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MARKET POWER IN MARITIME TRANSPORT OF BRAZILIAN IMPORTS

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Dissertação apresentada à escola de Economia de São Paulo da Fundação Getúlio Vargas, como requisito para obtenção do título de Mestre em Economia.

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Orientador: Prof. Dr. Lucas Ferraz

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RESUMO

O poder de mercado está presente na indústria de transporte marítimo à medida que as transportadoras conseguem cobrar fretes acima de seus custos marginais devido à presença de variáveis relacionadas ao *mark-up* – elasticidades de importação, baixa competição nas rotas comerciais e tarifas de importação. O presente trabalho apresenta estimativas feitas por MQO e por efeitos fixos para os impactos de cada variável relacionada ao *mark-up* nos fretes no Brasil, além de apresentar alguns *insights* sobre as fontes de poder de mercado nos diferentes setores econômicos e para cada parceiro comercial. As tarifas parecem exercer o papel mais importante em permitir fretes mais elevados, apesar de todas as variáveis apresentadas também importarem. As elasticidades de importação têm impacto negativo no poder de mercado, e seus coeficientes são bastante significativos para os bens industriais. O número de transportadoras competindo em uma rota também tende a diminuir os fretes. Apesar de apresentar elasticidades positivas em relação aos fretes para todos os setores, as distâncias apenas são definitivas para os fretes das importações de produtos agrícolas.

Palavras-chave: Fretes marítimos; Fretes; Mercadorias; Expedição; Importação.

ABSTRACT

Market power is present in shipping industry as carriers are able to charge freights above their marginal costs due to presence of markup related variables – import elasticities, low competition among trade routes and import tariffs. The present work presents OLS and fixed effects estimations for the impact of each markup related variables for freights in Brazil, as well as some insight about the sources of market power across economic sectors and trade partners. Tariffs seem to play the most important role in enabling higher freights, although all other variables are shown to also matter. Import elasticities have a negative impact on market power, and their coefficients are very significant for industrial goods. The number of carriers competing on a route also tends to diminish freights. Despite showing positive elasticity to freights in all sectors, distances are only definite for import freights of agricultural products.

Keywords: Maritime freights; Freights; Merchandise; Expedition; Imports.

SUMMARY

1. INTRODUCTION

Shipping costs are currently on the spotlight of trade discussions, as competition among shippers and infrastructure differences become more important every day. The decreasing trend of import tariffs worldwide, especially after the 1990s, alongside with increasing capacity in shipping industry have brought to light that other factors, besides those related to marginal costs of shipping and tariffs, are determinant to freight prices.

Recent research have demonstrated shipping companies charge markup margins over their marginal costs, and their ability to do it depend on some key product and industry specificities. This work aims at detecting importance of (1) competition among shippers along trade routes, (2) import demand elasticities and (3) import tariffs for market power among shippers for the case of Brazil in 2016. Besides finding evidence that supports our hypothesis of the presence of market power, we tried to exploit Brazil's specificities, in terms of imported variety of goods and origins.

Research made by David Hummels, Volodymyr Lugovskyy and Alexandre Skiba were the inspiration for this work. In 2009 they introduced a model for estimating freights – which we are going to describe and adapt for Brazilian case – and found strong evidence for the presence of market power among shipping companies for United States and Latin America.

We were successful in finding coefficients for our base estimation consistent and coherent with the theory presented, and detected an especially strong positive relation between import tariffs and markup, even though all variables also matter.

In further estimations, we found that manufactured goods' freights are more responsive to markup related variables, and that agriculture products' are less. In fact, for the latter, shipping distances matter the most for freight prices, indicative of lower market power in this sector. We also found even higher coefficients for tariffs in American products, which we believe has to do with imported varieties from this origin and tariffs applied on these.

This work is divided in three parts, besides this introduction and conclusion. In section 2 we contextualize the issue of transport costs for trade, as well as the importance of tariffs for them in Brazilian case. Section 3 presents the theoretical framework to address the questions about what determines shipping costs in Brazil.

Further on this section we propose an econometric model in accordance to that theory and perform a series of regressions on it. We also present the estimates results in this section, as well as some robustness checks. Still in section 3, we rerun our regression test for heterogeneity at both sector and regional levels. In the end explore the presence of market power by estimating markups for each country-product pair in our sample, and then divide these results into 42 sectors to draw some conclusions.

2. LITERATURE REVIEW

For as long as economics has been studied, trade seems to play an essential role in growth. The exchange of goods among specialized producers, which allows for gains of efficiency, although being the source of economic growth, has been much discussed, since the behavior of each country's trade balance depends on a host of other factors. Specificities such as geographical location, industrialization degree, climate, education, population age, income distribution, taxation, market structure are all determinants to trade, and have the potential, therefore, to benefit or harm a country's potential trade gains.

The study of shipping costs, its determinants and its implications is still an incipient subject considering the vast literature on international trade. Limão and Venables (1999), in one of the pioneer studies of that matter, relate transport costs to geographic and infrastructure variables using two different data sources. When analyzing transport of a uniform commodity from Baltimore to 64 different destinations, they find that distances are important in determining costs, and that increases in land distance cost 7 times more than equivalent increases in sea distances. They also find, however, that infrastructure is at least as important as distances in determining transport costs. When applying a similar model to IMF's cif/fob ratio database, that covers many countries, they find that changes in distance are statistically significant only in a very simple model that yields a low explanatory power. After controlling for some infrastructure parameters, distances lose its significance, and they conclude infrastructure matters the most.

Fink et all (2002), also aim at estimating the determinants to shipping costs, but they focus on the impact of restrictive trade policies and private anticompetitive practices on freights and run their estimates on US imports data from 59 countries in 1998. Besides confirming the positive correlation between shipping prices and distances, they find both policies and anticompetitive practices matter and have a positive impact on them, but the effect of the latter is stronger for their sample.

Hummels et al (2009) do a similar exercise, but seek for sources of market power, which enables carriers to overcharge for shipping services. In order to do that, they consider markup related variables, such as import-elasticity, tariffs and number of firms operating on each commercial route as determinants to freights. They find

strong evidence for the presence of markup in US import data from 1991-2004 and for Latin America's data from 2000.

Competition along trade routes is determinant to the presence (or absence) of markup, and is one of the biggest dilemmas in shipping industry nowadays. Data from UNCTAD's Review of Maritime Transport (2016) show that, as average vessels' capacity grow larger every year (it has tripled between 2005 and 2015), which contributes to shipping companies' competitiveness, the number of companies operating per country is shrinking (it has decreased 29% over the same period). Also, only 32% of all trade connections have 5 or more companies competing, and the most competitive *direct* trade routes (that do not require transshipments) are intraregional in Asia and Europe.

Data on competition along routes varies considerably from one source to another, but it is reasonable to conclude Brazil is not inserted among top competitive trade routes. Data from Hummels (2009), for example, finds the most competitive trade route from United States has 32 competing companies, whilst for Latin America, the maximum number of competitors in a route is 8. UNCTAD's report mentioned above shows that the most competitive *direct* trade route for Brazil (Brazil – Argentina) accounted for 23 competitors in May 2015, according to data provided by Lloyd's List Inteligence. This is less than half the number of companies competing on the top competitive route (Malaysia – Singapore), 51.

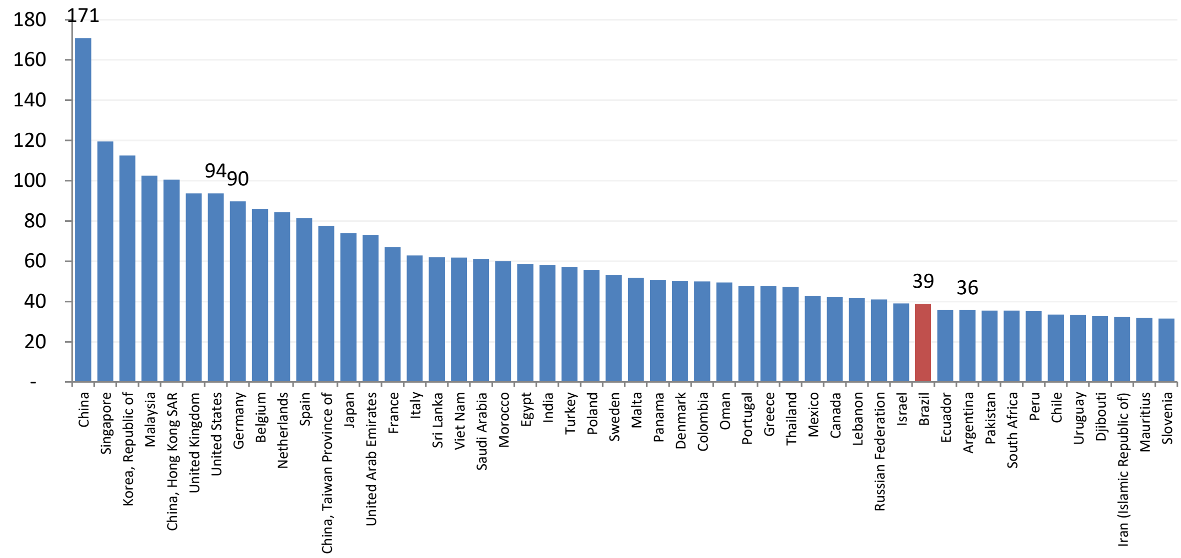
To make things worse, Brazil holds several bilateral maritime transport agreements restraining shipping from and to some of its top partners to national carriers. Since 1990, trade between Brazil and Argentina, for example, can only be conducted by national authorized companies from each country, with only very unlikely exceptions. For commerce with Chile, since 1975, and Uruguay, since 1976, restrictions are even stronger. These agreements, most of them signed during the 70's, aimed at promoting national infant maritime industries, but the observed effect was the opposite. According to Andrade (2016), route between Brazil and Chile is nowadays controlled by only two companies and employs only 8 ships, which are very few, compared to the 30 ships transporting goods between Brazil and Peru.

Messa (2017) estimated the effects of market power related variables on shipping prices, but focused on commerce between Brazil and Chile, under the above mentioned agreement. The author used data from 2002-2003 and did not only find evidence for the presence of markup charging on the average shipment to Brazil,

but also that imports coming from Chile have higher average freight rates and are much more sensitive to products elasticities (one of the determinants to markups) than other countries'. The augmented elasticity effect is also found for Argentina and Uruguay.

To illustrate the low competition among Brazil's routes, it is also valid to take a glance at UNCTAD's Liner Shipping Connectivity Index (Figure 1). Although this index incorporates other variables determinant to countries' connectivity by liner shipping[1], it holds a fairly good correlation to the number of carriers from our database.

Figure 1 – Unctad's Liner shipping connectivity index, 2016



Source: UNCTADstat

As for import demand elasticities, they are also determinant for shippers' markups and freight rates, even though shipping prices reflect them only partially. Ghodsi et al (2016) estimate import elasticities for 167 countries over all HS6 products, and find that Brazil is amongst the countries with highest import elasticities. A simple average calculation, considering only binding estimates, points at a 1.57 elasticity for Brazil. Only India and Japan exceed that number, with 1.75 and 1.73 respectively. Figure 2 shows countries with higher (light blue) and lower (dark blue) import demand elasticities.

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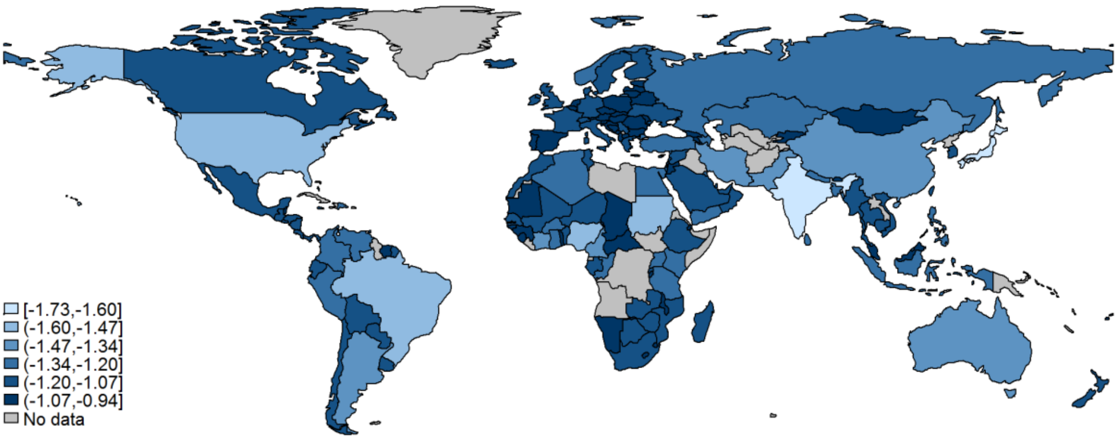
[1] According to Unctad's glossary, 'The current version of the LSCI is generated from five components: (a) the number of ships; (b) the total container-carrying capacity of those ships; (c) the maximum vessel size; (d) the number of services; and (e) the number of companies that deploy container ships on services from and to a country's ports.'

Figure 2 – Mean import demand elasticities



Source: The Vienna Institute for International Economic Studies (wiiw)

In contrast to competition along trade routes, the fact that elasticities for import demand in Brazil are on average high, can be interpreted as ‘good news’, since it implies a less ‘rigid’ demand, in the sense that consumers can satisfy their needs with other suppliers’ goods and are not always ‘stuck’ with the same ones. Also, and probably most importantly, elasticities cannot be easily influenced by policy, since they are determined by preferences.

Lastly, among the variables affecting carriers’ markups, tariffs deserve special attention, for its relative importance (and its potential damage) on Brazil’s imports. Differently from competition and elasticities, tariffs are more easily handled by policy decisions. Results from Hummels (2009) suggest not only tariffs are very determinant of freight rates, but they also affect carriers’ markups more than any other variable. For US imports, they find that high tariff products have freights 17 percent higher than low tariff ones. For Latin America, freights are 32 percent higher.

Despite theoretical framework demonstrating gains and benefits from free trade, real world not always cooperates, which is the reason why governments seem always concerned with national industries and try to protect them, either by discouraging imports or by promoting exports by subsiding them. Developing countries’ leaders worry that developed countries can produce manufactured goods more efficiently, and opening their economies might hurt their industry since they are supposedly not competitive. On the other hand, advanced economies that pay higher

wages worry that trade with underdeveloped countries might harm their living standards. (Krugman & Obstfeld pg 4)

During the 1960's and 1970's many developing countries have adopted protectionist policies, called 'import substitution policies', in order to protect their infant industries, which then proved not to work, given the inability of these economies' industries to converge. Among the restrictions imposed then, the most common were high tariffs and other non-tariff barriers such as import quotas of some products.

The 1980's and, especially, 1990's saw a wave of liberalization among developed countries, which was followed by developing countries. Many regional agreements were closed at this time, in all continents: European Community (EC), formerly European Economic Community (EEC), achieved its highest level of economic integration after the Maastricht Treaty in 1993, allowing free movement of goods, capital, services and people among EEC countries; the North American Free Trade Agreement (NAFTA) extended the free trade area (FTA) between US and Canada into Mexico; MERCOSUR, between Argentina, Brazil, Paraguay and Uruguay, not only established a FTA, but also a customs union among partners. Many other examples of trade agreements were seen in Africa, Asia and Oceania, and the trend for import tariffs went down all over the world, not only at regional level: multilateral liberalization took place as well. (World Trade Organization - World Trade Report, 2011)

World Bank data shows that average tariff rate for most favored nation (MFN) – which means the lowest tariff a country can access on another country[2]– decreased in Brazil, for instance, by almost 20% to 12.9%. Latin American tariffs followed the same trend (Clark et al). In China, weighted average tariffs in 1992 were over 32% and, by the end of that decade had been reduced to 14.5%. Looking at developed economies, US tariffs were reduced to 3%, from 4.27%, UK and European went down to 2.7% from 7.4%, and Japan, to 2.6% from 5.8%.

This generalized reduction has put in evidence the role of other trade costs, besides tariffs, that may impact on trade volumes, and that were somewhat neglected before, given the relative importance of tariffs. Nowadays, for most

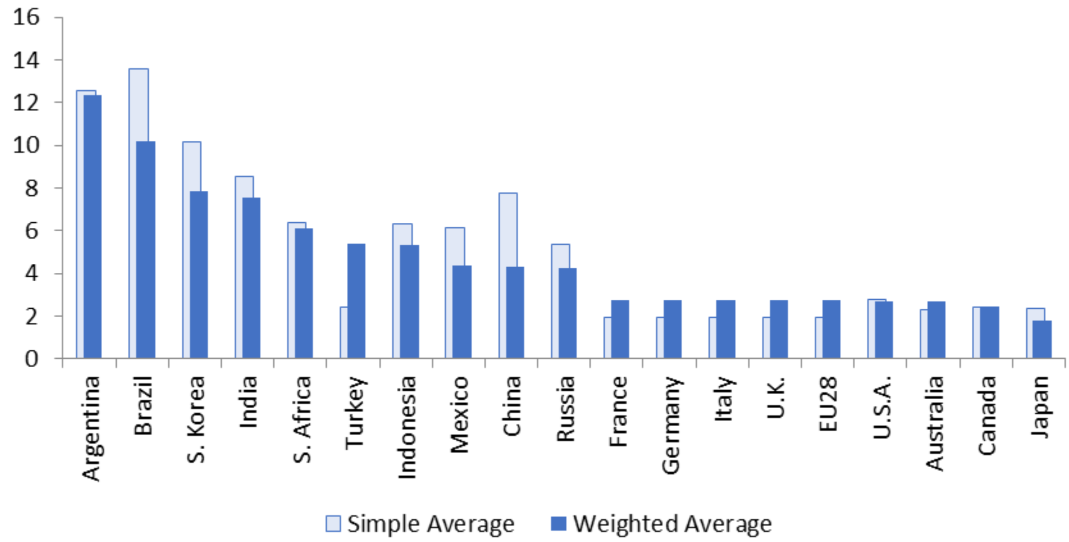
[2] https://financial-dictionary.thefreedictionary.com/MFN+Tariff

economies, shipping and handling costs are relatively more important (Clark). According to Hummels, 85% of US trade costs are attributed to freight bill.

Among Latin American economies, Paraguay's freight costs relative to total trade costs are the highest, 63%. In Brazil, as well as Argentina and Uruguay, freights still play a minor role in trade costs, around 31%.

A probable reason is that, although Brazil has indeed reduced its import tariffs during the 90s, nowadays those are still among the highest in the world. In 2016, weighted average tariffs[3] for Brazil were above 10%, granting that country the second highest average tariff among G-20 (first is Argentina). If we consider simple averages, Brazil's tariff is the highest among this group, over 13.5% (World Bank). In countries with higher tariffs, thus, not only are the tariffs themselves still relatively more important in total shipping costs, but these tariffs also impact more on freight costs. The mechanism through which tariffs are transmitted to freight costs was first explored by Hummels, and is subject to a further topic on this paper.

Figure 3 – Average Import Tariffs for G20 Economies, 2016



Source: World Bank Estimation[4]

The level of protectionism in Brazil has been theme for many studies, and many of those have aimed at estimating the impacts of an extension from

[3] Weighted accordingly to volumes imported of each commodity.

[4] World Bank staff estimates using the World Integrated Trade Solution system, based on data from United Nations Conference on Trade and Development's Trade Analysis and Information System (TRAINS) database and the World Trade Organization's (WTO) Integrated Data Base (IDB) and Consolidated Tariff Schedules (CTS) database.

MERCOSUR to European or North American Markets (i.e. to lower tariffs to other important economies and economic unions). These usually conclude that an agreement of this kind would benefit Brazilian economy and either benefit their (new) partners, or keep them at the same condition as nowadays.

Gurgel et al (2002), for example, argue that welfare is created with a FTA if the net trade creation amongst the block's members is positive, i.e. if trade creation exceeds trade diversion to non-members. That said, and using the GTAP model, they conclude that the creation of a Free Trade Area of the Americas (FTAA) would produce few positive effects both in welfare and economic growth to all countries – except for Mexico – and, especially to Brazil, would increase exports of most agricultural commodities and invigorate exports of manufactured products. In the case of the creation of 'Mercoeuro', all countries should benefit from the union, with stronger results than for FTAA.

Following the approach from Hummels, and under the notion that tariffs in Brazil are among the highest in the world, we believe that, not only do tariffs exert a relatively more important effect on final prices, but also that they have a strong impact in markups charged by carriers, which would allow for higher freights. As a consequence, final products' prices in Brazil are possibly more affected by tariffs than one would believe when neglecting presence of markup in shipping industry. Therefore, we suppose those studies of FTAA and Mercoeuro could underestimate the impact of lowering those tariffs, since they usually neglect the effects on carriers' markups.

In the subsequent sections, we apply Hummel's model to the Brazilian case, for imports in 2016, to obtain estimates for markup charged by carriers.

3. THE MODEL

Following the model presented by Hummels et Al (2009), we assume that a fixed number of identical cargo carriers compete à la Cournot among different trade routes, being able to exert market power depending on the number of competitors in each route (n). Besides n, market power is derived from the price-elasticity of import demand, which is a product specific variable and derives from its price-elasticity demand (σ) and the weight of the freight price in its final price (at destination), and tariffs (τ). To simplify our model, we consider all the costs related to shipping as the 'freight' price, since each country has its logistics' and ports' specifics.

Before moving on to deriving our theoretical model, it seems appropriate to illustrate the mechanisms through which each of the above mentioned variables affects markups.

Competition along a trade route is simplified here as the number of companies operating on that route. That means n companies sell that specific service and, because demand is usually inelastic (i.e. demand curve the firms face is not flat), these companies are able to set prices for their services that exceed their marginal costs, maximizing their profits. Their 'power' to overcharge for their services is decreasing with how many competitors there are. Demand will be distributed between competitors, so prices (freights) depend on how many they are.

Import demand elasticities should be negatively correlated with freight rates and markups. The rationale is that demand for freight services derives from demand for the product itself. High elasticity products should also have high elastic demand for shipping services. Imagine two goods (1 and 2) with factory prices equal to $50 are imported by a country, and their marginal costs of shipping are also the same, $5. Now suppose good 1 is inelastic, say a 0.5 import elasticity, and good 2 has an import elasticity of 5. If no markup is charged, final prices for both goods will be $55. If carriers charge a 20% markup on shipping costs, final prices will be $56 (50 + 5 + 1), which represents a 1.82% increase in shipping prices. For the inelastic good 1, this will result in a decrease of 0.90% of imports, while for the elastic good 2, the reduction will be of more than 9%. Therefore, carriers tend to charge more for less elastic products, since the change in their service's demand will be low, which explains the negative correlation for elasticities.

Finally, tariffs affect freight rates through final prices of products. High tariffs raise final prices and since demand for products is determined by the final prices, so are freight rates. Suppose a good whose factory price is $10 and freight costs are $2. If no tariffs are charged, freight costs would correspond to 17% of final prices. If a 20% ad valorem tariff is charged, freight bill as a percentage of final prices would drop to 14%. Because freight costs with tariffs 'matter less' to the final consumer, demand is less sensible to changes in freight costs, and carriers can charge higher markups.

To find the optimal freight prices (for carriers) we must find the demand for shipping services that derives from import demand. Our fundamental utility function will assume consumers from country i have quasi-linear preferences over the numeraire (money) and a variety of good from various origins (M), with its own price elasticity of import demand. Moreover, the final price of that good is a function of its price in its country of origin, multiplied by the tariffs plus the freight price. The price of the numeraire is normalized to one.

$$U_i = q_{i0} + \sum_{j=1}^{M} q_{ij}^{\frac{\sigma-1}{\sigma}} \qquad \sigma > 1 \tag{1}$$

$$p_{ij} = p_j \tau_{ij} + f_{ij} \tag{2}$$

Where q_{i0} is country i's consumption of the numeraire
q_{ij} is country i's consumption of a good from country j
τ_{ij} is an ad-valorem tariff rate, $\tau_{ij} \geq 1$ and
f_{ij} is the per unit freight price from country j to country i.

First, we need to find the demand of a good k from country j which matches its marginal utility to its relative price to the numeraire at the destination country, maximizing consumers' utility.

$$U_{Mg_i} = \frac{\partial U_i}{\partial q_{ij}} = \left(\frac{\sigma - 1}{\sigma}\right)\left(q_{ij}^{-\frac{1}{\sigma}}\right) = p_{ij} \tag{3}$$

In equilibrium

$$q_{ij} = \left(\frac{\sigma}{\sigma - 1} p_{ij}\right)^{-\sigma} \tag{4}$$

replacing p_{ij} according to Equation **2** we get

$$q_{ij} = \left(\frac{\sigma}{\sigma - 1}\left(p_j\tau_{ij} + f_{ij}\right)\right)^{-\sigma} \qquad (5)$$

Second, we maximize the carriers' profits in order to find optimal shipping prices and quantities.

$$\pi_{ij}^{l} = Q_{ij}^{l}\left(f_{ij} - c_{ij}\right) - C_{ij} \;\; \forall l = 1,2,\dots,n_{ij} \qquad (6)$$

Where$\pi_{ij}$is carrier l's profit of shipping a good k from country j to country i

Q_{ij}^{l} is the quantity of good k transported by l

c_{ij} is the marginal cost of shipping good k and

C_{ij} is the fixed costs associated with the transport of good k from country j to country i.

$$\frac{\partial \pi_{ij}^{l}}{\partial Q_{ij}^{l}} = \left(f_{ij} - c_{ij}\right) + \left(\frac{\partial f_{ij}}{\partial Q_{ij}^{l}}\right)Q_{ij}^{l} = 0 \quad \forall l = 1,2,\dots,n_{ij} \qquad (7)$$

We need to rearrange equation **5** to obtain f_{ij}:

$$\frac{\sigma - 1}{\sigma} q_{ij}^{-\frac{1}{\sigma}} = p_j\tau_{ij} + f_{ij} \leftrightarrow f_{ij} = \frac{\sigma - 1}{\sigma} q_{ij}^{-\frac{1}{\sigma}} - p_j\tau_{ij} \qquad (8)$$

And then derive it to obtain $\frac{\partial f_{ij}}{\partial q_{ij}}$:

$$\frac{\partial f_{ij}}{\partial q_{ij}} = \left(\frac{\sigma - 1}{\sigma}\right)\left(\frac{-1}{\sigma}\right) q_{ij}^{\frac{(-1-\sigma)}{\sigma}} \qquad (9)$$

Since $Q_{ij} = \frac{q_{ij}}{n}$

$$f_{ij} = \left(\frac{\sigma - 1}{\sigma}\right)\left(nQ_{ij}\right)^{-\frac{1}{\sigma}} - p_j\tau_{ij} \qquad (10)$$

and

$$\frac{\partial f_{ij}}{\partial q_{ij}} = \left(\frac{\sigma - 1}{\sigma}\right)\left(\frac{-1}{\sigma}\right)\left(nQ_{ij}\right)^{\frac{(-1-\sigma)}{\sigma}} \qquad (11)$$

Back to the profit maximization,

$$\frac{\partial \pi_{ij}^{l}}{\partial Q_{ij}^{l}} = \left(\left(\frac{\sigma-1}{\sigma}\right)\left(nQ_{ij}\right)^{-\frac{1}{\sigma}} - p_j\tau_{ij} - c_{ij}\right) + \left(\left(\frac{\sigma-1}{\sigma}\right)\left(\frac{-1}{\sigma}\right)\left(nQ_{ij}\right)^{\frac{(-1-\sigma)}{\sigma}}\right)Q_{ij}^{l} = 0 \quad (12)$$

After some algebra we reach the optimal quantity each carrier should transport, that maximizes their profit:

$$Q_{ij} = \frac{1}{n}\left[\left(\frac{\sigma}{\sigma-1}\right)\left(\frac{c_{ij}+p_j\tau_{ij}}{1-\frac{1}{\sigma n}}\right)\right]^{-\sigma} \quad (13)$$

Lastly, in order to obtain the optimal shipping prices f_{ij} we replace Q_{ij} in our freight equation **10**, and get

$$f_{ij} = c_{ij} + \frac{c_{ij}+p_j\tau_{ij}}{\sigma n - 1} \quad (14)$$

From the model presented above, we aim at finding determinants to f_{ij}, but, probably more importantly, to better understand variables affecting carriers markup. So some considerations are reasonable at this point.

Import demand elasticities vs. demand elasticity for shipping services

First, it is important to differentiate between the import demand elasticity σ, which is the price-elasticity of demand for imported goods, and the price-elasticity of demand for shipping services, which is the percentage change in quantities q_{ij} as a response for a 1 percent increase in shipping prices f_{ij}, therefore $\frac{\partial q_{ij}}{\partial f_{ij}}\frac{f_{ij}}{q_{ij}}$. Although σ appears on our f equation, import elasticities effect on quantities and, consequently, on shipping services demand is indirect and depends on how much of final prices correspond to freights.

Calculating elasticity from equation **5** we get

$$\frac{\partial q_{ij}}{\partial f_{ij}}\frac{f_{ij}}{q_{ij}} = -\sigma\left(\frac{f_{ij}}{p_j\tau_{ij}+f_{ij}}\right) = -\sigma s \quad (15)$$

Where s shortens the term in parenthesis, and represents the share of shipping charge in final prices. It means the importance of import elasticities σ in final demand for imported goods increases with its weight on final prices. Products with high demand elasticities might have an inelastic import demand if their freight share

in final prices is small. On the other hand, import elasticities can be amplified if freights represent a major share in final prices.

Markup

The markup μ charged by shipping companies is the result of freight prices divided by their marginal costs of shipping, $\frac{f}{c_{Mg}}$. From **14** we can see that markups are decreasing with elasticities σ, number of carriers n and marginal costs relative to prices inclusive of tariffs $c/p_j\tau_{ij}$:

$$\mu = 1 + \frac{1 + \frac{p_j\tau_{ij}}{c_{ij}}}{n_{ij}\sigma - 1} \qquad (\ \mathbf{16}\ )$$

It is interesting from markup equation above the relationship between competition and elasticity in markup. If a certain route is operated by a monopolist shipper, its markup is inversely related to product's demand elasticity. As the number of competitors grow large, markup shrink, since more companies compete along that route. So one should expect that in routes along which more shippers compete, elasticities effect on markups is amplified by number of competitors, i.e. each competitor ends up with less market power.

Marginal costs and its relationship with FOB prices

To proceed to our empirics, we need to define a functional form for marginal costs c_{ij}, since they are not observable. We assume, therefore, marginal costs are related to the sea distance across which goods are transported dist and the FOB price of imported products p_j. Distances matter for intuitive reasons – the farther a company must transport a certain imported good, the higher are its expenses related to the trip, like fuel, staff pay etc. Positive correlation with product prices, however, is less obvious, since the cost of transporting 1 kilogram of anything should be the same. But one must consider that shipping services are not homogeneous, and they get more expensive as they become faster, more careful, and also when their prices f include insurances, which is the case in this study. So we can adopt the following as our marginal our costs functional form.

$$c_{ij} = \exp(\beta_0)\left(p_j\right)^{\beta_1}(\mathrm{dist})^{\beta_2} \qquad (\ \mathbf{17}\ )$$

3.1. EMPIRICS

We derive our model from the profit maximizing function of the freight f, and the assumptions for the unobservable marginal costs c mentioned on the previous session. Because of the non-linearity of many relations between variables, and again following the lead by Hummels et al., we propose a log linear equation to relate all the variables in our sample.

We aim at finding evidence that markup related variables, namely, import elasticities σ, import tariffs τ and number of competitors n are significant to determining freight costs. Moreover, we expect products with more elastic import demand to influence less on freights, i.e., its coefficient to have a negative sign. The same goes for number of competitors, since the more competition, the less market power one expects competitors to exert. Finally, tariffs should have a positive impact on freight rates, with positive coefficient, since tariffs raise final prices, and therefore, enable carriers to charge for higher markups.

3.1.1. The data

In our model, we use official trade data from Brazil, available at open data area of the the Ministério da Fazenda's website (http://idg.receita.fazenda.gov.br/). This database contains data of all goods imported by Brazil in 2016, categorized by NCM (Nomenclatura Comum do Mercosul) code at 8 digits, and features the FOB price of each import order, its freight, its weight in kilograms, its "unidade de desembaraço" as well as its country of origin. Each file of this database corresponds to one month of one of the 97 chapters in year 2016, and each row of this raw data file corresponds to one import order, so for the year 2016 we initially had 12 times 97 files, which equals 1164 files, each with many orders lines amounting more than 2 gigabytes of data. We filtered all these imports, and considered in our analysis only those that came via maritime transport. We consider p as the log of FOB price per kilogram of each good, and similarly f as the log of freight (inclusive of insurances) per kilogram of that same good.

For the purpose of this work, data from 2016 fulfilled our needs, and we did not use data from previous years because it was only available in a completely different format, which would cost us valuable time and probably not improve our results as much. However, for a further analysis on this topic, data from other years could be included in the same model without prejudice.

One could point as a weakness of our database the absence of a variable measuring the cost of the excess time spent when shipping products by liner ships vis-à-vis other transports. However, a considerable amount of Brazilian imports are of products whose transport method is not substitutable. So we believe the addition of such variable, despite not harming our results, should also not change them dramatically.

Also from Ministério da Fazenda we obtain data on tariffs charged over each NCM good, and add a dummy for countries that do not belong to Mercosur, since Argentina, Paraguay and Uruguay are exempted from tariffs.

Two different sources for the variable $dist$ (distance) have been tested, the first from the CEPII database, which measures the linear distance between countries capitals or their most populous cities, both featuring also a "weighted average" measurement. Alternatively we tested (and stick to) the sea distance between countries, which better describes the distance faced by carriers, especially for countries whose accesses require a longer sea route despite a shorter linear distance (such as Peru). This data comes from the Centre d'Etudes et de Recherches sur le Développement International (CERDI) database. This database contains 'bilateral maritime distances between 227 countries and territories', and, for those countries that has more than one port, it considers the one with the 'highest number of shipping lines'[5].

For elasticities, we used those calculated by Vienna Institute for International Economic Studies (WIIW), and we preferred that source over Broda-Weinstein's, which is used by Hummels, for two reasons: first, it is more recent, estimates elasticities for the period 1996-2014, while Broda-Weinsteins' use data from period 1994 – 2003; second, it is estimated for HS at 6 digit level, which is more precise than the alternative at 3 digit level.

The number of carriers competing in each route was obtained by simulating an import order from each one of every import partners from Brazil at www.searates.com. This variable was checked using Unctad's Conectivity Index as a proxy for it, which yielded satisfactory results.

To get a coherent and consistent database, some manipulation had to be done on these data. First, we had to sum import, freight and insurance values for all

[5] http://cerdi.org/production/show/id/1791/type_production_id/1

twelve months of the year, to get totals for the year, for each NCM product. We then brought both these trade data and elasticities data to Harmonized System at 4 digits (HS4) classification, by calculating the mean elasticity for each HS4 product – that corresponds to NCM4 classification[6]. Then, we added the sea distance and the number of carriers' data to our HS4 database. Finally, we divided FOB values, freights and insurances by the total kilograms of each product imported, so that different products' parameters would become comparable. We added a few dummy variables later, related to region of origin and GTAP sectors to proceed with some tests.

Our final database contains total value imported, total freight, total insurance and total weight of each HS4 commodity from each country in 2016. It also features sea distances from exporters, the number of shipping companies competing along the route and the average tariff charged for each product-country pair.

A sample of our data looks like the following:

Figure 4 -

	GTAP	NCM4	PAIS.ALFA3	p	f	ins	kg	sigma_wiiw	seadistance	N.CARRIERS	tau
1	19	201	arg	8.500	0.833		5,401	1.305	2,689.920	12	1
2	19	201	arg	2.741	0.200	0.016	555,568	1.305	2,689.920	12	1
3	19	201	ury	2.060	0.161		50,069.100	1.305	1,709.760	10	1
4	19	202	arg	3.846	0.146	0.0002	2,514,286.000	1.396	2,689.920	12	1
5	19	202	ury	7.196	0.099		9,173.020	1.396	1,709.760	10	1
6	19	202	ury	3.720	0.192	0.006	48,526	1.396	1,709.760	10	1

Source:

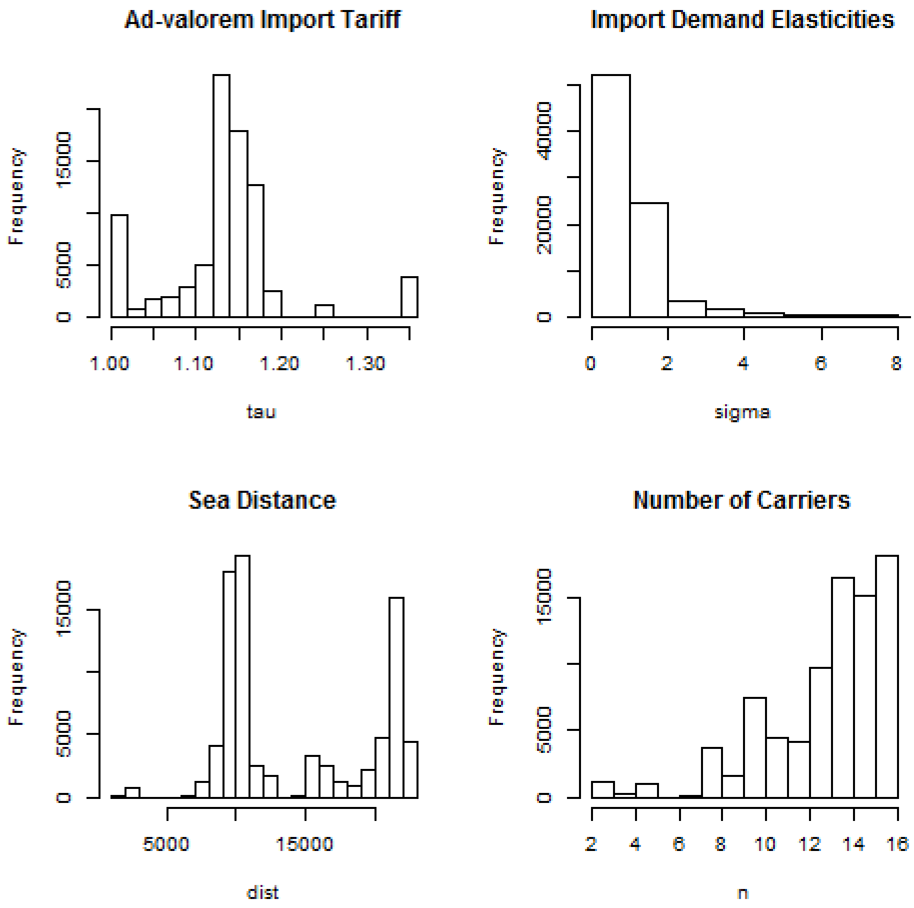
The series of histograms on Figure 5 below features some characteristics of our data. Firstly, we can see that average tariffs charged on imported goods are between 10 and 20 percent, with a mean value of 12.6 when we exempt MERCOSUR countries from those tariffs. Some products, however, are heavily charged, by 35 percent, and correspond to so called 'strategic' sectors of Brazilian industry (which are in fact protected sectors). These are mainly products from the textile industry, such as clothes, footwear, accessories, rugs, and from the automobile industry, such as cars and its parts and pieces.

As for the elasticities, it is clear that a great share of products are import inelastic (elasticity below 1), and only few exceed elasticity of 2, which would be

[6] The Harmonized System (HS) and NCM System correspond to each other up to the sixth digit. The seventh and eighth digits at NCM System are specific to Mercosur's classification.

considered “normal”. The mean elasticity for our sample is 1.24. The sea distance varies among Brazilian exporters, which shows the country actually trades with many other countries. Also interesting is the histogram for the number of carriers: routes through which more variety of products is traded (more observations in our sample) have a higher number of shipping companies. That is why the variable n should be considered in our model, and because there are not so many companies (maximum is 16 in our database) competing, we should expect to detect market power.

Figure 5 -



Source:

3.1.2. Specifications

We propose two different specifications for the problem presented. First, we run an exporter-fixed effects model, which considers as constant the distance

between countries and the number of competitors, and attributes one fixed-effects constant for each partner country.

$$\ln f_{ijk} = \alpha_j + \beta_1 \ln p_{ijk} + \beta_2 \ln \tau_{ijk} + \beta_3 \ln \sigma_k + e_{ijk} \qquad (18)$$

Where f_{ijk} is the freight price per kg, α_j is a vector of exporter-fixed effects, p_{ijk} is the FOB price of the good, τ_{ijk} is the ad-valorem tariff, σ_k is the price-elasticity of import demand and e_{ijk} is an error term.

The second specification is a simple OLS that considers the sea distance between countries and the number of competitors as determinants for the freight price, dropping the exporter fixed-effects vector. Moreover, we add an interaction between the elasticity and number of competitors to check if changes in the competition level affect the ability of firms to charge higher markups.

$$\ln f_{ijk} = \alpha + \beta_1 \ln p_{ijk} + \beta_2 \ln \tau_{ijk} + \beta_3 \ln \sigma_k + \beta_4 \text{dist}_{ij} + \beta_5 \ln n_{ij} + \beta_6 \ln n_{ij} \ln \sigma_k + e_{ijk} \qquad (19)$$

We decided to run both specifications because, as we will present next, OLS regressions yielded considerably strong elasticities for tariffs, and some of the elasticities estimated varied across different sections of our sample. Although these obstacles did not change our 'bottom line' conclusions, we found it valid to 'double check' our model by running it under a different specification. Besides, more than three thirds of Brazilian imports come from very few partners, i.e. a very concentrated market, which could disrupt results, especially when controlling for country-specific variables.

The results are presented in the table below, and in the OLS estimation we add each variable in steps, so we can be certain the signs don't change as we add more variables.

3.1.3. Results

Table 1 presents the results of both specifications. The first column represents the exporter fixed effects estimation and, in line with our expectations, the coefficients for FOB prices p and tariffs $(1 + \tau)$ are positive and the coefficient for import elasticity σ is negative. The magnitude of the elasticity of shipping prices f in respect to tariffs is impressive. In this specification, a 1% increase in tariffs results,

ceteris paribus, a 3.77% increase in shipping prices, which indicates higher tariffs allow freight companies to charge higher markups.

Table 1 – Estimation Results

	Dependent variable:							
	log(f)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ln(p)	0.537***	0.556***	0.560***	0.557***	0.550***	0.549***	0.549***	0.520***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
ln(σ)	-0.172***			-0.072***	-0.180***	-0.184***	-0.336***	-0.332***
	(0.010)			(0.010)	(0.010)	(0.010)	(0.066)	(0.067)
ln(τ)	3.777***				3.659***	3.587***	3.599***	0.907***
	(0.076)				(0.074)	(0.074)	(0.074)	(0.110)
ln(n)						-0.158***	-0.165***	-0.146***
						(0.015)	(0.015)	(0.015)
ln(n)*ln(σ)							0.061**	0.103***
							(0.026)	(0.026)
ln(dist)			0.192***	0.191***	0.101***	0.128***	0.129***	0.084***
			(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.012)
Constant (α)	-2.958***	-2.159***	-3.989***	-3.971***	-3.575***	-3.419***	-3.412***	-3.498***
	(0.110)	(0.006)	(0.107)	(0.107)	(0.105)	(0.106)	(0.106)	(0.136)
Exporter fixed effects	Yes	No	No	No	No	No	No	No
Sector dummy	--	--	--	--	--	--	--	NCM2
Observations	83,106	83,106	83,106	83,106	83,106	83,106	83,106	83,106
Adjusted R^2	0.491	0.457	0.459	0.460	0.475	0.476	0.476	0.498
Note:	*p<0.1; **p<0.05; ***p<0.01							

Columns (2) – (7) present the OLS estimations, by adding each variable at a time in order to detect any changes in signs – which doesn't happen after all – and column (8) adds a sectoral dummy at HS2 level.

Back to column (7), where the complete OLS estimation is presented, signs match theory and magnitudes of coefficients for $\ln p$, $\ln \sigma$ and $\ln(1+\tau)$ are very similar to those estimated in specification (1). Additionally, the number of carriers n has a negative impact on shipping prices, accordingly to out theory, and distance dist is positively correlated, although the coefficient is very low compared to other variables'.

The interaction between import demand elasticity and number of carriers is positive, which indicates that the more carriers competing along a route, the weaker the elasticity impact on shipping prices, and market power is therefore lower.

Column (8), which contemplates the sectoral dummy, also has a significant coefficient for the interaction, at 95% confidence level.

3.1.4. Testing for heterogeneity

We have made two additional estimations to test for differences in the markup-related variables' coefficients for different regions of imports origin, and also across different sectors. We reran our regression (1) adding dummies for United States, China, Argentina and European Union (EU28), so that rest of the world is our control group. Then, (2) we add dummies for Agribusiness, Agriculture and Extractive sectors, controlling for Industry sector. Our results are presented below.

Table 2 – Regression with sectoral dummies

	Dependent variable:
	f
ln(p)	0.544*** (0.002)
ln(dist)	0.114*** (0.012)
ln(σ)	-0.182*** (0.010)
ln(τ)	3.466*** (0.076)
ln(n)	-0.166*** (0.015)
ln(τ) EXTR	6.707*** (2.414)
ln(τ) AGRIC	-5.213*** (1.662)
ln(τ) AGROB	-0.359 (0.882)
ln(σ) EXTR	0.399*** (0.142)
ln(σ) AGRIC	0.294** (0.130)
ln(σ) AGROB	0.240*** (0.071)
ln(n) EXTR	0.246** (0.116)
ln(n) AGRIC	-0.512*** (0.189)
ln(n) AGROB	0.044 (0.115)
ln(dist) EXTR	-0.111*** (0.031)
ln(dist) AGRIC	0.135** (0.059)
ln(dist) AGROB	-0.065* (0.035)
Constant(α)	-3.226*** (0.108)
Observations	83,106
R^2	0.478
Adjusted R^2	0.478
Residual Std. Error	1.260 (df = 83088)
F Statistic	4,473.378*** (df = 17; 83088)
Note:	*p<0.1; **p<0.05; ***p<0.01

On Table 2 we reran our base regression, adding dummies for macro sectors Extractive, Agriculture and Agribusiness, considering Industry as our base sector. The base estimation shows a good 'behavior' compared to our previous ones, which should be expected, since manufactured goods represent a high share of Brazilian

imports. All coefficients estimated for industrial sector are statistically significant, with positive signs for p, dist and τ and negative ones for σ and n.

For the other sectors, there are some differences that deserve our attention.

Tariffs once again stand out, as its freight elasticity for the extractive sector is much higher than for the other sectors. We can relate that to the components of Extractive sector, vis-à-vis tariffs charged on them. GTAP Items 15, 16 and 17 correspond to coal, oil and gas products, and are exempt from tariffs. The average tariff rate on Extractive sector is 2.77%, which is the lowest average among the four sectors. Excluding those items, average tariffs raise to 2.94%, still the lowest among tariff subject sectors. Average freights as a percentage of final prices, however, are the highest, more than 10 percent for extractive sector as a whole and close to 9% for those enumerated items, which indicates strong market power. The other variables affecting markup, however, are not at extremes in our sample, with mean elasticity and number of carriers of 1.37 and 11.59, respectively. Therefore one can conclude that companies transporting extractive items subject to tariffs (forestry and fishing products) exploit market power derived from tariffs more than from other sources, even though tariffs are not the highest. Both import elasticities and number of carriers have inverse coefficients signs for extractive sectors, and a lower statistical significance.

For agriculture, tariffs' coefficient is negative and statistically significant. That might be due to inability of carriers to exert market power when transporting agriculture products, since they not only represent a low fraction (8 percent) of Brazil's imports, but are highly substitutable by national production. Even not exhibiting the highest import elasticities, nor the highest freight / final prices ratio, importers might decide not to import some of these items, if their freight rise too much. The same behavior is observed for elasticities' coefficient for agriculture items, that is positive, 0.1119.

Distances, however, are very important for agriculture sector, and that is in accordance to our diagnostic that market power is less present in this sector, since distances affect only marginal costs, and not markups. Distances elasticities for agriculture sector are twice as big as for industrial sector, and the highest among all sectors. For Agribusiness, distances still have a positive coefficient, but are statistically significant only at 10% level. For extractive sector, despite being statistically significant, distance elasticity is too close to zero, 0.0023.

Interestingly, elasticities are only negative for industrial sector, and, therefore, only for those items is determinant for market power. That should not be considered such ‘great news’, since those are the main products among Brazil’s imports.

Finally, the number of carriers’ coefficient is negative and has a larger absolute value for agricultural products than it has for any other. That indicates competition plays an important role among shippers of those products as freight rates are very sensitive to the entrance of a new competitor, with an elasticity of -0.6781. The mean value for n in agricultural sector is 12.11, but let’s suppose competition would increase from 12 to 13 companies, corresponding to an 8.3% increase. If a 1% increase in n would result in a 0.67% decrease in shipping prices, the additional company, at current level of competition would decrease shipping prices in more than 5%. For extractive sector, number of competitors has a very low elasticity in magnitude, and it is positive, which prevents us from detecting it as a source of market power in this sector.

Table 3 shows our base estimation (column 1) and the estimation with the regions dummies (columns 2 – 5). All the estimations keep the original coefficients close to the ones estimated at first, and all statistically significant, which once again reinforces our primary hypothesis of which variables affect freights and how.

Table 3 – Regression with regions' dummies

	Dependent variable:				
	f				
	(1)	(2)	(3)	(4)	(5)
ln(p)	0.549*** (0.002)	0.545*** (0.002)	0.549*** (0.002)	0.545*** (0.002)	0.545*** (0.002)
ln(dist)	0.128*** (0.011)	0.274*** (0.022)	0.125*** (0.011)	0.213*** (0.016)	0.263*** (0.022)
ln(σ)	-0.184*** (0.010)	-0.187*** (0.010)	-0.291*** (0.017)	-0.174*** (0.010)	-0.187*** (0.010)
ln(τ)	3.587*** (0.074)	3.745*** (0.075)	3.682*** (0.075)	3.426*** (0.089)	3.745*** (0.075)
ln(n)	-0.158*** (0.015)	-0.167*** (0.016)	-0.164*** (0.015)	-0.176*** (0.016)	-0.159*** (0.017)
ln(dist) USA		0.051*** (0.002)			
ln(dist) ARG		0.067*** (0.008)			
ln(dist) EU28		-0.008*** (0.002)			
ln(dist) China		-0.007*** (0.002)			
ln(σ) USA			0.064* (0.037)		
ln(σ) ARG			-0.010 (0.100)		
ln(σ) EU28			0.257*** (0.024)		
ln(σ) China			0.069*** (0.027)		
ln(τ) USA				3.196*** (0.124)	
ln(τ) ARG					
ln(τ) EU28				-0.298*** (0.092)	
ln(τ) China				-0.241** (0.094)	
ln(n) USA					0.179*** (0.007)
ln(n) ARG					0.204*** (0.024)
ln(n) EU28					-0.031*** (0.006)
ln(n) China					-0.027*** (0.005)
Constant(α)	-3.419*** (0.106)	-4.817*** (0.205)	-3.393*** (0.107)	-4.175*** (0.145)	-4.734*** (0.205)
Observations	83,106	83,106	83,106	83,106	83,106
R^2	0.476	0.485	0.477	0.483	0.485
Adjusted R^2	0.476	0.485	0.477	0.483	0.485
Residual Std. Error	1.262 (df = 83100)	1.251 (df = 83096)	1.261 (df = 83096)	1.254 (df = 83097)	1.251 (df = 83096)
F Statistic	15,093.070*** (df = 5; 83100)	8,682.695*** (df = 9; 83096)	8,410.143*** (df = 9; 83096)	9,687.763*** (df = 8; 83097)	8,683.891*** (df = 9; 83096)
Note:	*p<0.1; **p<0.05; ***p<0.01				

Taking a closer look at sea distances, estimation 2 indicates freights are more sensible to them for imports coming from Argentina and United States than for the rest of the World's. That might relate to the products imported from these countries. For instance, most of those oil, gas and coal products we mentioned in our former estimation come from the United States and extract almost the totality of its market power from tariffs. Argentina's imports not only are exempt of tariffs because of MERCOSUR, which makes tariffs impossible as a source of market power, but have a fair share of agricultural products – those whose markups depend almost exclusively from distances. (Foodstuffs, Vegetable Products and Animal Products

account for 35% of imports coming from Argentina). Distances matter less for imports from Europe and China, since share of agricultural products is relatively smaller.

When separating tariffs' coefficient among partners, it stands out the fact that freights from US imports are much more influenced by tariffs than other partner's. That might be because at least one third of imports coming from US in 2016 (mainly gas turbines, under 8411 HS4 code and refined petroleum, under 2710 HS4 code), as mentioned earlier, were not subject to import tariffs. The effect observed here is similar to the one observed for the extractive sector. Coefficient here is not so high, though. For Europe and china, freights are less sensible to tariffs than the rest of the world average, but only by minor coefficient differences.

Coefficients for n are all significant, but very little in magnitude for US and Argentina (0.02 and 0.045 respectively), which indicates few market power is extracted from low competition for these countries. European imports' freights have the highest elasticity in respect to number of competitors, -0.469, and Chinese's come right behind, -0.429.

Import elasticities are not relevant to determination of freights from Argentina. It would not be an overstatement to say products traded between Brazil and Argentina are extremely protected, both by domestic incentives and by bilateral agreements, besides the exclusive transport agreement mentioned in the beginning of this work. So one should not be surprised if manufactured products' freights, with relatively high import elasticities, are not sensible to elasticities at all, even in the presence of a huge world supply of those products.

Elasticities for American and Chinese products are very similar, -0.227 and -0.222, respectively, and still are pretty well acceptable within the scope of the theory presented by this work. In Europe, despite still being negative, elasticities have a minor importance in determining freights.

3.1.5. Robustness checks

In our model, the positive sign of tariff's τ coefficient means that the presence of markup allows carriers to charge higher shipping prices since higher tariffs increase product's final price. One could argue, however, that the positive correlation is due to economies of scale according to the following rationale: lower tariffs along a trade route would increase volumes traded along that route, which would encourage more competitors to enter, reducing shipping prices because of competition. We could check that hypothesis by re running our regression, but dividing our sample

into equally sized bins, increasing in weight. If economies of scale were the reason for the positive sign of τ, one would expect its coefficient to decrease with increases of scale.

We first divided our entire sample into 10 bins, with slightly more than 8 thousand observations each. As we can see from Table 4 below, the weights (the total volume of each commodity transported along a route during 2016) range from 0 kilograms to more than 4 million tons. After re running our model, on this test not only did τ coefficients not decrease, but instead they increased. The positive correlation between FOB prices and shipping prices remains significantly positive in all 10 bins. The sign of σ coefficient is positive for very light shipments (below 101 kilograms) and then becomes significantly negative, which matches our theory. Those first bins' estimates might be distorted to noise, since shipments of such low scale are not necessarily representative of trade along a certain route.

Table 4 – Robustness check for economies of scale (1)

	Dependent variable:									
	f									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ln(p)	0.59***	0.54***	0.45***	0.43***	0.38***	0.36***	0.36***	0.33***	0.25***	0.21***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
ln(σ)	0.21***	0.07*	-0.03	-0.12***	-0.12***	-0.27***	-0.31***	-0.37***	-0.38***	-0.36***
	(0.05)	(0.04)	(0.04)	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)	(0.02)	(0.02)
ln(τ)	1.11***	1.97***	1.82***	2.52***	2.62***	3.15***	4.39***	5.70***	5.25***	5.80***
	(0.34)	(0.30)	(0.28)	(0.25)	(0.23)	(0.21)	(0.20)	(0.19)	(0.17)	(0.15)
min Kg	0	17	102	436	1,510	4,776	14,400	42,000	137,500	633,441
max Kg	17	102	436	1,510	4,776	14,400	42,000	137,500	633,441	4,089,815,000
Observations	8,014	8,015	8,015	8,015	8,015	8,015	8,015	8,015	8,015	8,014
Adjusted R^2	0.34	0.26	0.25	0.35	0.48	0.62	0.74	0.81	0.86	0.92
Note:	*p<0.1; **p<0.05; ***p<0.01									

Because of the high variability of coefficients across our sample sections, and also because of the big range of weights, however, we preferred to do the test over, but this time with 10 equally sized bins taken from 8^{th} to 10^{th} original bins, i.e. above 42 tons.

Table 5 - Robustness check for economies of scale (2)

	Dependent variable:									
	f									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ln(p)	0.353***	0.294***	0.338***	0.275***	0.266***	0.248***	0.199***	0.211***	0.167***	0.173***
	(0.017)	(0.018)	(0.017)	(0.017)	(0.017)	(0.016)	(0.016)	(0.015)	(0.015)	(0.014)
ln(σ)	-0.374***	-0.391***	-0.357***	-0.361***	-0.414***	-0.342***	-0.351***	-0.332***	-0.375***	-0.317***
	(0.046)	(0.046)	(0.044)	(0.043)	(0.042)	(0.040)	(0.037)	(0.039)	(0.037)	(0.033)
ln(τ)	5.738***	5.574***	5.846***	5.102***	5.202***	5.421***	5.469***	5.121***	5.567***	6.218***
	(0.358)	(0.346)	(0.335)	(0.322)	(0.316)	(0.306)	(0.293)	(0.292)	(0.285)	(0.250)
min Kg	42,000	58,904	83,754	120,000	177,674	272,482	444,044	766,800	1,520,909	4,444,776
max Kg	58,904	83,754	120,000	177,674	272,482	444,044	766,800	1,520,909	4,444,776	4,089,815,000
Observations	2,405	2,406	2,406	2,405	2,406	2,406	2,405	2,406	2,406	2,402
Adjusted R^2	0.785	0.789	0.831	0.841	0.847	0.870	0.885	0.896	0.903	0.946
Note:	*p<0.1; **p<0.05; ***p<0.01									

Positive coefficients for τ can now be more comfortably assumed as an effect of *markup* charged by carriers, with no evidence of economies of scale. In our latter subset, coefficients range from 5.102 to 6.218, all highly significant at 99% level.

Another robustness check we ran was checking whether elasticity σ's coefficients were consistent. If they are, they should be negative across the entire dataset, and increasing in magnitude with elasticities. We therefore created a dummy variable for the elasticities, and reran our regressions controlling for low elasticity products, yielding coefficients for high and medium elasticity ones. In line with theory, all coefficients keep negative, and the high elasticity ones with a greater magnitude, both in fixed effects and OLS estimations. The specification featuring the interaction between n and σ also has positive signs, but the enteraction itself was only found significant for the high elasticity. Results are shown on Table 6 below.

Table 6 - Robustness check for import elasticities

	Dependent variable:		
		f	
	(1)	(2)	(3)
ln(p)	0.532***	0.544***	0.544***
	(0.002)	(0.002)	(0.002)
ln(τ)	3.606***	3.399***	3.415***
	(0.074)	(0.073)	(0.073)
ln(σ med)	-0.231***	-0.234***	-0.290***
	(0.011)	(0.011)	(0.092)
ln(σ high)	-0.241***	-0.254***	-0.539***
	(0.011)	(0.011)	(0.089)
ln(n)		-0.154***	-0.204***
		(0.014)	(0.026)
ln(dist)		0.123***	0.124***
		(0.011)	(0.011)
ln(σ med)*ln(n)			0.022
			(0.036)
ln(σ high)*ln(n)			0.112***
			(0.035)
Constant (α)	-2.783***	-3.193***	-3.072***
	(0.110)	(0.107)	(0.120)
Observations	83,106	83,106	83,106
R^2	0.493	0.478	0.478
Adjusted R^2	0.493	0.478	0.478
Residual Std. Error	1.241 (df = 83062)	1.259 (df = 83099)	1.259 (df = 83097)
F Statistic	1,879.763*** (df = 43; 83062)	12,684.680*** (df = 6; 83099)	9,516.233*** (df = 8; 83097)
Note:	*p<0.1; **p<0.05; ***p<0.01		

3.2. STRENGTH OF MARKET POWER

Because our estimations result in statistically significant coefficients for those variables that affect markup, namely tariffs τ, import demand elasticity σ and number of carriers n, we have reason to believe that sipping prices are not only determined by marginal cost related variables (distance dist and FOB price of imported product p), but also by carriers, who charge higher markups. In fact, as we will demonstrate below, variables affecting markup have more impact on shipping prices than those affecting marginal costs.

After removing the outlier values for p and f, we divide the variables in our sample into quantiles (5^{th}, 50^{th} and 95^{th}) to represent 'low', 'medium' and 'high' values for them. We then estimate shipping prices for each variable at these quantiles, while keeping the others at their means. Finally we compare those estimations to see the impact of each variable across our sample.

We begin by analyzing the distance between countries, which is usually used as a proxy for shipping prices. Countries with a low, medium and high distance from Brazil are respectively 8,824.13, 10,409.30 and 22,374.60 kilometers away. Shipping prices for countries with medium distance are only 2% higher than for those with low distance, and prices for distant countries, 13% higher.

The comparison with product prices follows the same logic and shows that more expensive items (USD 53.90 at the 95^{th} percentile) have shipping prices more than 17 times shipping prices of cheaper items (USD 0.31 at the 5^{th} percentile).

Goods with low import demand elasticity (0.61) at the 5^{th} percentile of our sample) have shipping prices 7.5% higher than goods with medium (0.92) elasticity and 31.6% higher than those with high elasticity (2.69). As for the competition along trade routes, those with few competitors (8) are 8.70% more expensive than those with a medium quantity (14) and 11.11% higher than very competitive routes (16).

The comparisons with tariffs τ are the most impressive among those variables affecting markup. Goods facing higher tariffs (26%) have shipping prices 213% higher than goods with lower tariffs (2%), and even goods with medium tariffs (14%) cost 49% more to be transported.

Table 7 – Response in freights for changes in each determinant

	Product Price (p)	Import Elasticity (σ)	Tariffs (τ)	Number of Carriers (n)	Distance (dist)
	0.55	-0.18	3.59	-0.16	0.13
f(50pct/5pct)	4.69	0.93	1.49	0.92	1.02
f(95pct/5pct)	17.01	0.76	2.13	0.90	1.13

3.2.1. Markup estimation

After having confirmed the presence of markup on freight rates with the NCM4 data, and that tariffs have a highly positive effect on those, we now try estimate markup levels for each country – product pair, with a back of the envelope calculation presented by Hummels (2009), as well as the reduction in trade and increase in prices the presence of markup produces. After that, we ponder those markup data across 42 GTAP sectors, in order to detect the presence of higher markup levels depending on the type of product.

Markup is commonly defined as the reason between prices and marginal costs. Prices, by their turn, are determined by marginal costs and by the demand function, which, on its turn, depends on its elasticity. The more elastic the demand, i.e., the higher the number of competitors and the 'flatter' the demand facing the firm, the weaker the market power exerted by the firm.

In our model, however, prices (freights) have more determinants besides demand elasticity. Since final product prices are also affected by tariffs, and by freights themselves, and these in turn are also determined by product demand and prices at origin, as well as competition along the route, our markup equation has to be more elaborated.

Remember from Equation **14** that $f_{ij} = c_{ij} + \frac{c_{ij}+p_j\tau_{ij}}{n_{ij}\sigma-1}$. So markup μ should be the result of the ratio $\frac{f}{c}$, where c are marginal costs facing shippers. The equation for markup according to our model would be

$$\mu_{ij} = \left(c_{ij} + \frac{c_{ij} + p_j\tau_{ij}}{n_{ij}\sigma - 1}\right)\left(\frac{1}{c_{ij}}\right) = 1 + \frac{1 + \frac{p_j\tau_{ij}}{c_{ij}}}{n_{ij}\sigma - 1} \qquad (20)$$

As one should expect, market power decreases with the number of firms competing, i.e. if n tends to infinity, in the imaginary situation of perfect competition, μ would converge to 1, meaning that companies would be incapable of charging any value above the marginal cost of shipping. The markup is also decreasing in respect to price elasticity of demand σ, even though the elasticity effect is 'diluted' in shipping prices: the greater the sensitivity of demand to price changes, holding fixed all the other variables, the smaller the market power. The marginal cost of shipping also diminishes market power because it weights negatively on all the other variables that affect markup.

The term $\frac{p_j \tau_{ij}}{c_{ij}}$, on the other hand, has a positive effect on markup. That is because it measures the 'peg' of freight rate to marginal cost of shipping. The greater this reason, the more exacerbated is the effect of both elasticity σ and competition n over the freight rate, via price. For example, imagine two goods with the same price elasticity of demand σ that are delivered by the same n shipping companies, along the same route, and have the same marginal cost c of transportation. Suppose additionally that these goods are free of tariffs, but one good is more expensive at origin than the other. The markup for the more expensive good will be higher than the markup for the cheaper one, because the effect of the elasticity will be amplified on it. When the marginal cost is so big that it diminishes the importance of the price, however, the effects of elasticity will be reduced as well.

There is a complication in our model here, because the marginal cost c cannot be observed, as is the case with the other variables. So we assume c is correlated with the distance across which the good is transported and with its price, since it is reasonable to assume that more valuable goods demand more attention and care to be transported, resulting in grater marginal costs. To estimate marginal costs from data available, one needs to isolate it from freight – the difference should be attributable to markup.

In order to estimate marginal costs, however, we cannot simply adapt our freight equation, and assume random high values for n and σ, removing tariffs from it. Instead, we estimate freights for a 'benchmark' shipment, in which n and σ are equal to the highest and τ is equal to the lowest available in our sample. That estimation will not result exactly in marginal costs, but costs in an imaginary shipment in which markup equals the lowest markup in our sample.

$$\ln c_{ij} = \alpha + \beta_1 \ln p_{ij} + \beta_2 \ln \tau_{1\%} + \beta_3 \ln \sigma_{99\%} + \beta_4 \text{dist} + \beta_5 n_{99\%} \qquad (21)$$

After some transformation, and replacing c_{ij} in our base f_{ij} equation, we get

$$f = c\left(\frac{\tau^{\beta_2}\sigma^{\beta_3}n^{\beta_5}}{\tau_{1\%}^{\beta_2}\sigma_{99\%}^{\beta_3}n_{99\%}^{\beta_5}}\right) \qquad (22)$$

And the term in parenthesis, therefore, is our estimation for the markup.

We then simulate the freight data for the hypothetical scenario in which markups are the lowest possible, and, therefore, freights are as close to marginal costs as possible. On average, this yields a significant increase in trade and reduction of final prices. Mean shipping prices are 1.82 times higher than they would be if markups were minimal, with standard-deviation of 0.548. That results in final prices 3.6% greater (sd= 0.068) and in 3.4% reduction in total imports (sd=0.062).

3.2.2. GTAP Markups

Since HS4 is too long a list of products to inspect, dividing our data into 42 GTAP sectors seems a fine way to obtain primary conclusions from our estimation. Table 8 reports weighted average estimated markups, elasticities and tariffs for 42 sectors of GTAP. Sector 11 (raw milk) cannot be converted from HS to GTAP, since the conversion table does not contemplate it, and sector 12 (wool) does not have any representative in our sample – items 5001, 5030, 5101, and 5102 of HS4 – therefore these are not shown in our summary table.

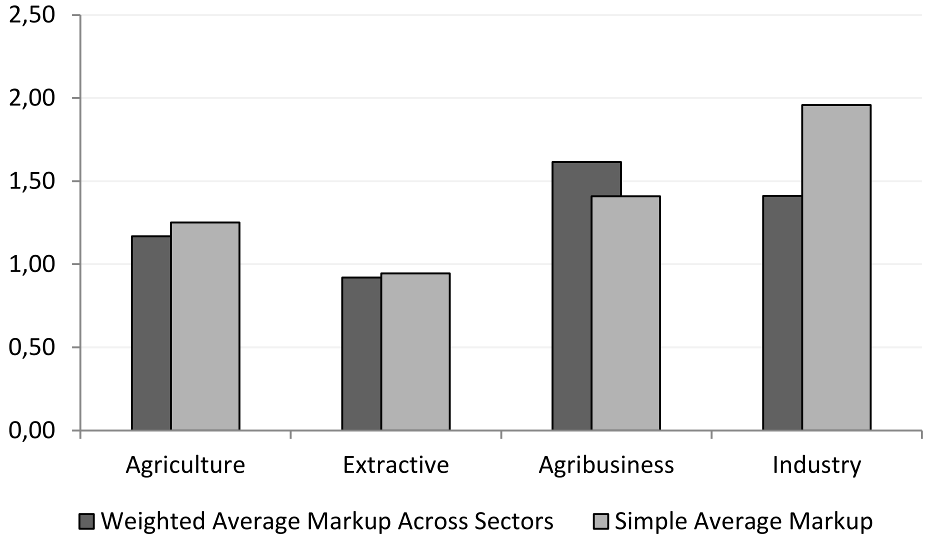
It is clear that shipping companies transporting industrial goods (26-28) are able to charge the highest markups, especially for wearing apparel and other textile-related industries. It might be the case that, because manufactured goods carry more value added, and therefore are ‘less substitutable’, carriers are able to do that.

However, these high markup sectors also coincide with the most protected sectors in Brazilian industries, i.e. the ones with highest import tariffs, which coincides with our theory and the high coefficients found for τ in all specifications. The correlation between these GTAP classified markups and tariffs is higher than 90 percent. Also interesting is that, despite sector 28’s high elasticity associated with high markup for this sector, negative correlation between elasticities and markups is only 16%, which reinforces that, for carriers case, and differently from other products, elasticities matter less for markups, since it is less determinant in final product’s prices. This counters the former ‘substitutability’ approach, not to mention these

goods, despite manufactured, are actually highly substitutable, but this exceeds the scope of the work.

Extractive Industries (13-18) are the least protected ones, and have also the lowest markups in our sample. Agriculture (1-12) and Agribusiness (19-25), have markups and tariffs closest to the average from all products. In both these groups, correlation with elasticities is also low.

Figure 6 – Average Markup for macrosectors



A topic of interest for further analysis is weather the protection of these industry sectors is good or bad for the economy as a whole. As pointed throughout this work, Brazil is among the highest tariff charging countries in the world, comparable only with Argentina among G20. Our GTAP markup estimation allows us to experiment tariff reduction effects on trade volumes and prices, not only via product prices, but also considering that a portion of final prices are shipping prices, which also respond to eventual tariff changes.

There are many papers that employ GTAP model to estimate tariff reduction impacts on trade, but it is unusual to alter shipping costs parameter for these estimations. After detecting the presence of markup and estimating it for each GTAP sector, one can now include these results for the input on the model. From our results, we not only advocate for the inclusion of markups, but we also believe it will enhance the good results for commerce, prices, growth and welfare obtained in those studies for the case of Brazil.

Table 8

GTAP	Description	Markup (w.a.)	Elasticity (w.a.)	Tariff (w.a.)
1	Paddy rice	0.965	0.955	1.005
2	Wheat	1.129	0.936	1.024
3	Cereal grains n.e.c.	1.094	0.890	1.011
4	Vegetables, fruit, nuts	1.373	1.206	1.079
5	Oil seeds	1.087	2.837	1.041
7	Plant-based fibers	1.394	0.865	1.060
8	Crops n.e.c.	1.329	1.314	1.046
9	Bovine cattle, sheep and goats, horses	1.113	1.042	1.080
10	Animal products n.e.c.	1.783	0.858	1.080
13	Forestry	0.875	0.944	1.040
14	Fishing	0.791	2.768	1.100
15	Coal	0.882	1.764	1
16	Oil	1.189	0.992	1
17	Gas	1.047	1.214	1
18	Minerals n.e.c.	0.886	1.015	1.002
19	Bovine meat prods	1.117	1.353	1.032
20	Meat products n.e.c.	1.020	3.955	1.100
21	Vegetable oils and fats	1.511	1.020	1.092
22	Dairy products	1.662	1.250	1.118
23	Processed rice	0.965	0.955	1.005
24	Sugar	1.907	1.294	1.160
25	Food products n.e.c.	1.683	1.121	1.106
26	Beverages and tobacco products	1.495	1.224	1.110
27	Textiles	2.319	1.705	1.217
28	Wearing apparel	3.081	2.608	1.349
29	Leather products	3.241	0.978	1.292
30	Wood products	2.201	0.949	1.179
31	Paper products, publishing	1.594	1.562	1.104
32	Petroleum, coal products	0.935	2.882	1.000
33	Chemical, rubber, plastic products	1.212	1.471	1.064
34	Mineral products n.e.c.	1.616	1.662	1.089
35	Ferrous metals	1.722	1.832	1.120
36	Metals n.e.c.	1.268	1.390	1.071
37	Metal products	2.153	1.025	1.162
38	Motor vehicules and parts	1.675	1.146	1.144
39	Transport equipment n.e.c.	2.185	0.906	1.155
40	Electronic equipment	1.994	0.807	1.107
41	Machinery and equipment n.e.c.	1.953	1.015	1.126
42	Manufactures n.e.c.	2.637	1.055	1.214

4. CONCLUSION

We were successful in finding evidence that markup related variables (import demand elasticity σ, tariffs τ and number of carriers n are statistically significant for determination of freights f in Brazil. Also, that freights are more sensible to these variables than it is to variables related to marginal costs, especially distances dist, which is commonly used as a proxy variable for transportation costs in trade studies, and, thus, is not the most adequate one.

Furthermore, we found markup in shipments carrying industrial goods are above average, and that they are driven by import demand elasticities more than by other variables. On the other hand, Agriculture goods transportation exhibit low market power, as their freights are more determined by sea distance than they are in any other sector.

Tariffs are the most definite determinant to markups, with elasticities to freights ranging from just above 3 to more than 6, depending on dummies used for each purpose along this work. Goods imported from US's freights are especially sensible to tariffs.

With evidence found in this work, which goes accordingly to evidence previously found by Hummels et al (2009), we believe tariff reductions, especially in Brazil, would have an amplified effect on trade, as they would reduce final prices also via freight costs. The current context of shipping industries, where tariffs are the only variable subject to be changed by policies, and where competition gets harder every year, only corroborates with our findings. It is also worth mentioning that the eventual increase in competition as a consequence of tariff reductions could also impact on elasticities σ, possibly improving Brazilian consumers' situation as well.

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