

**UNCTAD Multiyear Expert Meeting on Transport,
Trade Logistics and Trade Facilitation**

21-23 November 2018, Geneva

**“Sustainable freight transport in support
of the 2030 Agenda for Sustainable
Development”**

**Impact of carbon reduction policies on
international maritime transport**

**contributions to the sustainability and competitiveness
of Brazilian foreign trade**

by

**Andre F. P. Lucena
Energy Planning Program**



COPPE

Alberto Luiz Coimbra Institute for Graduate Studies and Engineering Research



Impact of carbon reduction policies on international maritime transport

contributions to the sustainability and competitiveness of Brazilian foreign trade

Energy Planning Program
PPE
Rio de Janeiro

Andre F. P. Lucena

2018

Team

PPE | COPPE | UFRJ



Professors



Alexandre Szklo



André Lucena



Roberto Schaeffer

Researchers

- Régis Rathmann** (DSc.)
- Bruno Cunha** (MSc)
- Camila Ludovique** (MSc)
- Eduardo Casseres** (MSc)
- Marcella Freitas** (Eng.)
- Francielle Carvalho** (MSc)





1

Brazilian Exports

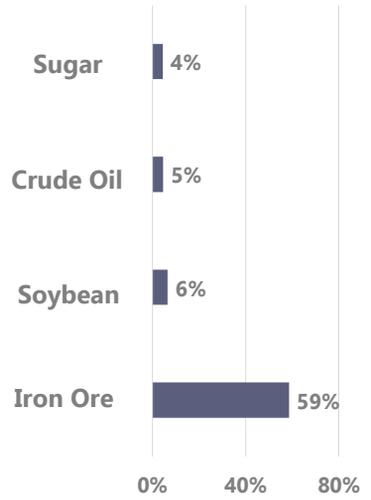
Characterization of the main products, ports and markets

The 4 main products

Brazilian Exports (net Kg)



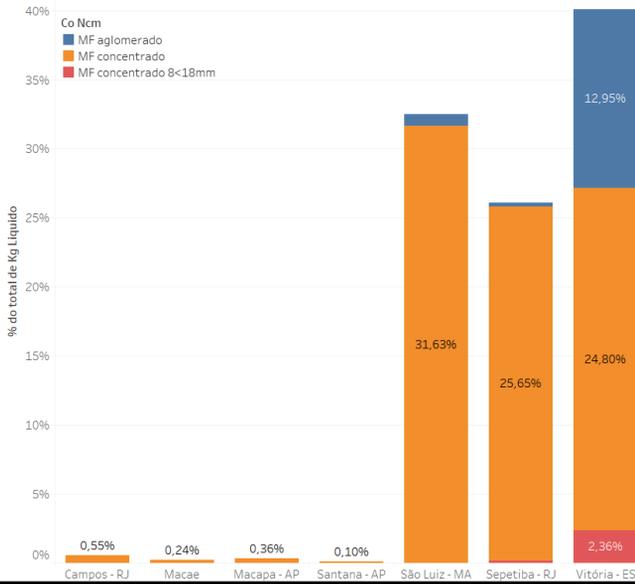
Main Products



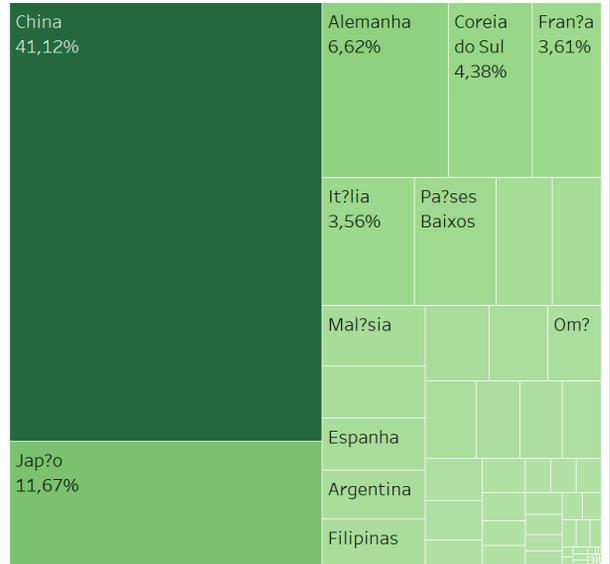
Source: Aliceweb, February of 2018

Iron Ore: from where to where?

Main Exporting Ports

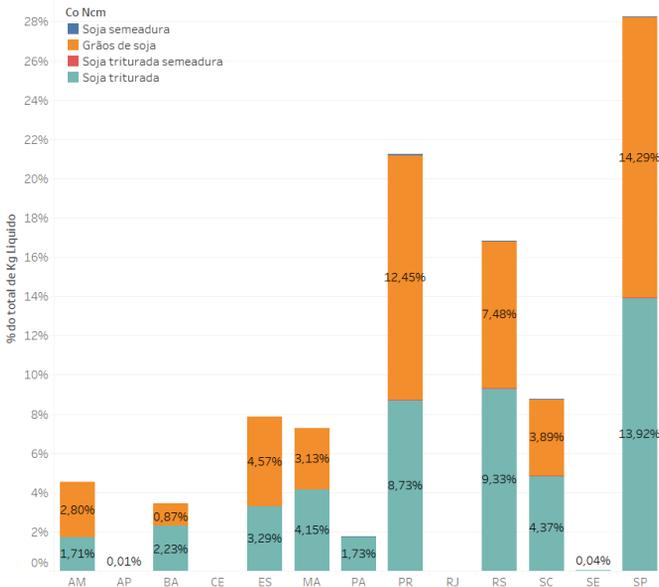


Main Importing Countries

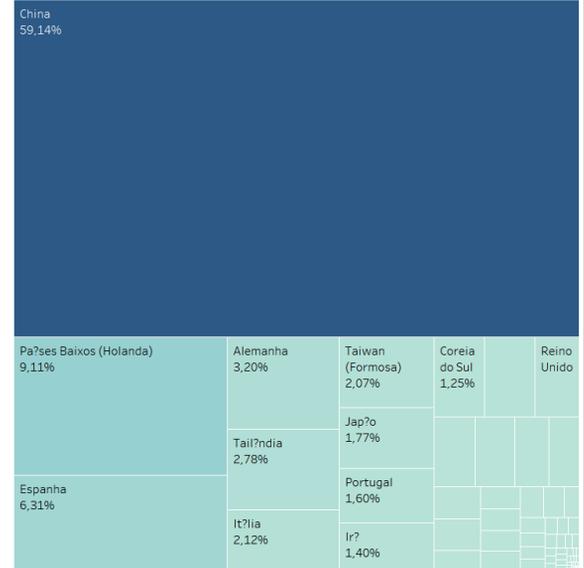


Soybean: from where to where?

Main Exporting Ports

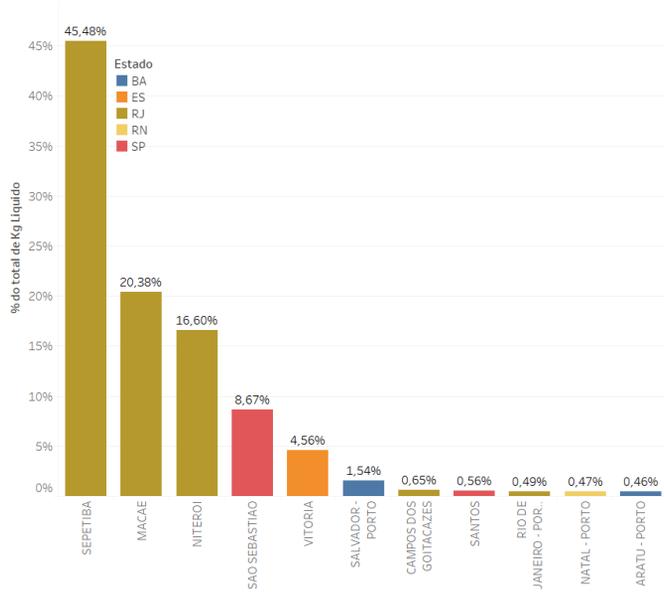


Main Importing Countries

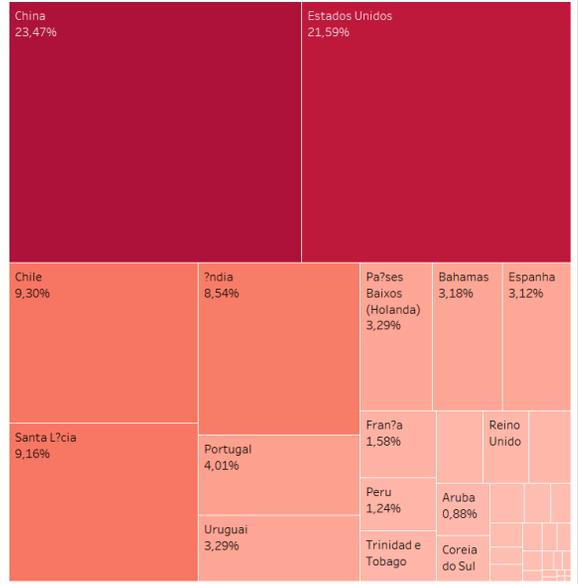


Crude Oil: from where to where?

Main Exporting Ports

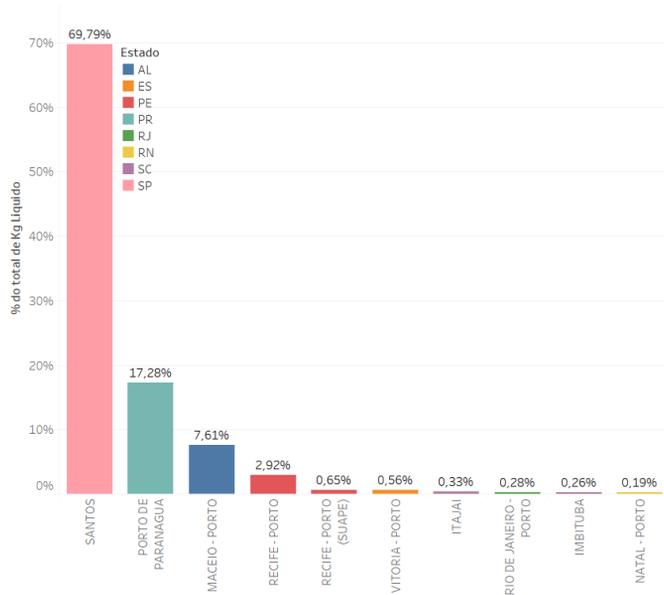


Main Importing Countries

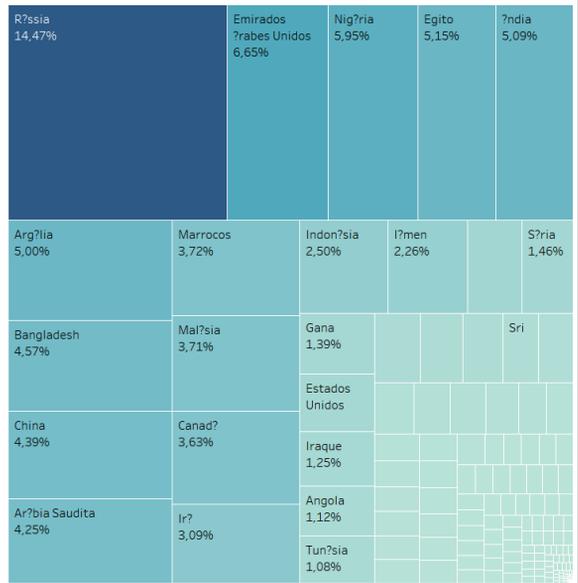


Sugar: from where to where?

Main Exporting Ports



Main Importing Countries



2



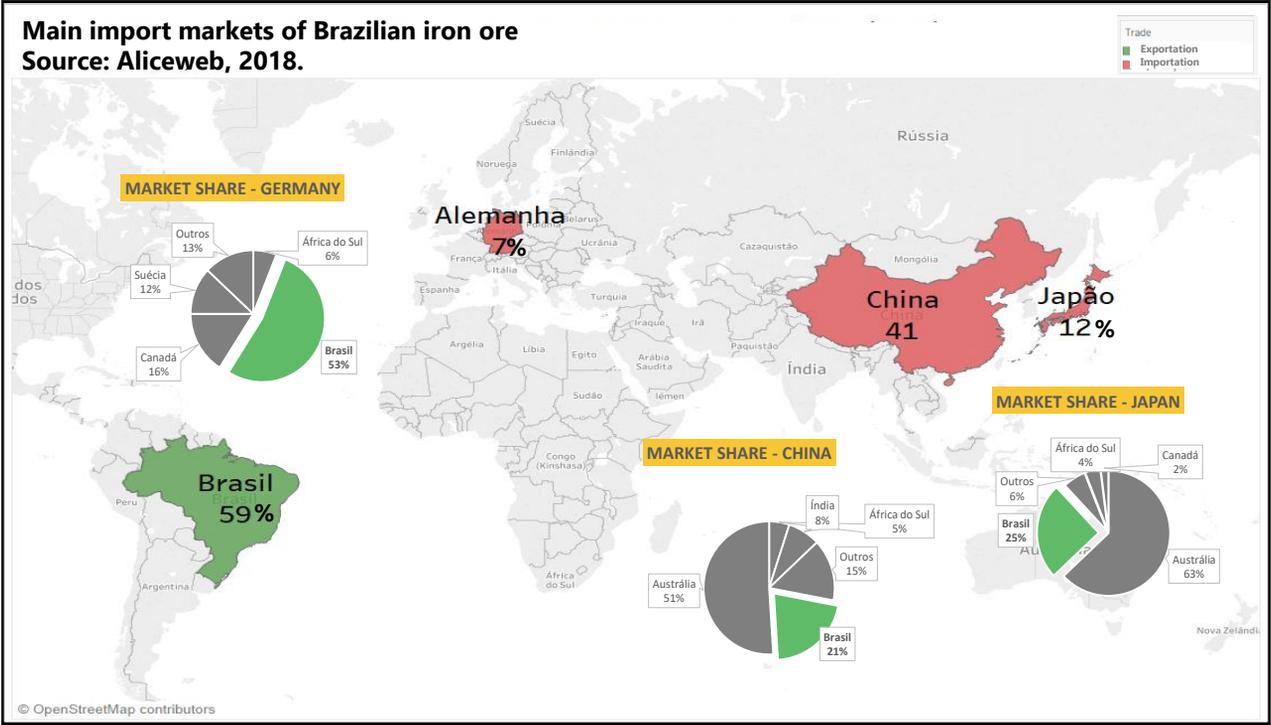
Technical-economic characterization

In this section, the main products, routes, competitors, level of activity and intensity of CO₂ emissions are characterized.

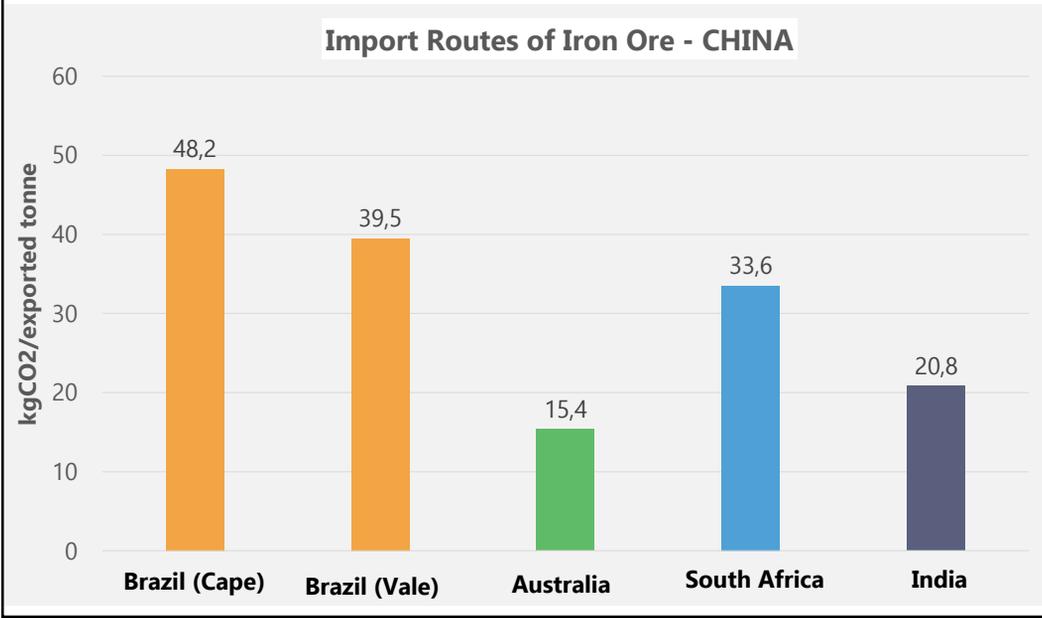


2.1 Iron Ore

Characterization of the main routes, competitors, level of activity and CO₂ emissions



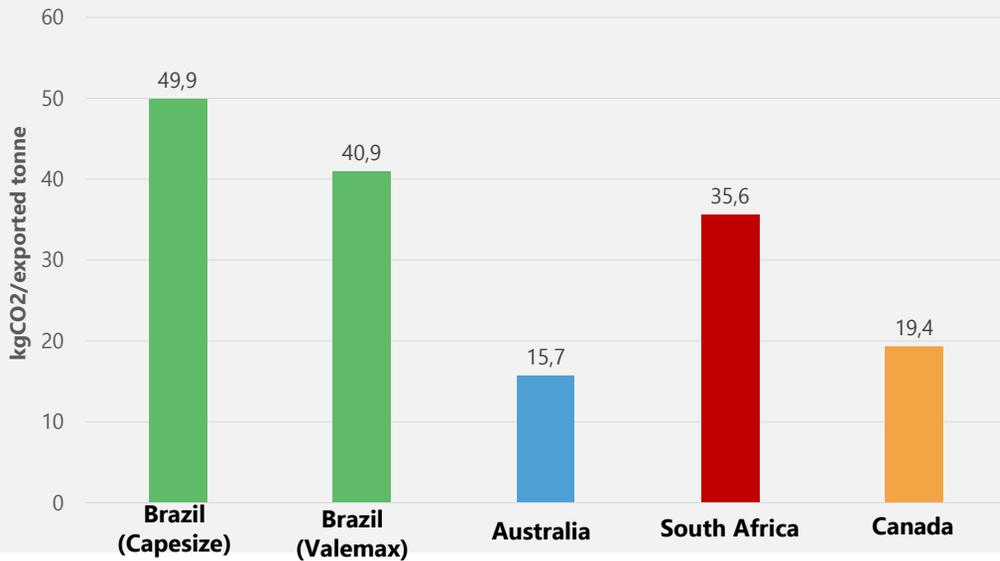
Emissions per exported tonne



Despite the scale gain provided by Valemax, CO₂ emissions per ton are **3 times higher** than its main competitor, Australia

Emissions per exported tonne

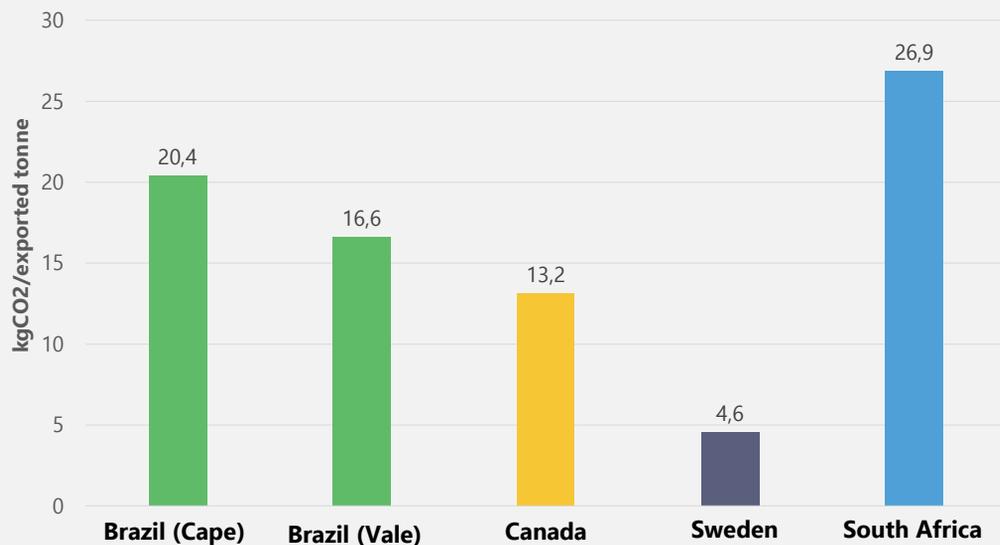
Import routes of iron ore - Japan



Brazil is biggest emitter per ton transported to the Japanese market. In a competitive analysis of location, the country would be the most affected by emissions restrictions.

Emissions per exported tonne

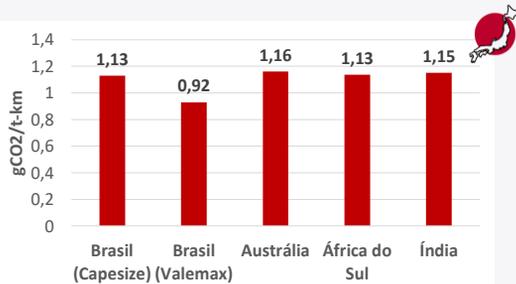
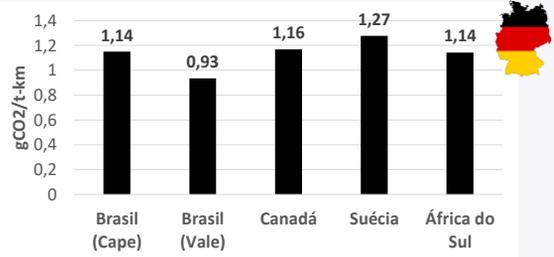
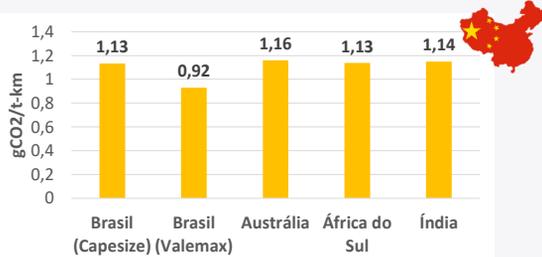
Import route of iron ore - Germany



Brazil accounts for almost 70% of imports in the German market, with emissions per ton about 15-35% higher than Canada, its main competitor

What if ... we compare only by intensity?

The goal is to evaluate how the carbon emission intensities would be compared with an indicator that considers the locational factor (km traveled) in the analysis



Brazil stands out, since it has vessels of lower emission intensity, the Valemax. Therefore, the tkm-based indicator would reflect the freight profile and the efficiency of the transport, without penalizing markets that are further away from the large consumer centers.



2.2 Crude Oil

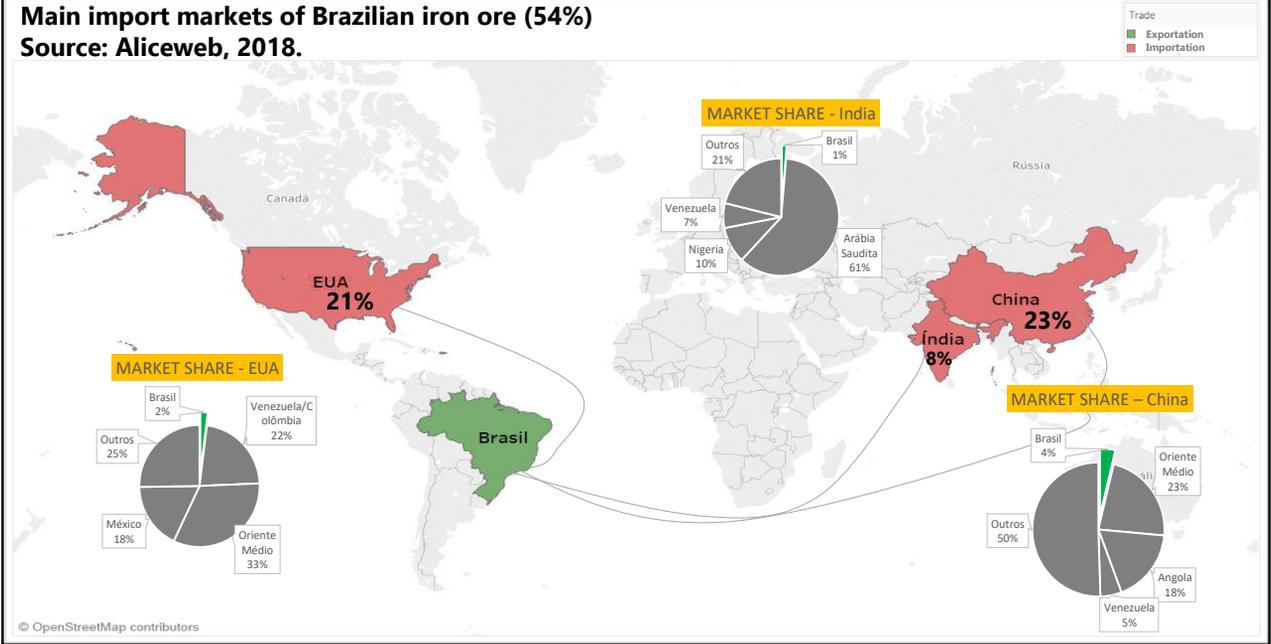
Characterization of the main routes, competitors, level of activity and CO₂ emissions



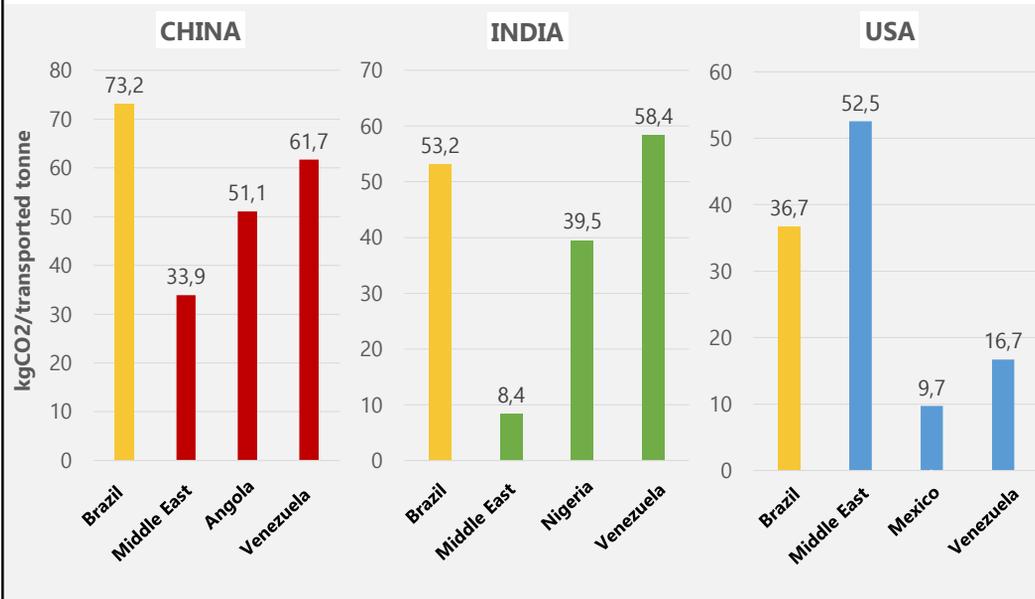
Main import markets for Brazilian oil

Main import markets of Brazilian iron ore (54%)

Source: Aliceweb, 2018.



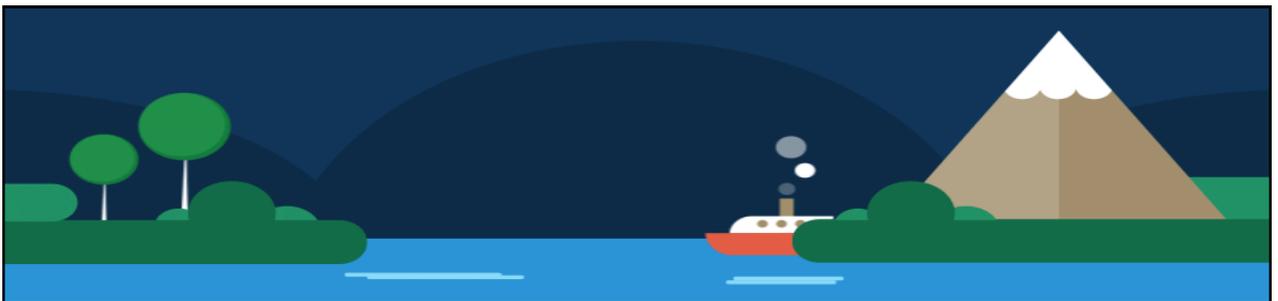
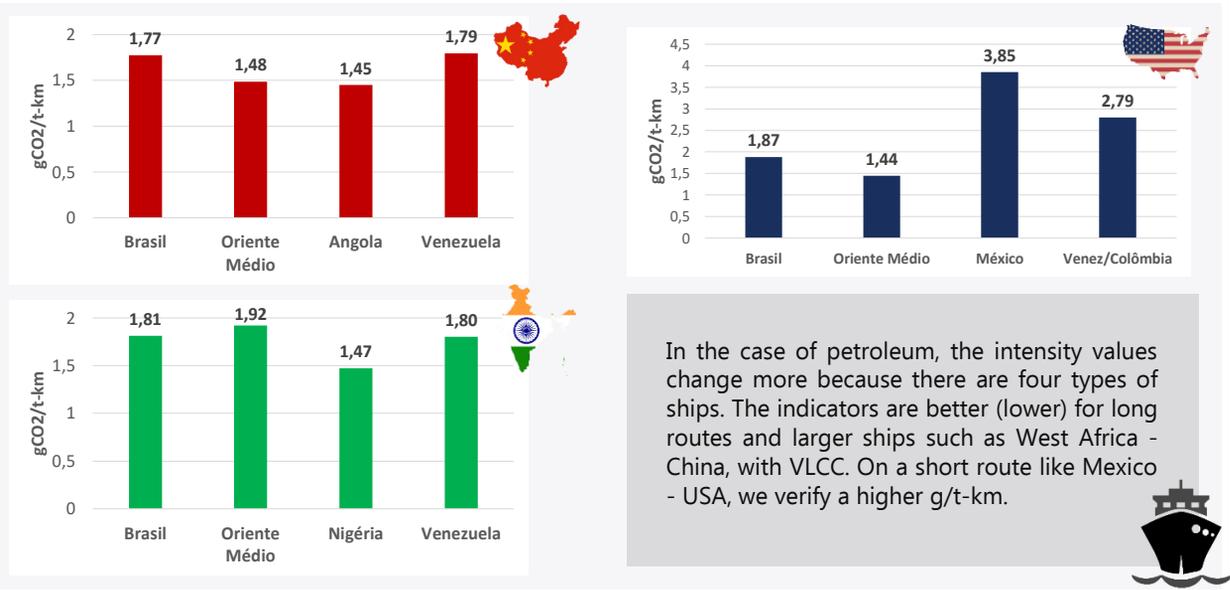
Emissions per exported tonne



Brazil is the least competitive in the Asian markets and has some geographical advantages in relation to the American market.

What if ... we compare only by intensity?

The goal is to evaluate how the carbon emission intensities would be compared with an indicator that considers the locational factor (km traveled) in the analysis

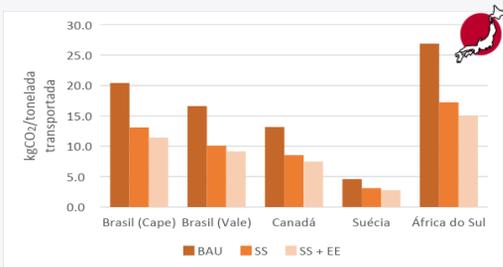
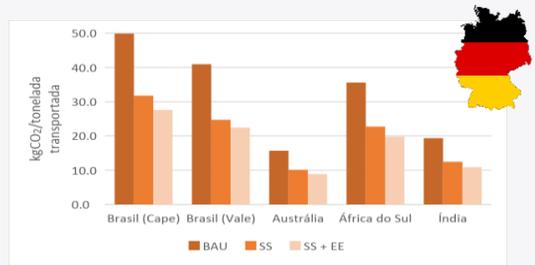
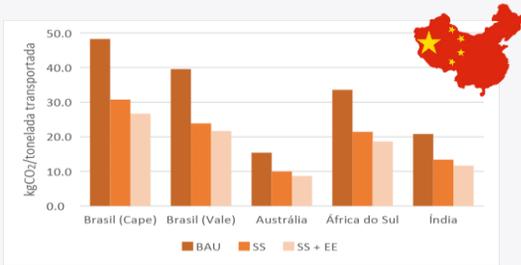


3 Measures to reduce energy consumption of vessels in operation

1. *Slow Steaming*
2. Other Energy Efficiency Measures

Iron Ore

Average CO2 emissions of the main iron ore exporting countries in the main Chinese, Japanese and German markets in 2017 for BAU, SS and SS + EE cases

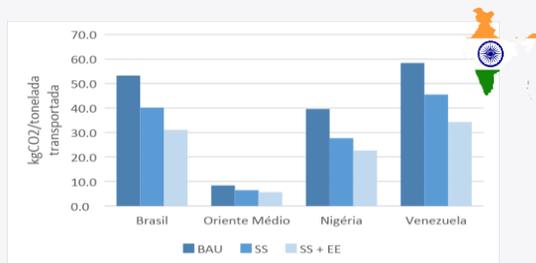
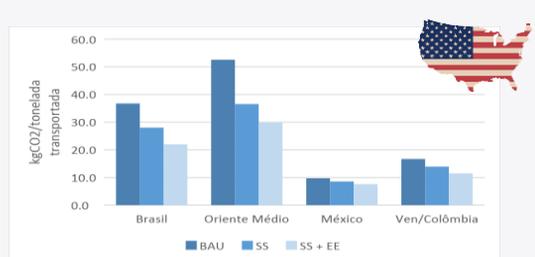
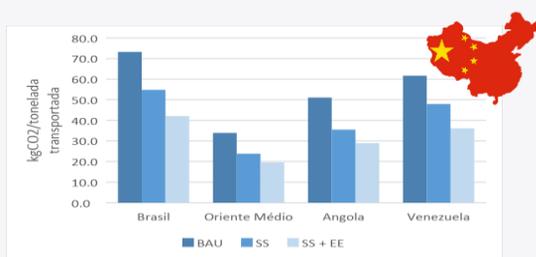


It is verified that a significant reduction of the carbon intensity occurs when adopting a regime of slow steaming (SS), in average 36% in relation to the case BAU. The effect of energy efficiency (SS + EE case) leads to an additional reduction of approximately 9% of CO2 intensity.



Crude Oil

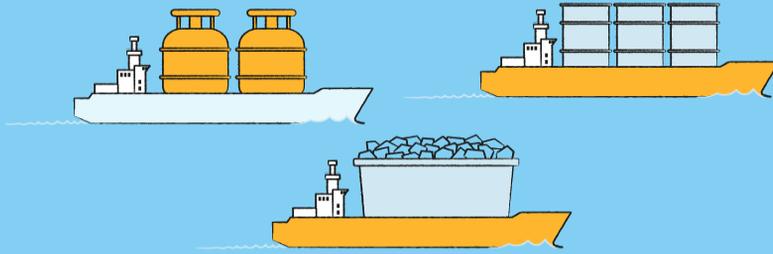
Average CO2 emissions from the main oil-exporting countries in the main Chinese, Indian and American markets in 2017 for BAU, SS and SS + EE cases



The intensity in the SS case is, on average, 27% lower in relation to the BAU case, due to the fact that the emissions of engines and boilers are more significant in oil tankers. The effect of energy efficiency (SS + EE case) leads to an additional reduction of approximately 12% of CO2 intensity.



4



Biofuel Requirement to achieve IMO's target

Growth Scenarios

How much will maritime trade grow?

In order to realize projections of future fuel demand, it was necessary to establish a market growth scenario

Projeções para o desenvolvimento do comércio marítimo (2016-2030)			
	Taxa de crescimento	Ano	Fluxo do comércio marítimo
Lloyd's List Intelligence	3,1	2017-2026	Comércio marítimo
	4,6	2017-2026	Comércio por containers
	3,6	2017-2026	Comércio de granéis sólidos
	2,5	2017-2026	Comércio de granéis líquidos
IHS Markit	Fator de 2,7	2016-2030	Comércio Marítimo
UNCTAD	3,2	2017-2022	Comércio Marítimo
	5,0	2017-2022	Comércio por containers
	5,6	2017-2022	Comércio dos 5 principais granéis sólidos
	1,2	2017-2022	Óleo bruto
	1,7	2017-2022	Derivados de petróleo e gás

Source: Adapted from UNCTAD (2017)

0%

Low Growth Scenario (CB):

stabilization of international trade and maintenance of export levels of the products under consideration, ie without annual growth in the tonne transported.

1.5%

Medium Growth Scenario (CM):

increase of 1.5% a.a. in tonne transported. This scenario is in line with global export growth levels in recent years (1.4% in 2015 and 1.7% in 2016).

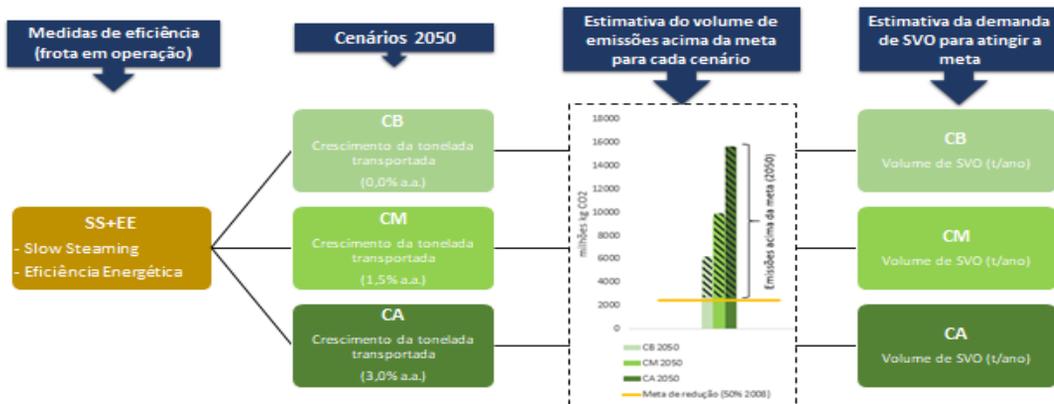
3%

Accelerated Growth (AC) scenario:

growth in the transported ton of 3.0% a.a. This scenario represents a conservative estimate, when compared to the projections presented in the table opposite and compatible with the annual average recorded in the last four decades.

Methodology

In addition to the energy efficiency measures presented in the previous chapter, this study evaluated the use of biofuels in maritime transport, aiming at meeting the goals defined by the IMO in the year 2050.



Next, the amount of biofuel required in 2050 was determined for each scenario to meet the IMO goal, considering the export routes evaluated and discussed previously.



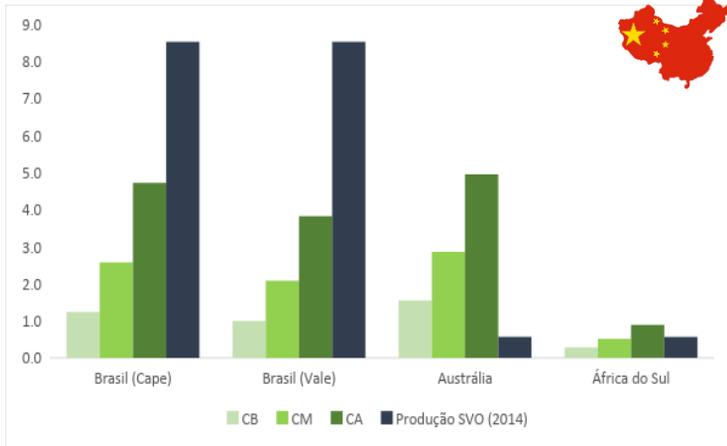
What is the demand for biofuel from soybean oil (SVO) so that Brazil and its competitors reach the emissions target defined by the IMO for the year 2050 in the routes considered?

What is the SVO availability from each country?

This section presents the results for the CB, CM and CA scenarios for the routes of the main Brazilian export products, including their main competitors.

Results for Iron Ore Demand and Supply of Biofuels

Comparison between supply in 2014 and estimated SVO biofuel demand in 2050 of the main iron ore exporting countries to China for the CB, CM and CA scenarios

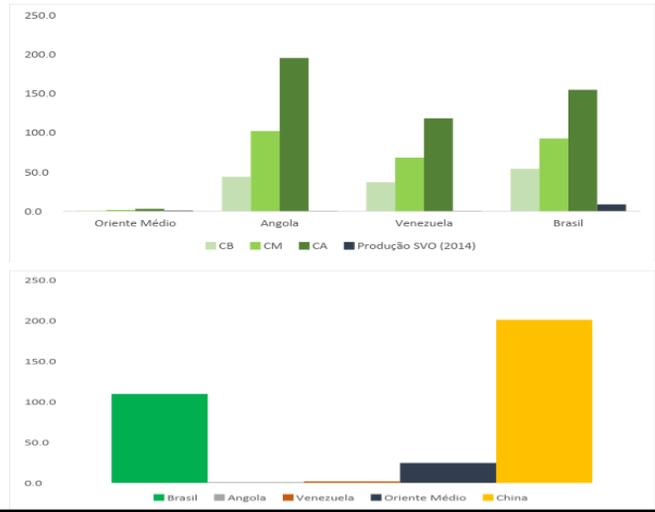


India was the only competitor to submit CO2 emissions within the IMO target set in 2050, without the need to use biofuels. The results for Brazil are presented for the two types of vessels: Capesize (Cape) and Valemax (Vale). It is noted that the demand for biofuel of the Brazilian route with Capesize type ships is on the same levels of the Australian route, its main competitor. Considering Valemax-type ships, Brazil has a certain advantage over its largest competitor, because it requires less biofuel in all the scenarios considered.

Note 1: Cape: Capesize vessel; Vale: Valemax vessel.
 Note 2: CB: low growth; CM: moderate growth; CA: High growth.

Results for Crude Oil Demand and Supply of Biofuels

Comparison between supply in 2014 and demand for SVO biofuel estimated in 2050 from the main crude oil exporting countries to China for CB, CM and CA scenarios; and, Supply of SVO biofuel from the main crude oil exporting countries to China, including, between 2004 and 2014



Angola is the exporter that demands the largest quantities of SVO for biofuel scenarios. The Middle East has a much lower demand than other competitors, and for this reason the data is barely visible. The advantage of Brazil over other competitors is noted. Although the demand for SVO is very high in the scenarios considered, the country stands out among the others for its superior production. Thus, Brazil would be the competitor with the highest potential to reduce emissions using biofuels on the oil export routes to China.

5

Impacts on Brazilian economy

The objective of this section is to measure impacts on costs, profitability and GDP resulting from international shipping policies on CO₂ mitigation.



Biofuels Options

How much is it?

In relation to the price, the use of soybean oil implies an additional cost for the sector, since it is a product of higher value and, therefore, with prices higher than conventional fuel (HFO).

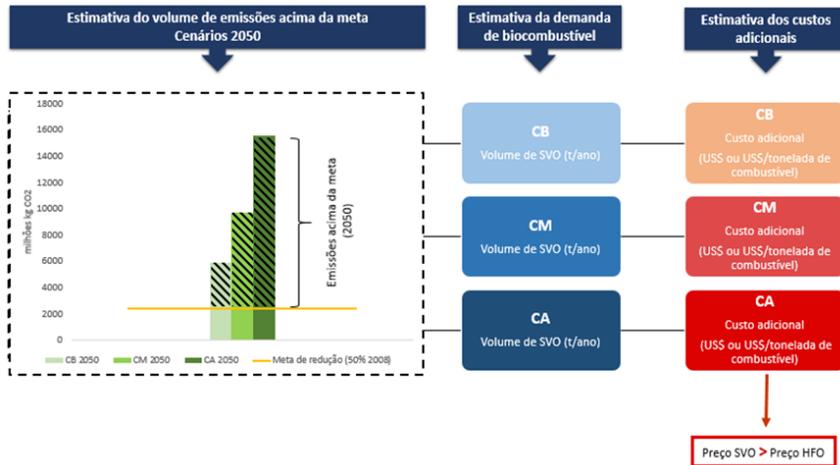


Price evolution of soybean oil (SVO) and traditional HFO fuel between 2014 and 2018

For fair competition between SVO and conventional fuels, it would be necessary to implement MBMs, such as emission pricing. Given the price difference presented above, it was estimated that ceteris paribus only one carbon price of at least US \$ 152 / tCO₂, would make SVOs competitive in the shipping industry.

Estimated additional cost for biofuel SVO

This section presents estimates of additional cost in the year 2050 for the use of biofuel in export routes of the main Brazilian products in each scenario evaluated. The results obtained will be used to evaluate the impact of the variation of fuel cost on the input-output matrix.



The cost change was calculated in 2050 per tonne of fuel used for all countries in all the scenarios considered. For the calculations, SVO and HFO price data for April 2018 (BIX, 2018 and INDEXMUNDI, 2018) were used.

Methodological procedures



Model

- Update of the input-output matrix (MIP) for 2017, from the National Accounts by the RAS method.
- Projection of MIP up to 2050, from the economic scenario FIPE III (Mitigation Options Project).¹



Scenarios

- International trade growth scenarios: CB, CM and CA.
- Products analyzed: iron ore, petroleum and soy.
- Sugar exports are not impacted by the cost of replacing the fuel.
- Route analyzed: Brazil-China.



Parameters measured

- Economic aggregates analyzed: costs, profitability and sectorial GDP.
- Impact transmission hypotheses: producer and final consumer.



Economic Impacts - 2050



Producer transmission hypothesis

Impact on costs by sector	CB ^{0%}	CM ^{1.5%}	CA ^{3%}
Iron ore	6,5%	13,6%	24,9%
Crude Oil	17,3%	29,7%	49,7%
Soybean	0,7%	1,5%	2,5%
Impact on industry profitability	CB	CM	CA
Iron ore	-3,4%	-7,2%	-13,1%
Crude Oil	-71,8%	-81,4%	-93,7%
Soybean	-0,6%	-1,1%	-1,9%
Impact on total GDP in 2050	CB	CM	CA
Brazil	-1,6%	-2,8%	-4,7%



Economic Impacts - 2050



Hypothesis of transmission to the final consumer

Impact on costs by sector	CB ^{0%}	CM ^{1.5%}	CA ^{3%}
Iron ore	5,1%	10,7	19,7%
Crude Oil	13,7%	23,5%	39,2%
Soybean	0,6%	1,1%	2,0%
Impact on industry profitability	CB	CM	CA
Iron ore	-2,4%	-4,7%	-8,3%
Crude Oil	-49,5%	-53,7%	-59,0%
Soybean	-0,4%	-0,7%	-1,2%
Impact on total GDP in 2050	CB	CM	CA
Brazil	-1,1%	-1,8%	-2,8%



Economic Impacts



Hypothesis of transmission to the final consumer

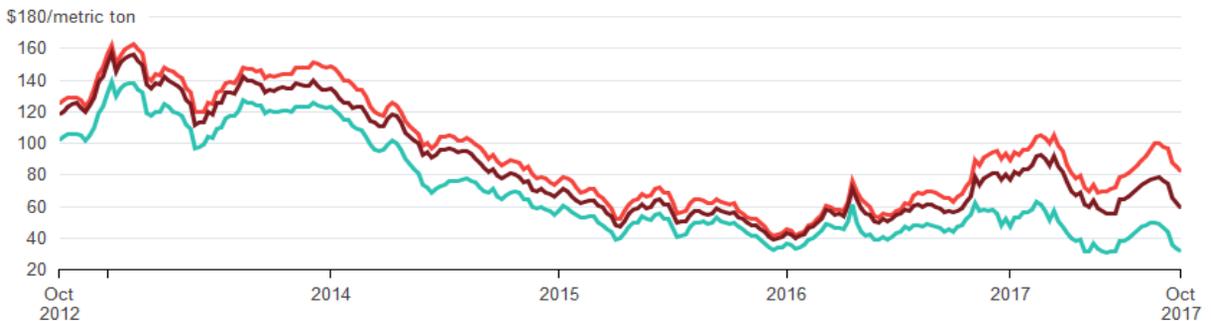
The transfer to consumers would allow the loss of export profitability to be reduced in any growth of maritime transport. However, in the case of oil, the transmission of part of the over-cost to final consumers would not be enough to rebalance the industry's margins.



Reserve Price of Brazilian Mineral Products

The unique quality of the Carajás **iron ore** province gives it benefits that no other commodity of its kind has, which has led the international price market to create a own index to give value to the mineral resources of Pará

● Brazil-China 65% ● Australia-China 62% ● India-China 58%-59%



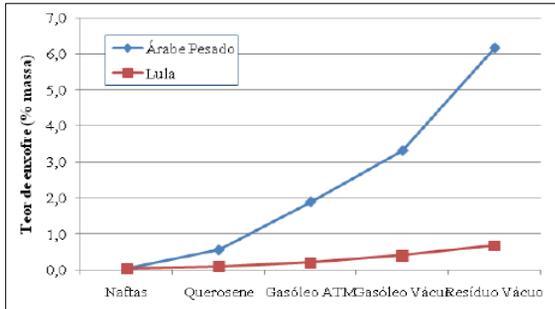
International quotation of iron ore
Source: BLOOMBERG (2017)

Comparando o minério de ferro indiano de menor qualidade (58% a 59%) com os melhores minérios brasileiros (65%), a diferença encontrada era de cerca de um terço ou 30%. Porém, nos últimos 2 anos está diferença disparou para cerca de 160% (BLOOMBERG, 2017).

Reserve Price of Brazilian Mineral Products

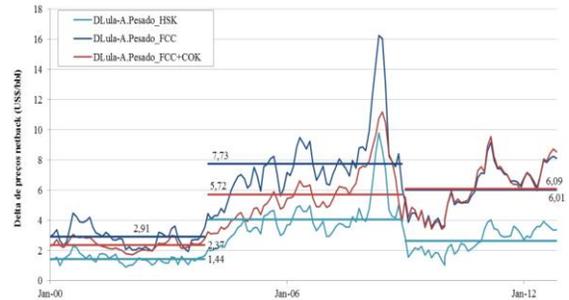
In addition to the difficulty in meeting its growing demand for **oil**, recent episodes of local pollution at levels of high toxicity to the population have forced a sharp increase in the specification of derivatives in China.

China has been seeking more and more low-sulfur oils, which explains in part the interest and recent investments made in Brazilian fields, such as the participation in the Libra field consortium (MME, 2013).



Presence of sulfur in fractions - comparison between Heavy Arabi and Lula
Source: OHARA (2014)

Lula's premium on heavy Arabi in the Chinese market is due mainly to the large difference in sulfur content between the two oils (OHARA, 2014).



Differences between the netback prices of Lula and Heavy Petroleum for 3 types of refinery configuration (hydroskimming, cracking and coking)
Source: Ohara (2014)



Differential quality income of Brazilian iron ore and crude oil



price premium

Conservatively, it is assumed the maintenance of the current average premium in 2050.

The case of iron ore:

- Together with the transfer of part of the extra cost to the final consumer, they significantly reduce the impact on the profitability of the sector.
- In the CA scenario, the decline in the industry margin would be approximately 6%, lower than the gains observed in China's iron ore futures contracts in 2017 alone, which were 7% (MINING, 2018).

The case of oil:

- It indicates the need for the implementation of compensatory mechanisms aimed at protecting the competitiveness of the sector.
- Even with the transmission of part of the impact to the final consumers and premium paid to the national oil in the Asian market, the fall in profitability would be significant, which is 45% and 50% among the growth scenarios of international maritime freight.



Economic Impacts - 2050



Hypothesis of transmission to the final consumer and incorporation of quality income effect

Impact on costs by sector	CB 0%	CM 1,5%	CA 3%
Iron ore	3,6%	7,5%	13,8%
Crude Oil	12,3%	20,9%	34,5%
Impact on industry profitability	CB	CM	CA
Iron ore	-1,7%	-3,3%	-5,8%
Crude Oil	-44,6%	-45,7%	-50,2%
Impact on total GDP in 2050	CB	CM	CA
Brazil	-1,0%	-1,7%	-2,5%

Thank you!

Contact

@ andrelucena@ppe.ufrj.br

+55 21 3938-8777

+55 21 3938-8760

