1.7)	13 <sup>o</sup> (1.8)
New Zealand	22 <sup>o</sup> (1.1)	19 <sup>o</sup> (1.3)	19 <sup>o</sup> (1.5)	18 <sup>o</sup> (1.5)	17 <sup>o</sup> (1.6)	14 <sup>o</sup> (1.8)
Italy	13 <sup>o</sup> (2.5)	16 <sup>o</sup> (2.0)	14 <sup>o</sup> (2.0)	14 <sup>o</sup> (1.9)	13 <sup>o</sup> (1.9)	15 <sup>o</sup> (1.8)
Netherlands	14 <sup>o</sup> (2.2)	13 <sup>o</sup> (2.1)	16 <sup>o</sup> (1.7)	19 <sup>o</sup> (1.4)	19 <sup>o</sup> (1.6)	18 <sup>o</sup> (1.6)
Thailand	25 <sup>o</sup> (0.9)	25 <sup>o</sup> (0.9)	22 <sup>o</sup> (1.1)	20 <sup>o</sup> (1.4)	18 <sup>o</sup> (1.6)	19 <sup>o</sup> (1.5)
Vietnam	47 <sup>o</sup> (0.2)	33 <sup>o</sup> (0.6)	27 <sup>o</sup> (0.8)	24 <sup>o</sup> (1.0)	26 <sup>o</sup> (1.0)	24 <sup>o</sup> (0.9)
United Kingdom	20 <sup>o</sup> (1.3)	22 <sup>o</sup> (1.2)	23 <sup>o</sup> (1.1)	23 <sup>o</sup> (1.1)	24 <sup>o</sup> (1.0)	25 <sup>o</sup> (0.9)
Uruguay	38 <sup>o</sup> (0.4)	36 <sup>o</sup> (0.5)	36 <sup>o</sup> (0.5)	32 <sup>o</sup> (0.7)	31 <sup>o</sup> (0.7)	28 <sup>o</sup> (0.8)
Singapore	36 <sup>o</sup> (0.4)	39 <sup>o</sup> (0.4)	38 <sup>o</sup> (0.4)	29 <sup>o</sup> (0.7)	28 <sup>o</sup> (0.7)	30 <sup>o</sup> (0.7)
Rest of the world	48430.48	65036.61	63770.68	59024.39	63079.98	65922.18
<b>World</b>	<b>188252.38</b>	<b>247445.77</b>	<b>246029.54</b>	<b>228979.05</b>	<b>245178.10</b>	<b>262430.73</b>

Source: Prepared by the authors (2023).

The European nations declined in the ranking of forest products exports between 2009 and 2018, such as Germany (2→3), Sweden (4→6), Austria (9→10), France (8→11), Italy (13→15), Netherlands (14→18) and the United Kingdom (20→25). Furthermore, there was also the rise of American countries such as Brazil (10→8) and Uruguay (38→28), as well as Asian countries like China (6→4), Indonesia (11→9), Thailand (25→19), Vietnam (47→24) and Singapore (36→30). There are exceptions: countries that gained positions in the ranking, such as Poland (18→13) and New Zealand (22→14), and American and Asian countries that lost positions, such as Canada (3→2) and Malaysia (17→20).

The countries that improved their position in the world export ranking were those that incorporated added value to forest products (COELHO JUNIOR et al. 2013). For this outcome, it is necessary to improve the production process and the exported product quality. This makes the competitiveness between nations grow and opens up new markets, increasing and bringing flexibility to the exports (SILVA et al. 2017). In addition, emerging and developing countries such as the Americans and Asians that have stood out in the sector have greater benefits in terms of long-term economic growth by introducing policies that encourage the participation of the industrial sector in GDP (VIEIRA et al. 2014 and SANTOS et al. 2022).

In Table 3 is the aggregate of the main forest products for the 20 largest exporting countries in 2018. These top 20 were responsible for 74.88% of global exports. The largest segment was Cellulose, with 84.05% of the world total in this sector, followed by “Paper and Cardboard”, with 78.74%; “Wood Panels”, with 71.5%;

“Wood for industrial purposes”, with 54.51%; and “wood for energy”, with 23.68%. The product that presented expressiveness regarding the entire world was “Paper and Cardboard” with 39.34%, with the largest exporters in this sector being Germany, the United States, Finland and Sweden.

There is a greater highlight on German exports, which uses recycled paper and packaging as the main raw materials (approximately 75% of the used fibers), unlike the Finnish and Swedish paper and cardboard industries. In Europe, the increase in production was partially driven by the expansion of exports, making it excellent in paper products (FAO 2009, FAO 2015) until 2018. However, despite being the region of the globe that exports the most, it was also the one that had, along with the Americas, the lowest growth over the years, both with only 6%. On the Other hand, Asia, Oceania, and Africa showed significant growth during the evaluated period, with a growth of 37%, 20% and 16%, respectively boosting the observed development in exports in 2018.

Table 3 - Ranking of the top 20 exporting countries of forest products, and their exporting revenue in Millions of dollars (US\$ x10<sup>6</sup>), in 2018

	Countries	Wood for industrial purposes	Paper and cardboard	Sawnwood	Wood for Energy	Cellulose	Wood panels	Others	Total
1	United States	2362.64	10433.33	3812.38	19.45	5929.22	660.83	4934.26	28152.12
2	Canada	682.62	5738.08	8237.99	3.87	7049.14	2707.65	1075.18	25494.53
3	Germany	532.19	14563.66	2516.47	9.22	831.96	3069.86	923.26	22446.62
4	China	55.93	7217.25	228.01	0.2	139.6	6721.18	830.67	15192.84
5	Finland	112.6	8541.38	2166.34	5.14	3099.11	690.14	71.79	14686.48
6	Sweden	110.05	8002.37	3347.47	4.25	2747.45	115.41	148.23	14475.22
7	Russia	1461.73	2272.05	4512.12	8.92	1555.55	2067.21	564.99	12442.55
8	Brazil	46.72	1683.97	737.43	0.01	6453.81	898.07	215.49	10035.49
9	Indonesia	26.49	3326.22	349.91	0.51	2377.94	1780.23	472	8.333.31
10	Austria	103.79	3369.85	1616.67	2.47	370.14	1367.67	375.1	7205.68
11	France	383.51	3976.44	459.59	23.58	450.56	957.82	602.55	6854.04
12	Poland	290.67	2378.71	321.26	13.94	149.79	1147.69	431.46	4733.51
13	New Zealand	2905.12	276.21	651.36	-	530.26	230.79	135.65	4729.39
14	Italy	23.93	3291.05	246.01	1.34	75.61	602.7	488.23	4728.87
15	Netherlands	33.54	2388.14	198.23	25.97	779.06	145.69	672.63	4243.24
16	Thailand	2.6	1036.14	1511.85	0.06	115.78	963.51	287.97	3917.91
17	Vietnam	43.79	157.41	82.87	0.62	0.97	511.79	1658.23	2455.69
18	United Kingdom	30.4	1363.11	85.4	4.59	3.3	130.16	791.31	2408.27
19	Uruguay	177.19	3.37	116.19	-	1684.88	76.31	103.01	2160.95
20	Singapore	27.89	1282.70	10.66	1.02	333.01	16.6	139.97	1811.85
	SubTotal	9413.39	81301.41	31208.21	125.15	34677.13	24861.28	14921.98	196508.55
	Rest of the World	7852.66	21946.45	10293.81	403.34	6576.17	10126.28	8723.47	65922.18
	<b>World</b>	<b>17266.06</b>	<b>103247.86</b>	<b>41502.01</b>	<b>528.49</b>	<b>41253.30</b>	<b>34987.56</b>	<b>23645.45</b>	<b>262430.73</b>

Source: Prepared by the authors (2023).

For wood for industrial purposes, the share of total exports was only 6.58%, with New Zealand being the country in the top 20 with the largest share of the market. Oceania and Europe were the regions that most exported wood for industrial purpose, even though the fastest growth were for the Oceania and the Americas, with an increase of 74% and 53%. Obi and Visser (2020) highlighted the increase in the



country's timber industry between 2009 and 2018, due to the new technologies implemented and their efficiency, which makes the country a high-potential player for exports. Next were the United States, Russia and Canada, all nations with a robust forestry market and industry, as highlighted by Lundbäck et al. (2021).

“Sawnwood” represents 15.81% of the world's total exports, with its main representatives being Canada, Russia, the United States, Sweden and Germany. Europe led exports throughout the period, followed by the Americas and Asia, which experienced a substantial growth of 56% and 40%, respectively. Canada had a steady increase starting from 2012 remaining until 2018 as the main sawnwood exporter. This was due to the recovery of the US real estate market after the 2008 crisis, which is Canada's main consumer market for sawn wood (FAO 2016b).

“Wood products for energy” accounted for a low share of global exports in 2018, with only 0.2%. Only the Netherlands and France exceeded 20 million dollars in exports, followed by the United States, Poland and Germany. Although still in its infancy, the market for timber forest products for energy is expected to expand in the coming years (POUDYAL et al. 2017). In many countries, wood from sawmills is being used to meet heat demands (SAUD et al. 2015). Another point that should intensify exports is the use of the resource in the European and North American markets, due to the European Union's energy policies that aim to achieve up to 20 percent of total energy consumption from renewable sources and the 30 American states that have adopted Renewable Portfolio Standards (RPS) for fuel production (DWIVEDI et al. 2014, NATIONAL CONFERENCE OF STATE LEGISLATORS 2017, REN21 2010).

The “Cellulose” sector reached 15.71% of total exports in 2018. The most relevant market shares were observed for Canada, Brazil, the United States and Finland, with greater concentration in the Americas and in Europe. Exports in the Americas increased consistently over time, mainly as a result of higher productivity between 2012 and 2016, when new pulp mills began operating in South America, specifically in Brazil, Chile and Uruguay. Countries that have high-performance planted forests have a competitive advantage in pulp manufacturing (FAO 2016b; COELHO JUNIOR et al. 2023b). An example of this was the constant increase in exports from Brazil.

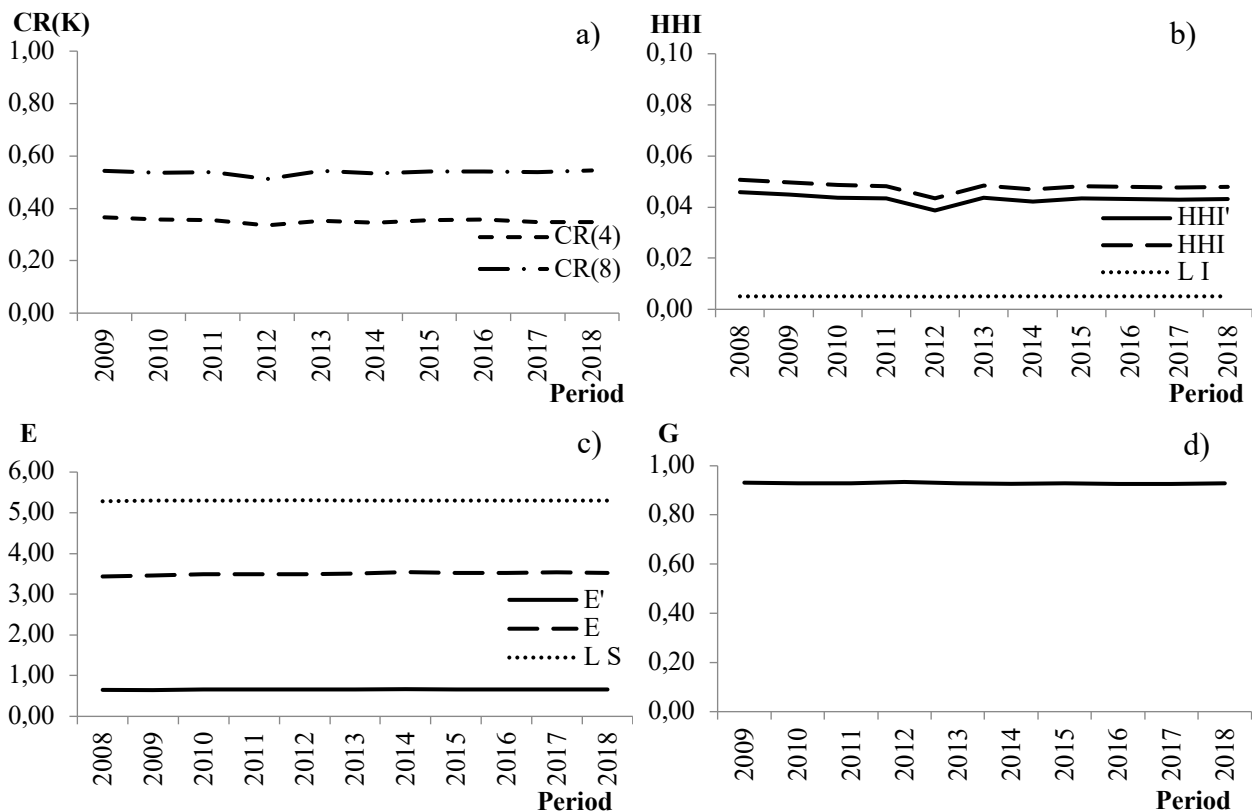
The product “Wooden panels” accounts for 13.33% of the world's total forest products and its main exporter is China, followed by Germany, Canada and Russia. The results were similar to those found in a study by Coelho Junior et al. (2019), where they showed that China and Germany stood out for being the leading MDF exporters, the main product in the sector. Most of the market growth occurred in the Americas and Asia, with an increase of 41% and 37%, despite the sector's export concentration being 48.3% in Europe.

The impact of the global economic crisis is evident in statistics for all major products in 2009, but there was a continuous and gradual recovery from 2012 onwards. The fastest growth occurred in Asia-Pacific, North America and Europe (FAO 2016b). An example is of Brazil that in 2018 Brazil reached the 8th place in the world ranking obtaining a revenue of US\$ 12.5 billion with a new record in the sector's trade balance, which increased on average 12.3% since 2012. This scenario is characterized as positive due to the increase in exports and the sale price, mainly in the pulp and sawn wood sectors (IBÁ 2019). These categories together accounted for 81% of all forest products exported in 2018, driven by demand from the foreign market. Pulp alone corresponded to 64.3% of the country's total exports. The importance of the forestry sector in the Brazilian economy is evident, as already observed by Valverde et. al. (2005), Sousa et al., (2010), Martins et al. (2015) and

Kureski et al. (2015), also due to its place in the world ranking as the eighth largest exporter. Brazil ranks as the 2nd largest exporter of pulp, 12th for wood panels, 12th for sawn wood, 19th for paper and cardboard, 46th for wood for industrial and as 103rd of wood for energy purposes.

Figure 1 presents the evolution of the indicators of world concentration of exports of timber forest products, from 2009 to 2018. The concentration of the four largest exporters (CR4), between the years 2009 and 2011, was moderately low and reduced over the years. In 2012, the CR4 index indicated a minimum market concentration representing the period of greatest dispute in the market. In 2014, the index dropped again. However, there was an increase in 2015 and the market was classified with moderately low concentration until 2016. The years 2017 and 2018 were characterized by low concentration, with high competition between the countries involved (Figure 1.a).

Figure 1 – Evolution of the indicators of world concentration of exports of timber forest products, from 2009 to 2018



Source: Prepared by the authors (2023).

The CR4 was represented, between 2009 and 2013, by the United States, Canada, Germany and Sweden. Nonetheless, Sweden lost its position to China after 2014. The concentration of the eight largest exporters (CR8) was mostly represented by: United States, Canada, Germany, China, Finland, Sweden, Russia and Brazil and was rated as moderately low concentration between 2009 and 2018. The USA was responsible for the largest share of exports of all timber forest products, and this expressiveness is due to its superiority in technology, ease of production flow, the adoption of protectionist economic policies and free trade, in addition, for featuring

among the world's largest producers for several products (TEIXEIRA; CAMPELO FILHO 2020).

We can see in Figure 1 that the trend lines of CR4 and CR8 are very similar and follow the same distribution, despite presenting different results in terms of classification. This is explained by the number of countries that are part of the index, their participation and the fluctuation in product exports, making the index more sensitive.

Regarding the HHI, there was a trend of deconcentration as seen in Figure 1.b. The HHI' decreased from 2009 to 2012, approaching the lower limit, which represents the lowest concentration of the period, followed by increases 2013, 2015 and 2018. According to the HHI classifications, the market is not concentrated ( $HHI < 0.15$ ) and highly competitive ( $HHI < 0.1$ ). The same classification is given by the HHI', which showed the same trends as the HHI (Figure 1.b). Furthermore, there was no variation in the number of member countries and there was no entry or exit of any new country in the trade over the years.

There was no variation in the number of timber forest product's exporting countries, justifying the low values of the upper limits found over the years using the Entropy index. In addition, the index presented a small variation, with a maximum value of 5.31 and a minimum value of 5.29, yielding an average of 5.30. The maximum concentration occurred in 2009 and the minimum occurred in 2014 and 2017, as all values were above zero, it was characterized as a competitive market. In order to compare the entropy index with the adjusted entropy index, the variation of the indices in relation to the upper limit (LS) was evaluated, given that the closer the value is to the LS, the lower the concentration. The two Entropy indices showed the same variations over the years. Therefore, it can be concluded that they present the same patterns (Figure 1.c).

The inequality data displayed in Figure 1.d reduced over the years, measured by the Gini index, with an average of 0.929. The main peaks of this factor occurred in 2009 and 2012, with 201 and 202 participating countries, respectively. These peaks and the trend of concentration reduction in both indices characterized periods of economic instability. The 2008 crisis impacted the economy of developed countries more aggressively than most emerging and developing countries. Developing countries in Asia and Latin America managed to avoid excessive depreciation in the exchange rate maintaining a solid financial base (UNCTAD 2010). Thus, the main explanation for the reductions in exports of wood products was the impact of the world crisis in relation to the dollar power, which devalued against the main currencies (Santana et al. 2010). Developed countries in Europe, dominated the market for forest products until, and started to lose market relevance to Asian and American countries. These emerging American and Asian countries managed to maintain or increase their exports in the post-crisis period. Thus, the new economic path made it possible for some emerging and developing countries to be positioned among the largest exporters in the ranking of development (SILVA et al. 2013).

After the contraction of almost 2% of the global GDP (Gross Domestic Product) in 2009, there was a reacceleration of the product in most regions of the globe, with highlights for China, India and Brazil that led the recovery at regional and global levels. The growth rates of developing countries were much higher than developed countries, driven by exports (UNCTAD, 2010). The European economic instability persisted in spite of the slow world economic growth culminating in the Euro crisis at the end of 2011 and drop in forest products exports from most European countries. Furthermore, in 2012 there was a market growth deceleration in all world regions due to the austerity measures adopted mainly in Europe, which

reduced the forest products demand in developed countries and affecting exports from most developing countries (UNCTAD 2012). This fact generated the marked inequality observed in Figure 1.d.

From 2013 onwards, the Gini index reduced on a very small scale, despite showing a variation over the years. As it presents values greater than 0.901 throughout the period, there was a very strong to absolute market inequality. Despite remaining constant, inequality between countries remained high, characterized by trade deceleration. This is explained by the strategy adopted by each nation as some turned to asset markets, mainly in Europe, aiming to raise income, and others sought to expand their export markets, such as American and Asian countries (UNCTAD 2018).

#### **4 – CONCLUSION**

American and Asian countries have gained places in the ranking of exports of timber forest products, and European nations have lost positions. The most outstanding products in the world, was “Paper and cardboard”, followed by “Lumber”, “Pulp”, “Wooden panels”, “Wood for industrial purposes” and “Wood for Energy”, respectively. The market classification for CR4 indicates low concentration, decreasing over the years. For the CR8 index, the markets classified with moderately low concentration. Using the HHI and Entropy Indices, the market can be understood as deconcentrated and highly competitive, with reduction over the years. In addition, with G indicated a market inequality from very strong to absolute. Developed countries, mainly European, adopted austerity measures as a result of the global economic crisis, and bet on asset markets for their recovery. On the other hand, developing countries sought strategies in exports, which made American and Asian countries grow in the market for forest products.

The results show that there is competitiveness among exporting countries, which favors the development of the sector and the entry of new players into the timber forestry trade. The dynamics and implications presented in this study are essential for formulating strategic decisions, policies and determining investments that will shape the development of the sector. Future studies can assess market dynamics and competitiveness based on domestic production of timber products or their imports, helping to understand the forestry sector on a global scale.

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