



Comparison of revealed comparative advantage indexes with application to trade tendencies of cellulose production from planted forests in Brazil, Canada, China, Sweden, Finland and the United States



Fabrícia Gladys F.S. Rossato^{a,*}, Andres Susaeta^a, Damian C. Adams^a, Ieda Geriberto Hidalgo^b, Thais Duekc de Araujo^c, Adriana de Queiroz^c

^a School of Forest Resources and Conservation, University of Florida, 315 Newins Ziegler Hall, Gainesville, FL 32610-0410, United States

^b Universidade Estadual de Campinas, UNICAMP/Faculdade de Tecnologia – FT, Rua Paschoal Marmo, 1888 - Jardim Nova Itália, CEP:13484-332 Limeira, SP, Brazil

^c Universidade Federal do Mato Grosso do Sul, R. UFMS, 40 - Vila Olinda, Campo Grande, MS CEP 79070-900, Brazil.

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ABSTRACT

The pulp industry is an important sector of the global economy and a positive contributor to the trade balance in pulp producing countries. The main objective of this study was to analyze the competitiveness in the production of wood pulp in the United States, Brazil, Canada, Sweden, Finland, and China. We employed two indexes – the revealed comparative advantage (RCA) index and the revealed symmetric comparative advantage (RSCA) index – to ascertain the underlying comparative advantages between countries. Further, we used the trade balance index (TBI) to assess wood pulp's impacts on trade balance. Results showed that under the RCA index, all countries but China have comparative advantages. The RSCA indicated that the highest comparative advantages belong to Finland, Canada, and Sweden. Trade balance, assessed via the TBI index, found positive trade balances for Brazil, Finland, Canada, Sweden, and the USA. China has the greatest comparative disadvantage. We concluded that the wood pulp industry has a strong positive influence on the export economies of Brazil, Finland, Canada and Sweden; and in the USA it has a moderate positive influence.

1. Introduction

Forests play an important role in maintaining the earth's biological and climatic characteristics, as well as in generating wealth through the use of forest resources. Tree plantations, in addition to their productive functions, play an important role in the provision of socio-environmental services. This implies conserving biodiversity, achieving greater energy efficiency of the forest production processes, diversifying the economic use of planted trees, and increasing the social benefits generated (IBA, 2015). Aligning such expectations of sustainability with wealth generation is a complex challenge that involves a review of the development model of the nations involved (CNI, 2016).

Planted forests absorb CO₂ during growth (Demirbas et al., 2009) thus helping to offset the climate change impacts of development. The cultivation of homogenous and cultivated forests has grown rapidly in order to meet the increasingly high demand for wood in world markets. Among the existing forest sector products, pulp is responsible for a

significant share of the total market of forest products. Another important wood product is biomass for power generation, due to its renewable nature compared to fossil fuels.

Companies in the forestry and pulp sector with a main focus on energy sources (bioelectricity and biofuels) are intensifying their research to improve techniques for preservation of land, water and sustainable use of other natural resources, calling them the 4Fs—food, fiber, fuel and forests (IBÁ, 2015). In this regard, the idea of sustainability has led to increasing expectations regarding social and environmental performance (HART and MILSTEIN, 2004), considering the possibility of tradeoffs between environmental, social and economic factors (ELKINGTON, 1998; Porter and var der Linde, 1995). However, historically, concerns about the environment have not greatly affected corporate or technological decisions, or have even been viewed dismissively by companies and industries. Instead, companies' decisions were made based on their perceived competitive advantage¹ (Porter and var der Linde, 1995). The trade-off regarding competitiveness is a

* Corresponding author.

E-mail address: fabgladys@ufl.edu (F.G.F.S. Rossato).

¹ A way to incorporate environmental impacts into decision-making process, generate competitive advantages and improve corporate responsibility is through environmental certification (BAIRD and QUASTEL, 2011).

broader issue, having profound implications for the debate on environmental policy: how to approach it, how to regulate it, and how strict the regulations should be (Porter and van der Linde, 1995).

Global concerns about environmental sustainability and economic growth are connected to changes in established trade flows between countries. These changes are caused by economic development in different countries and ongoing trade liberalization and trade policy progress. In this context, it is critical to understand the competitiveness of the world's forest sector for pulp production and bioenergy to ensure sustainable development. The purpose of this study was to assess the relationship between the planted forests vs the pulp produced, and the economic performance in countries that fit the pulp market economic and sustainability criteria. Unlike previous studies, we employed three indexes – the revealed comparative advantage (RCA) index, revealed symmetric comparative advantage (RSCA) index, and the trade balance index (TBI), to determine, respectively, the comparative advantages between countries and the specialization of a country in imports or exports in the context of wood pulp production. These indexes have desirable properties: simple to understand; statistical quantification and coherent logic; and communicate efficiently the state of the phenomenon observed (Mueller et al., 1997; Siche et al., 2007, p. 139).

We selected six countries for this analysis based on their prominence in the production of wood pulp: USA, Brazil, Canada, Sweden, Finland and China. The remainder of this paper is as follows. Section 2 discusses the forest sector in the selected countries. Section 3 illustrates the different comparative indexes employed in this analysis. The results and discussion of this study are presented in Sections 4 and 5. Finally, we offer concluding remarks.

2. Forestry sector of selected countries for pulp production

According to United Nations Food and Agriculture Organizations (FAO), the world's forest cover is approximately 4 billion hectares (FAO, 2017). The five countries with the highest forest area are, in order, Russia, Brazil, Canada, the United States and China. Together, they account for over 54% of the world's forest area (FAO, 2017). Of this coverage, Table 1 shows the comparison of countries worldwide that are classified as the largest producers of wood pulp with the highest native cover and area of planted forests, as well as certified forest area.

Table 1 also shows that in North America, certified hectares represent 40.13% of the total certified area in the world. Canada is the country with the highest certified area (54.5 million ha) and the United States has the highest number of certified forests (103) in North America, representing 13.5 million ha. (FSC, 2018). In South America, Brazil has the largest area of native forest (493.5 million ha) and a certified forest area of 6.6 million ha, with 119 certificates issued (FSC, 2018). Brazil has a significant number of certificates, which may be expected given their large share of forest products in international markets (FSC, 2018). The European continent has the largest number of certified hectares, representing 40.75% of all certified areas in the

Table 1

World comparison of native cover area and planted forest area.

Source: Prepared by the authors from FAOSTAT/FSC (2018) data.

Country	Native cover area [ha]	Planted forest area [ha]	Wood pulp produced [ton]	Certified forest area [ha]	Number of certificates
United States	310,095.00	26,364.00	49,534.43	13,560.39	103
Brazil	493,538.00	7736.00	19,409.00	6601.91	119
Canada	347,069.00	15,784.00	17,080.00	54,586.67	62
Sweden	28,073.00	13,737.00	11,568.74	12,239.37	22
Finland	22,218.00	6775.00	10,920.00	1611.18	8
China	208,321.00	78,982.00	10,639.20	1112.37	75

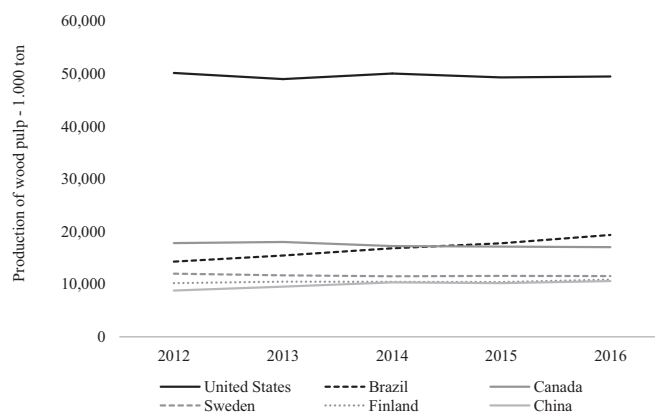


Fig. 1. Largest producers of wood pulp in the world [1000 tons] from 2012 to 2016.

world. Finland has a certified forest area of 1.6 million ha – about 7% of the total forest area in the country – and Sweden stands out with a certified area of 12.2 million ha, or 44% of the total area. (FSC, 2018).

The Chinese government recently adopted a new forest policy that aims to reforest areas that are deemed more ecologically sensitive for protecting native species and remaining natural forests (Zhang et al., 2000). Asia currently has just 2.95% of the total certified areas in the world, and China has the largest certified area on the continent, with 1.1 million ha and 75 certified forests (FSC, 2018).

Among the existing aggregates in the forestry sector, pulp is responsible for most of the wood consumption with great energy potential. Fig. 1 shows the largest pulp producers in the world. Notably, the global pulp supply market is largely supplied by eucalyptus and pine as the principal raw materials for pulp production.

In the United States, forest products are diversified, and the country is a major supplier of timber products to local and foreign markets. With just 5% of the world's population, the USA consumes an estimated 28% of the world's industrial timber products, of which 96% originates in the USA (USDA, 2015). The consumption of forest biomass for power generation has decreased during the last few years. Despite recent declines, however, energy derived from wood plays an important role in USA forested regions and continues to constitute approximately 2% of the country's total energy consumption (USDA, 2015). In 2011, the sector recovered 66.8% of the paper consumed and was the main generator and consumer of renewable energy (USDA, 2015).

In Brazil, 7.8 million hectares of trees planted with eucalyptus, pine and other species (acacia, araucaria, paricá and teak), and the paper and pulp sector represent 32% of this segment (IBÁ, 2015). Eucalyptus plantations occupy 5.56 million ha of the area planted in the country, representing 71.9% of the total area. Brazil contributed a little > 3% to the forest products world market (US \$230 billion in 2015) (FAO, 2017). However, among the forest products, the pulp and paper chain are very competitive in Brazil, especially the production of hardwood pulp. The demand for pulp is strongly influenced by the performance of the world market, since more than half of the sector's production is destined for foreign markets (EPE, 2015).

Exports of forest products are significant contributors to the Brazilian economy, representing more than US \$10 billion in 2015, with a positive trade balance of US \$4.9 billion. Among forest product exports, there was a trend toward dominance of short fiber pulp from eucalyptus (CNI, 2016). The global success of the Brazilian forestry industry is a result of the high productivity of their planted forests. In 2014, Brazil led the world in forest productivity: the average productivity of Brazilian eucalyptus plantations reached 39m³/ha/year and the productivity of pine plantations was 31m³/ha/year (IBA, 2015).

While only 6% of Canadian forests are privately owned, they

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