THE BRAZILIAN INSERTION INTO THE INTERNATIONAL TRADE OF FOREST PRODUCTS CHAIN[1]

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ABSTRACT – The growing demand for forest products and the increasing interest worldwide in this market requires studying the behavior and defining Brazil's role in relation to other competitive countries in the sector. This study analyzed the international trade in forest products from 2000 to 2014 emphasizing Brazil's role. The Revealed Comparative Advantage index (RCA) and Revealed Comparative Disadvantage index (RCD) were analyzed based on the matrix of the symmetric Aquino index, also through the intra-industry and inter-industry analysis using the Grubel-Lloyd index. Brazil shows RCA in fuel wood, wood panels, wood floors and wood articles as well as wood pulp. Brazil imports relatively small amounts of wood; nevertheless, it still has relatively high dependence on paper importations.

Keywords: Comparative Advantage; Intra-industry trade; Forest economy.

A INSERÇÃO DO BRASIL NO COMÉRCIO INTERNACIONAL DE PRODUTOS DA CADEIA FLORESTAL

RESUMO – A crescente demanda por produtos florestais e o aumento do interesse mundial por esses mercados gera a necessidade de se estudar o comportamento e definir o papel do Brasil diante de outros países competitivos do setor. Neste cenário, o objetivo deste artigo é analisar o comércio internacional de produtos da cadeia florestal no período de 2000 a 2014. Para isto, utilizaram-se indicadores de Vantagens Comparativas Reveladas (VCR) e Desvantagens Comparativas Reveladas (DCR), analisando-os a partir da matriz do Índice de Aquino, e também por meio da análise intraindustrial e interindustrial com o uso do Índice de Grubel-Lloyd. Os resultados apontam que o Brasil possui VCR em alguns dos segmentos avaliados, como nos setores de biomassa florestal energética; painéis, pisos e obras de madeira; e celulose. Para a categoria madeira, o Brasil é pouco dependente de importações, e para o item papel ainda existe uma grande dependência relativa dos mercados externos.

Palavras-Chave: Vantagem Comparativa; Comércio intraindustrial; Economia florestal.

1. INTRODUCTION

In the world, there are over 4 billion hectares (ha) of forests. Brazil has a leading role among the forest-holding countries with 493 million ha, behind only Russia with 814 million ha. Other countries with large cover are Canada (347 million ha), the United States of America (310 million ha) and China (208 million ha). These five countries account for more than half of the world's forests (FAO, 2015a).

The forest industry has a diversified range of products with different energy and industrial applications (Brasil, 2007). Forest production worldwide presented a growth of 3% in 2014 compared to 2000, generating exportation revenues of US$ 255 billion in 2014. In 2014, 3.7 million m^3 of timber were produced for energy (50.36%) and industrial (49.64%) purposes (FAO, 2015b).

The major countries in the international trade of forest industry are China, the United States and Russia, the major producers and consumers. Brazil stands out among the top ten producers and consumers in almost all segments (except for paper consumption) (FAO, 2014).

Forest extension, edaphoclimatic conditions and silviculture are factors that confer many competitive and comparative advantages to Brazil in the forest sector (Heimann et al., 2015). In economic terms, the forest chain products is an important generator of products, taxes, jobs and income. According to Brazilian Tree Industry – IBÁ (2015), in 2014, exportation revenue of the forest industry reached US$ 8.49 billion and the planted forest segment generated approximately 600 thousand jobs.

The Brazilian forest industry generates a large variety of raw materials and products. To native forests, exported goods have low value added such as logs and lumber (Brasil, 2007). On the other hand, the destination of products from planted forest is diversified and are used mainly in industrial processes and as biomass for energy generation (IBÁ, 2015).

Brazil is one of the main exporters of forest chain products; however, the Brazilian need for imports of the same products may show weaknesses in international insertion in industrial segments with higher processing levels or value added. According to Ferreira et al. (2015), Brazilian pulp exportations are competitive and have comparative advantages. Nevertheless, paper produced in Brazil is not competitive in the international trade and is used mainly in the domestic market. Thus, the analysis of the Brazilian performance in the international intra-industry trade of the forest sector becomes important, especially, when associated with the study of comparative advantages.

This research aimed to analyze the international trade of forest products chain from 2000 to 2014, highlighting Brazil's role compared with other players of the sector. Specifically, it is expected to: i) identify the main exporting countries; ii) calculate comparative advantages of large exporters, identifying Brazil's role; and iii) verify the intra-industry and inter-industry trade of the main exporting countries of forest products chain.

This research is justified by the relevance of Brazil's role in the international scenario of forest products, due to its large endowment of forest resources.

2. MATERIALS AND METHODS

2.1. International trade theory

The Heckscher-Ohlin (HO) model postulates that international trade is determined by relative differences in the production factor endowments among countries and by differences in the proportions of factors used in production. The HO theorem shows that countries export goods that are intensive in the production factors and that are relatively abundant. Therefore, countries specialize in the production of goods that they have comparative advantages, which reflects inter-industry trade (Markusen et al., 1995; Krugman and Obstfeld, 2010; Maxir and Faria, 2013). Hence, nations with abundance in forest resources tend to export goods whose production uses these resources intensively.

The HO theorem and the concept of intra-industry trade are complementary, since the intra-industry trade does not reflect comparative advantages (Nonnenberg, 1995). The intra-industry trade is dominant in regions or industries with increasing returns to scale of production, in markets with monopolistic competition, and where product differentiation plays an important role (Algieri, 2004).

In the inter-industry trade of forest products, wood importations by a country j and paper exportations by the same country j may reflect the comparative advantage in a segment of the productive chain. However, in the intra-industry trade, wood pulp

importations by a country j and wood pulp exportations by the same country j do not reflect comparative advantages, because other factors, such as economies of scale, can influence international trade. Therefore, to avoid problems in measuring comparative advantages, international trade indicators are adopted considering exportations and importations of a country, evidencing intra-industry trade.

2.2. Indicator of revealed comparative advantages and disadvantages

Comparative advantages arise when a country is relatively better producing a specific good than other countries are, as proposed in the HO theorem. However, comparative advantages are not measurable directly; thereby, indicators based on the earlier trade flows are used. For this purpose, different formulations of the Revealed Comparative Advantage (RCA_{ij}) index, developed by Balassa (1965) and complemented by Laursen (1998) are used:

$$RCA_{ij} = (X_{ij}/X_{ik})/(X_j/X_k) \quad 1$$

Where, X_{ij} = exportations value of the *i*-th product from j-th country; X_{ik} = exportations value of the *i*-th product from the *k*-th reference set (world); X_j = total exportations value from *j*-th country; and X_k = total exportations value from *k*-th reference set (world).

Standardizing RCA_{ij} to remain within the interval -1 and 1 (Laursen, 1998), it is obtained the Revealed Symmetric Comparative Advantage (RCA^*_{ij}):

$$RCA^*_{ij} = (RCA_{ij} - 1)/(RCA_{ij} + 1) \quad 2$$

Where, if $0 < RCA^*_{ij} \leq 1$, the j-th country presents revealed comparative advantage; if $RCA^*_{ij}=0$, the *j*-th country does not present revealed comparative advantage nor disadvantage; and if $-1 \leq RCA^*_{ij} < 0$, the *j*-th country does not present revealed comparative advantage.

A country can be a major exporter of a specific commodity and a net importer of the same commodity. Thus, the lack of information on importations flow in the analysis of comparative advantages may present misleading assessments of competitiveness. In this sense, it is used the Revealed Comparative Disadvantage (*RCD*) index (Aquino, 1999; Algieri, 2004):

$$RCD_{ij} = (M_{ij}/M_{ik})/(M_j/M_k) \quad 3$$

Where, M_{ij} = importations value of the *i*-th product from *j*-th country; M_{ik} = importations value of the *i*-th product from the *k*-th reference set (world); M_j = total importations value from *j*-th country; and M_k = total importations value from *k*-th reference set (world).

Adopting the procedure of Laursen (1998), Algieri (2004) normalizes the RCD_{ij} to hold within the interval -1 and 1, originating the Revealed Symmetric Comparative Disadvantage (RCD^*_{ij}) :

$$RCD^*_{ij} = (RCD_{ij} - 1)/(RCD_{ij} + 1) \quad 4$$

Where, if $0 < RCD^*_{ij} \leq 1$, the *j*-th country presents revealed comparative disadvantage, because it imports relatively more the product *i* than other countries do; if $RCD^*_{ij}=0$, the *j*-th country does not present revealed comparative advantage nor disadvantage; and if $-1 \leq RCD^*_{ij} < 0$, the *j*-th country does not present revealed comparative disadvantage.

The index developed by Aquino (1999), the Aquino Index (*AI*), is composed of the Revealed Comparative Advantage (*RCA*) index in the numerator and the Revealed Comparative Disadvantages (*RCD*) index in the denominator:

$$AI_{ij} = (RCA_{ij})/(RCD_{ij}) \quad 5$$

Adjusting the Aquino Index to remain within the interval -1 and 1:

$$AI^*_{ij} = (RCA_{ij} - 1)/(RCD_{ij} + 1) \quad 6$$

The Aquino Index considers exportations and importations, providing unbiased measurements of the specialization degree and the AI^*_{ij} overcomes limitations of the Balassa index, RCA_{ij}.

However, in this research, the Aquino Index will be analyzed observing the RCA^*_{ij} and RCD^*_{ij} separately to determine the evolution of trade flows. The indexes RCA^*_{ij} and RCD^*_{ij} will be inserted into a specialization patterns matrix as proposed by Algieri (2004) and Dieter and Englert (2006), therefore:

i. Inter-industry specialization (INTER): if

$0 < RCA^*_{ij} \leq 1$ and $-1 \leq RCD^*_{ij} < 0$;

ii. Intra-industry trade (INTRA): if

$0<RCA^{*}_{ij}\leq 1$ and $0<RCD^{*}_{ij}\leq 1$;

iii. Net importer (NI): if

$-1\leq RCA^{*}_{ij}<0$ and $0<RCD^{*}_{ij}\leq 1$;

iv. Closed economy (CE): if

$-1\leq RCA^{*}_{ij}<0$ and $-1\leq RCD^{*}_{ij}<0$;

v. No trade specialization (NS): if

$RCA^{*}_{ij}=0$ and $RCD^{*}_{ij}=0$.

2.3. Grubel-Lloyd index

Another way to evaluate the intra-industry trade is through the Grubel-Lloyd index (Grubel and Lloyd, 1975). According to Hidalgo (1993), the index is defined as:

$$GL_{ij} = \{[(X_{ij} + M_{ij}) - |X_{ij} - M_{ij}|]/(X_{ij} + M_{ij})\} \; x \; 100\% \quad 7$$

Where, X_{ij} = exportations value of product i from the country j; M_{ij} = importations value of product i from the country j; $|X_{ij}-M_{ij}|$ = inter-industry trade of product i from country j; and $[(X_{ij}+M_{ij})-|X_{ij}-M_{ij}|]$ = intra-industry trade of product i from country j.

To interpret the GL_{ij} index, the intra-industry trade predominance occurs when $GL_{ij}> 50\%$, which is associated with economies of scale effects and product differentiation. The inter-industry trade prevails when $GL_{ij}\leq 50\%$, which is in conformity with differences in the relative endowments of production factors, as in the HO theorem (Hidalgo,1993; Rosa and Alves, 2006).

2.4. Data

The data on exportation and importation flows were obtained from the United Nations Commodity Trade Statistics Database (UNCOMTRADE, 2016). The selected categories of forest products chain are classified by the Harmonized System (HS) with two and four digits. Table 1 shows the selected categories and their description.

The analyzed categories are an aggregation of several products of the forest sector. However, these categories differ in terms of processing degree, i.e., they analyze raw products, such as logs, as well products with a higher processing intensity, such as wood pulp and paper.

The period of analysis is from 2000 to 2014 and is justified by the increasing world concern about the forest-based sector. The studied countries were selected according to their expressiveness in exportations of forest products (billions of dollars Free on Board - FOB). It was created a ranking of the main countries in 2014, selecting those that altogether account for approximately 70% of the total exportations in the forest segment.

3.RESULTS

3.1.*Ranking* of international trade in the forest sector

Table 2 presents the ranking of the 15 major forest products exporters in 2014, showing that the market share aggregation of these countries concentrate approximately 71% of all exportations of different segments in the forest sector.

3.2. Revealed comparative advantage and disadvantage indexes

Figure 1 shows the behavior of countries in terms of international trade insertion in an aggregated way. Note that the beginning of the arrow indicates the year 2000 and the end, the year 2014.

Figure 2 presents RCA^{*}_{ij} and RCD^{*}_{ij} indexes in a disaggregated manner for the forest chain segments.

3.3.Grubel-Lloyd index

The Grubel-Lloyd index allows to characterize the intra-industry trade share of a given country j of a product i. Figure 3 shows the results of the GL_{ij} index for the years 2000 and 2014.

4.DISCUSSION

4.1. *Ranking* of international trade in the forest sector

Total exportations value of forest products chain in the world amounted to US$ 192.39 billion FOB in 2000 and US$ 346.07 billion FOB in 2014, which represents growth of 79.89% in the period. The products with the highest average participation over the analyzed period were paper (52.40%), panels, floors and wood articles (17.65%) and wood (17.28%). Cork was the category with lowest average participation, with 0.62% from 2000 to 2014. There were no significant changes in the exportation composition of forest products chain during the analyzed period.

Table 1 – Classification of selected products in the forest chain.
Tabela 1 – *Classificação dos produtos selecionados da cadeia florestal.*

Products	HS	Description
Wood fuel	44.01	Fuel wood, in logs, in billets, in twigs, in faggots or in similar forms; wood in chips or particles;sawdust and wood waste and scrap, whether or not agglomerated in logs, briquettes, pellets or similar forms.
Wood	44.03	Wood in the rough, whether or not stripped of bark or sapwood, or roughly squared.
	44.04	Hoopwood; split poles; piles, pickets and stakes of wood, pointed but not sawn lengthwise; wooden sticks, roughly trimmed but not turned, bent or otherwise worked, suitable for the manufacture of walking-sticks, umbrellas, tool handles.
	44.05	Wood wool; wood flour.
	44.06	Railway or tramway sleepers (cross-ties) of wood.
	44.07	Wood sawn or chipped lengthwise, sliced or peeled, whether or not planed, sanded or finger-jointed, of a thickness exceeding 6 mm.
	44.08	Veneer sheets and sheets for plywood (whether or not spliced) and other wood sawn lengthwise, slicedor peeled, whether or not planed, sanded or finger-jointed,of a thickness not exceeding 6 mm.
Panels, floors and wood articles	44.09	Wood (including strips and friezes for parquet flooring, not assembled) continuously shaped (tongued, grooved, grooved, rebated, chamfered, V-jlinted, beaded, moulded, rounded or the like) along any of its edges or faces, whether or not.
	44.10	Particle board and similar board of wood or other ligneous materials, whether or not agglomerated with resins or other organic binding substances.
	44.11	Fiberboard of wood or other ligneous materials, whether or not bonded with resins or other organic substances.
	44.12	Plywood, veneered panels and similar laminated wood.
	44.13	Densified wood, in blocks, plates, strips or profile shapes.
	44.14	Wooden frames for paintings, photographs, mirrors or similar objects.
	44.15	Packing cases, boxes, crates, drums and similar packings, of wood; cable-drums of wood; pallets, box pallets and other load boards, of wood; pallet collars of wood.
	44.16	Casks, barrels, vats, tubs and other coopers' products and parts thereof, of wood, including staves.
	44.17	Tools, tool bodies, tool handles, broom or brush bodies and handles, of wood; boot or shoe lasts and trees, of wood.
	44.18	Builders' joinery and carpentry of wood, including cellular wood panels, assembled parquet panels, shingles and shakes.
	44.19	Tableware and kitchenware, of wood.
	44.20	Wood marquetry and inlaid wood; caskets and cases for jewelry or cutlery, and similar articles, of wood; statuettes and other ornaments, of wood; wooden articles of furniture not falling in Chapter 94.
	44.21	Other articles of wood.
Cork	45	Cork and articles of cork.
Pulp of wood	47.01	Mechanical wood pulp.
	47.02	Chemical wood pulp, dissolving grades.
	47.03	Chemical wood pulp, soda or sulphate, other than dissolving grades.
	47.04	Chemical wood pulp, sulphite, other than dissolving grades.
	47.05	Semi-chemical wood pulp.
Paper	48	Paper & paperboard; art of paper pulp, paper/paperboard.

Source: prepared by the authors according to UNCOMTRADE (2016).
Fonte: *Elaboração dos autores segundo UNCOMTRADE (2016).*

The main exporting countries of forest products in 2014 were Germany, the United States and Canada, which altogether accounted for 26.91% of forest products exports. In 2014, Germany was the leader country of forest products exportations, accounting for 9.55% of the total exported. Germany's performance is due to paper exports, the country exported 13.18% (US$ 22.52 billion FOB) of the total in this category (US$ 170.91 billion FOB) in 2014. Paper is the product with the highest technological processing level and value added, corresponding to 49.93% of the total exported by the forest chain in 2014. The United States takes the second position in the rank, accounting for 9.26% of forest products exportations. However, the United

Table 2 – Rank of the major forest products exporters in 2014 (US$ billion FOB).
***Tabela 2** – Ranking dos principais exportadores de produtos florestais em 2014 (US$ bilhões FOB).*

Country	Forest chain		Fuel wood		Wood		Panels, floors and wood articles		Cork		Pulp of wood		Paper	
Germany	32.70	9.55%	0.42	5.20%	2.80	5.17%	5.91	8.22%	0.036	2.01%	1.01	2.85%	22.52	13.18%
USA	31.70	9.26%	0.83	10.31%	6.55	12.08%	2.34	3.26%	0.031	1.69%	5.60	15.85%	16.34	9.56%
Canada	27.74	8.10%	0.35	4.35%	8.93	16.46%	3.38	4.70%	0.005	0.27%	6.52	18.44%	8.56	5.01%
Chile	23.23	6.79%	0.31	3.83%	1.03	1.89%	1.17	1.62%	0.012	0.68%	2.89	8.18%	17.82	10.43%
Sweden	17.49	5.11%	0.08	0.96%	3.64	6.71%	0.94	1.30%	0.003	0.19%	2.65	7.49%	10.18	5.96%
China	16.01	4.68%	0.05	0.59%	0.59	1.10%	13.74	19.11%	0.020	1.09%	0.01	0.04%	1.60	0.93%
Finland	14.82	4.33%	0.03	0.36%	2.18	4.01%	1.06	1.48%	0.000	0.01%	2.12	6.00%	9.43	5.52%
Russia	11.14	3.26%	0.25	3.06%	5.65	10.42%	1.86	2.59%	0.001	0.04%	1.12	3.17%	2.26	1.32%
France	10.67	3.12%	0.12	1.47%	0.84	1.54%	1.95	2.71%	0.085	4.67%	0.44	1.24%	7.25	4.24%
Austria	10.58	3.09%	0.20	2.43%	1.58	2.91%	3.11	4.33%	0.009	0.49%	0.28	0.78%	5.41	3.16%
Italy	10.04	2.93%	0.01	0.17%	0.38	0.69%	1.69	2.35%	0.057	3.14%	0.03	0.07%	7.88	4.61%
Brazil	9.46	2.76%	0.13	1.66%	0.49	0.90%	1.62	2.25%	0.002	0.12%	5.29	14.97%	1.92	1.12%
Indonesia	9.38	2.74%	0.23	2.87%	0.08	0.15%	3.60	5.01%	0.000	0.01%	1.72	4.86%	3.74	2.19%
Poland	8.58	2.51%	0.14	1.77%	0.54	0.99%	3.45	4.79%	0.007	0.40%	0.12	0.35%	4.32	2.53%
Belgium	8.13	2.37%	0.10	1.20%	0.84	1.56%	1.82	2.54%	0.013	0.69%	0.57	1.61%	4.78	2.80%
Total	241.66	70.61%	3.25	40.23%	36.11	66.58%	47.64	66.26%	0.280	15.50%	30.37	85.91%	124.02	72.56%
Others	100.60	29.39%	4.82	59.77%	18.12	33.42%	24.26	33.74%	1.528	84.50%	4.98	14.09%	46.89	27.44%
World	342.27	100.00%	8.07	100.00%	54.23	100.00%	71.90	100.00%	1.808	100.00%	35.35	100.00%	170.91	100.00%

Source: Prepared by the authors.
***Fonte:** Elaboração dos autores.*

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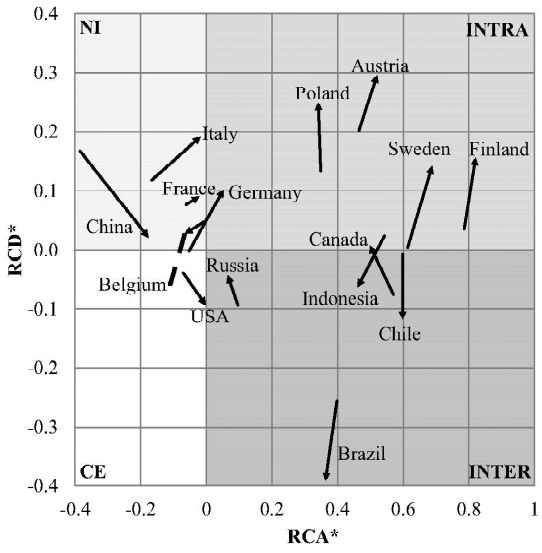


Note: the beginning of the arrow represents the year 2000 and the end the year 2014.
***Nota**: o início da seta representa o ano de 2000 e o fim da seta representa o ano de 2014.*

Figure 1 – Revealed comparative advantages and disadvantages in the forest chain (2000-2014).
***Figura 1** – Vantagens e desvantagens comparativas reveladas da cadeia florestal (2000-2014).*

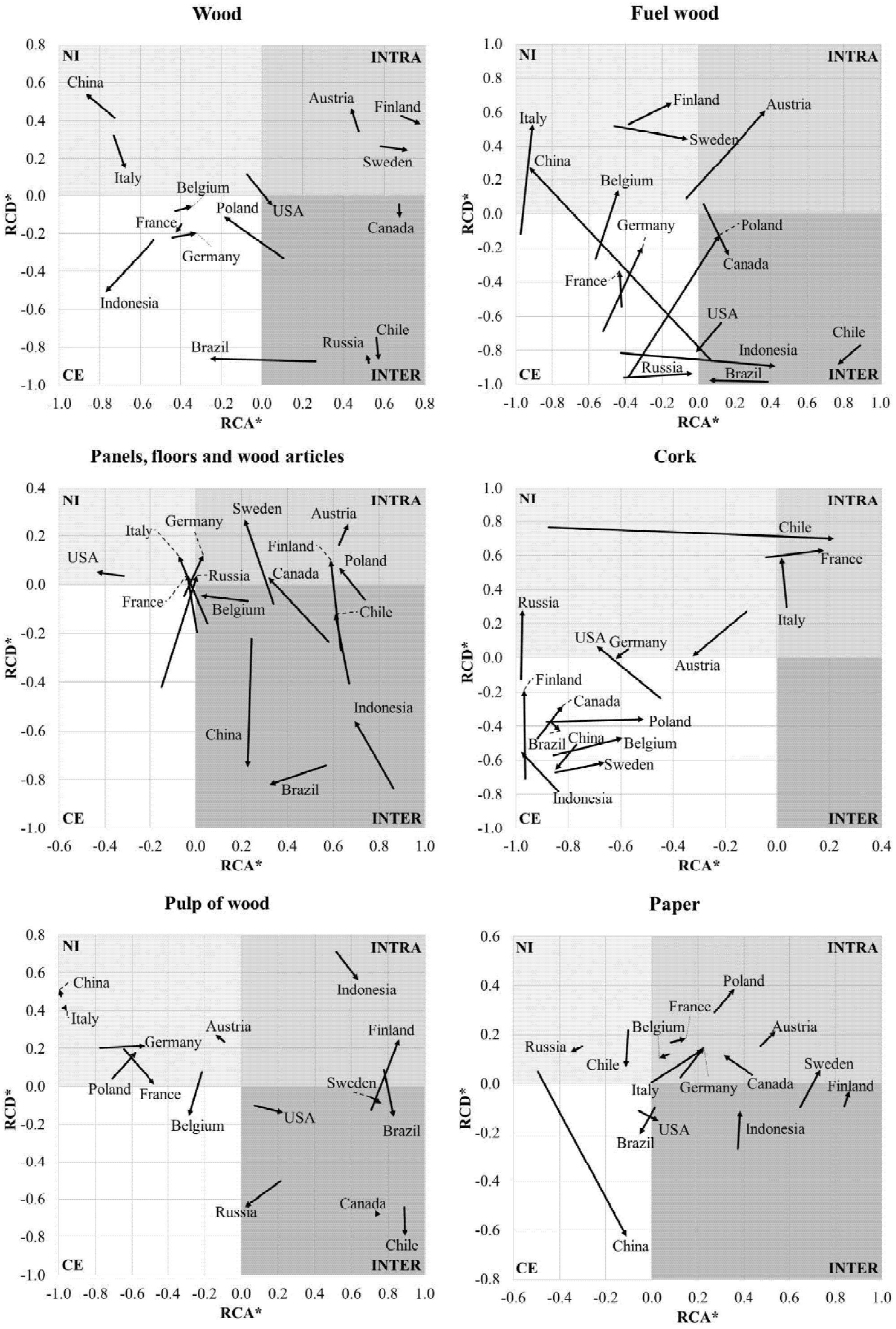
States has a greater diversification in the productive forest segments, such as wood fuel (10.31%), wood (12.08%), wood pulp (15.85%) and paper (9.56%). The Canadian market share is 8.10% of the total of forest products exportations, contributing to 17.82% of wood pulp exportations in 2014 (Table 2).

Brazil is ranked in the 12th position in the world exportations of forest products, accounting for 3% of total exportations. Brazil's exportations in the forest chain totaled US$ 9.46 billion FOB of which US$ 5.29 billion FOB were generated by the wood pulp segment. The country is expressive in the world pulp exportations (14.97%, Table 2) and the third largest supplier in the international market, behind Canada and the United States.

4.2. Revealed comparative advantage and disadvantage indexes

In the period between 2000 and 2014, countries such as Sweden, Finland, Austria and Poland remained in the first quadrant, indicating intra-industry trade specialization; however, these countries showed an intensification of RCD^*_{ij}. China, Italy, France and Belgium were characterized as net importers, indicating that these countries export forestry products (US$ FOB), but they depend on large volumes of importations of the same products (Figure 1).

Source: Prepared by the authors.
Fonte: *Elaboração dos autores.*



Note: The beginning of the arrow represents the year 2000 and the end the year 2014.
Nota: *O início da seta representa o ano de 2000 e o fim da seta representa o ano de 2014.*
Figure 2 – Revealed comparative advantage and disadvantage by segment of the forest chain in (2000-2014).
Figura 2 – *Vantagens e desvantagens comparativas reveladas por segmento da cadeia florestal (2000-2014).*

Source: Prepared by the authors.
Fonte: *Elaboração dos autores.*

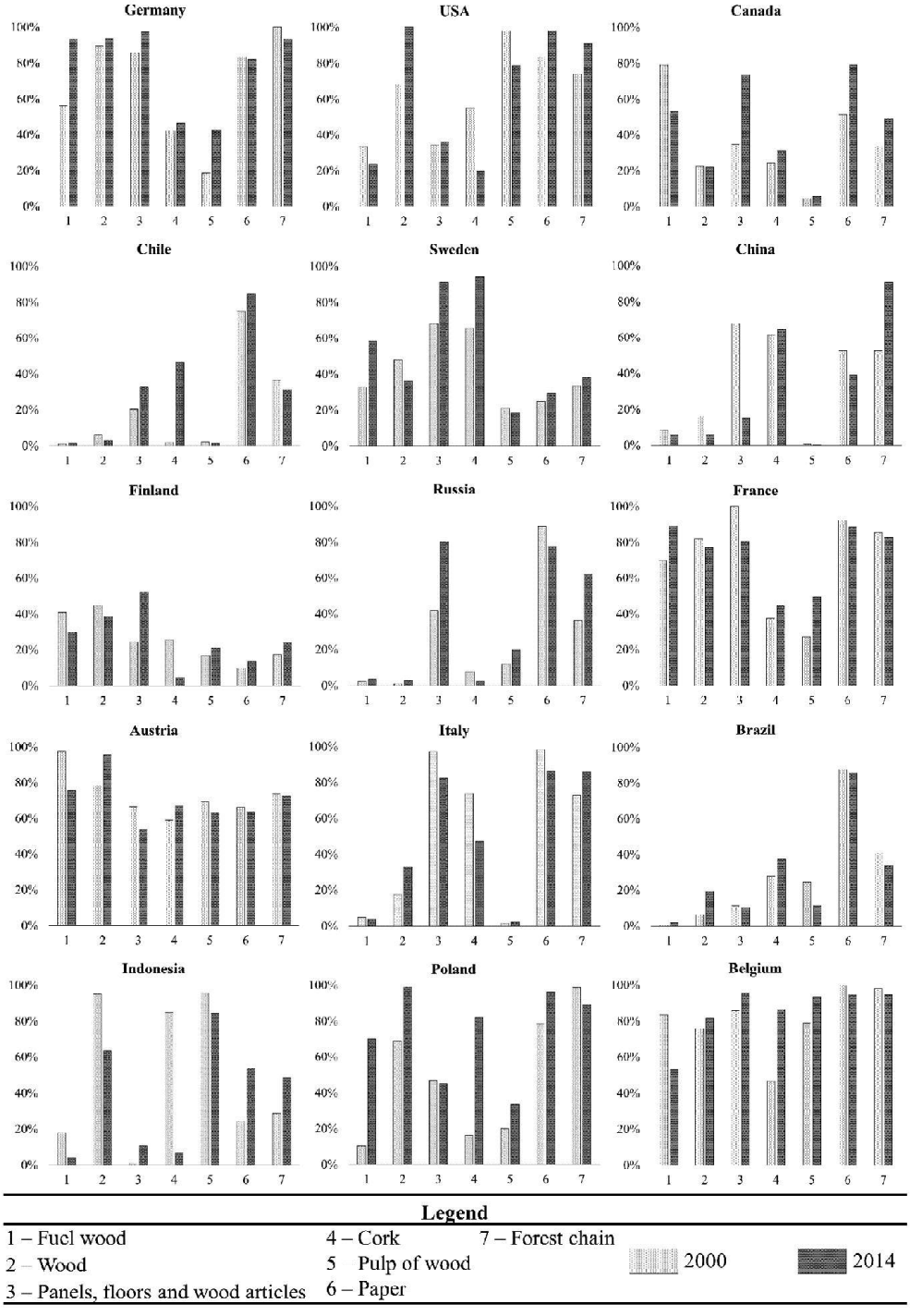


Figure 3 – Grubel-Lloyd index in the forest chain (2000-2014).
Figura 3 *– Índice de Grubel-Lloyd para a cadeia florestal (2000-2014).*

There are changes related to the type of external insertion in some countries, such as Indonesia, which had intra-industry trade in 2000 and became inter-industry trade in 2014. On the other hand, Canada exhibited the opposite movement, leaving the position of inter-industry trade in 2000, establishing in the intra-industry trade in 2014 (Figure 1).

The United States was the only country that remained in the third quadrant, which in extreme cases indicates a closed economy ($RCA^*_{ij} = -1$ and $RCD^*_{ij} = -1$); however, in 2014, the country was near to an inter-industry trade situation.

Brazil, Chile, and Russia continued in the second quadrant of Figure 1, indicating inter-industry trade insertion in aggregate terms. However, Brazil presented a slight reduction in the revealed comparative advantage, where $RCA^*_{ij} = 0.398$ in 2000 and $RCA^*_{ij} = 0.363$ in 2014. Considering importation flows, Brazil began to import relatively fewer products from the forest chain if compared to the world share of importations of the same products, as evidenced by the decrease of $RCD^*_{ij} = -0.255$ in 2000 to $RCD^*_{ij} = -0.390$ in 2014.

Disaggregating the forest sector by products (Figure 2) shows that in the first segment, wood, the highlights were Canada, Russia and Chile, since these countries are classified by inter-industry trade flow between 2000 and 2014. However, other countries, such as the United States, left the net importer status to the inter-industry trade specialization, meaning that the country is exporting relatively more wood and importing relatively less.

Regarding the wood segment, Brazil changed from an inter-industry trade situation (associated with revealed comparative advantage) in 2000, moving toward a closed economy in 2014. Petrauski et al. (2012) analyzed Brazilian competitiveness in the international lumber market and observed that the country presented revealed comparative advantage in the period 2000-2007. According Noce et al. (2003), the international performance in this sector is related to economic factors such as costs, productive systems, exchange rate and product quality.

The transition from inter-industry to near closed economy does not reflect a worsening of the Brazilian condition, since it is necessary to verify if the country has been able to enter the inter-industry trade condition in other segments of the forest chain with greater value added, such as panels, floors and wood articles, wood pulp and paper.

In the segment of fuel wood, Brazil reduced RCA^*_{ij}, but remained classified as inter-industry trade. In the same sector, the highlights were Poland and Indonesia, which left the condition near closed economy to the inter-industry trade.

For the international trade in panels, floors and wood articles, Brazil, Indonesia, China and Chile remained under the classification of inter-industry trade between 2000 and 2014. However, this segment in the forest industry changed, as several countries migrated to other classification such as Canada, Sweden, Finland, Poland and Italy. Noce et al. (2008) studied the international trade in the agglomerated panels and found that the market structure is concentrated, which allows the adoption of an anticompetitive behavior. Moreover, for Brazil, exportations in this segment were driven by the growth of world trade and the effect of exportation destination in the period 1998-2000.

In the cork international trade, most of the selected countries were near a closed economy, because cork is a product associated with specific forest species and Portugal is the world's largest exporter (country not selected for analysis). Meanwhile, Italy, Chile and France stood out in the intra-industry trade.

Sweden, the United States, Canada, Chile and Russia continued in the inter-industry trade in the wood pulp sector, with the shift of Finland and the Brazilian insertion into the intra-industry trade, both in 2014. Carvalho et al. (2009) showed that Brazil has relevance in the international pulp market and presents comparative advantage for the period 2000 to 2006. Despite the presence of traditional wood pulp exporters, such as Canada, the United States, Sweden and Indonesia, Brazil presents significant competitiveness. Valverde et al. (2006) indicate that the growth of world trade and the competitiveness effect were driving factors that increased the Brazilian wood pulp exportations in the period 1993-2002 due to the rapid growth of reforestation and the low production cost.

For the paper sector, Brazil moved from inter-industry trade in 2000 to a reduction of RCA^*_{ij} in 2014. According to Ferreira et al. (2015), this occurs because the national production of paper is allocated to supply the domestic market.

Therefore, according to the results found, Brazil in the international trade of the forest chain is characterized as supplier of fuel wood, panels, floors and wood articles, and wood pulp. The results obtained in this section indicate that although the country has left the condition of raw material supplier and has explored segments of higher technological level, it was not able to reach external insertion in the paper sector.

4.3. Grubel-Lloyd index

The inter-industry trade is characterized by exportations of products according to the endowments of production factors in each country. Thus, the inter-industry trade is associated to the HO model differently from the intra-industry trade (Krugman and Obstfeld, 2010).

Following the classification of Hidalgo (1993) and Rosa and Alves (2006) in which 50% is the limit (critical value) that divides the products groups between inter-industry and intra-industry trade, then Canada, Chile, Sweden, Finland, Brazil and Indonesia are characterized by inter-industry trade in the forest chain. On the other hand, Germany, the United States, China, France, Belgium, Poland, Italy and Austria belong to the group of countries categorized by intra-industry trade. Russia is the only country that migrated from the inter-industry condition in 2000 to intra-industry in 2014 (Figure 3).

The segments of fuel wood, cork and wood pulp were classified predominantly as inter-industry trade in 2000, while sectors like wood, panels, floors and wood articles, and paper were classified as intra-industry flow. From 2000 to 2014, the wood sector was the only segment that shifted groups and is classified in the inter-industry trade with fuel wood, cork and wood pulp.

In the forest chain, Brazil presented a reduction in intra-industry trade from 40.72% in 2000 to 33.80% in 2014. In the disaggregated way, Brazil has higher level of intra-industry trade with increased degree of industrial processing of the product. This is due to a greater number of segments described as inter-industry trade flows in the year 2014, such as wood (GL_{ij} = 19.40), fuel wood (GL_{ij} = 1.93), panels, floors and wood articles (GL_{ij} = 10.61), cork (GL_{ij} = 37.62), and wood pulp (GL_{ij} = 11.67), and a higher level of intra-industry trade in the paper segment (GL_{ij} = 85.71). These results are in accordance with those found by Ferreira et al. (2015), who stated that although the domestic production of pulp is allocated to the international market, the paper segment has small insertion due to the growing Brazilian demand.

5.CONCLUSION

Several countries were classified in the intra-industry trade for the forest chain such as Germany, the United States, France, Austria, Italy, Poland and Belgium. On the other hand, countries like Brazil, Chile and Finland were inserted into the inter-industry trade.

The results showed that Brazil was in 12th place in the world ranking of forest products exports in 2014, and presented revealed comparative advantage throughout the analyzed period (2000-2014). The country presented revealed comparative advantage in the categories of fuel wood, panels, floors and wood articles, and wood pulp, fitting into the trade flow postulated by the Heckscher-Ohlin model. For the wood and paper segments, Brazil exhibited revealed comparative disadvantage at the end of the period.

The Grubel-Lloyd indexes for Brazil were less than 50% in the segments of wood, fuel wood, panels, floors and wood articles, cork, and pulp of wood, characterizing inter-industry trade in the period. For the paper segment, high indexes of intra-industry trade were evidenced demonstrating the need for importation of this product.

Brazil, in the international trade of the forest chain, has exported relatively less raw wood. However, it has lost competitiveness in the chain with higher value added, the paper sector. Therefore, although Brazil exports several products of the forest chain, the country presents difficulties of insertion into segments with higher level of industrial processing.

Hence, it is suggested that further studies detail each category evaluated in this article in order to specify the origin of the forest product, i.e., from native or planted forests.

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