QUALITY AND PENETRATION OF BRAZILIAN EXPORTS: WHAT IS THE EFFECT OF COMPARATIVE ADVANTAGE?[1]

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Abstract: Many economies seek to upgrade the quality of their exports in order to gain improved access to the importing market, enhance competitiveness in international trade, higher productivity, better wages, and an increase in the product price and in the income, resulting in a possible improvement in the terms of trade. Furthermore, a growth trend was observed for Brazil at the beginning of the 21st century, while there was an increase in the concentration of Brazilian exports on low value-added goods, mainly due to a higher revealed comparative advantage in these sectors. This research sought to contribute to the debate over the quality of Brazilian exports and relate to the existence of a revealed comparative advantage. Moreover, it was intended to associate the existence of comparative advantage with penetration in the markets of the main trading partners of Brazil. Unconditional quantile regression and 2SLS were used as methods. Among the results, it was evidenced that, regardless of the income of the country and the product groups, the existence of revealed comparative advantage provides higher quality in the Brazilian exports. In addition, the RCA also contributes to a greater penetration of Brazilian products in the importing countries.
Keywords: quality of exports; revealed comparative advantage; exports penetration; unconditional quantile regression; instrumental variable.

Resumo: Muitas economias procuram elevar a qualidade de suas exportações com o intuito de ter maior acesso ao mercado importador, aumentar a competitividade no comércio internacional, maior produtividade, melhores salários, e aumento no preço do produto e na renda. Dessa forma, observa-se para o Brasil, no início do século XXI, uma tendência de concentração da pauta de exportações brasileira em produtos de baixo valor agregado, principalmente devido à uma maior vantagem comparativa revelada nesses setores. Portanto, o presente trabalho possuiu o intuito de contribuir para o debate acerca da qualidade das exportações brasileiras, relacionando-as com a existência de uma vantagem comparativa revelada. Além disso, pretendeu-se associar a existência de vantagem comparativa com a penetração nos mercados dos principais parceiros comerciais do Brasil. Como metodologia, utilizou-se a regressão quantílica incondicional e MQ2E. Entre os resultados, evidenciou-se que, independente da renda do país e dos grupos de produtos, a existência de vantagem comparativa revelada proporciona uma maior qualidade nas exportações brasileiras. Além disso, a RCA também contribuiu para uma maior penetração nos países importadores de produtos brasileiros.
Palavras-chave: qualidade das exportações; vantagem comparativa revelada; penetração das exportações; regressão quantílica incondicional; variável instrumental.

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1. INTRODUCTION

With the expansion of world trade, the transformations that occurred in Brazil in recent years were crucial to reinforce one of the main structural characteristics of the Brazilian foreign trade insertion - the concentration of the export agenda on products with low added value. The process of primarization of the country's export agenda was accentuated while the low export penetration in medium- and high-technology markets was maintained (HIRATUKA; CUNHA, 2011).

However, even if Brazil exports, in its majority, products with lower added value, it is still possible that, among the countries that trade the same good in the international market, it differentiates itself in terms of the quality of this product. In addition, even if the country is unable to export most technologically more advanced products, it can specialize in the marketing of small groups of products with higher added value and, in relation to other countries, increase its quality and/or achieve greater diversification of its exports in the international market.

Products can be distinguished vertically or horizontally. The horizontal dimension refers to the different types of goods, such as cars, wines, coffee beans, among others. The vertical dimension refers to the intrinsic quality of each specific product, i.e., characteristics that show substantial differences from one product to another, such as ageing time or grape selection in wine preparation (JAIMOVICH; MERELLA, 2015).

The main results of recent work relate the increase in the quality of exports of countries with greater access to the importing market of trading partners, mainly due to an increase in the competitiveness of their products in international trade. In addition, they associate better quality products with higher productivity, better wages, higher prices of goods and income, resulting in a possible improvement in the terms of trade[5].

Many studies have indicated new patterns of trade regarding the differentiation of exported products. Recent research has found that richer countries export better quality goods[6] and that they have consumers with a higher inclination to pay for these products and, therefore, also import better quality goods[7]. However, more developed countries do not always produce higher quality goods than less developed ones, due to the possibility of poorer nations marketing those products in which they have a comparative advantage[8] (ALCALÁ, 2008).

According to Alcalá (2016), companies in a country with a comparative advantage in one sector tend to be more productive globally and therefore produce higher quality goods. Jaimovich and Merella (2015) stressed that comparative advantage is strengthened as product quality increases. These authors showed that the comparative advantage and quality of exported products contributed to greater penetration in importing markets. According to Crinò and Epifani (2012), improving quality could be a prerequisite for effective access to the markets of richer countries. Moreover, when a firm sells better quality products, it can reach more distant markets, i.e. more difficult to penetrate, as evidenced in Bastos and Silva (2010), Baldwin and Harrigan (2011), Johnson (2012) and Verhoogen (2008).

Unlike existing studies in the literature, both national and international, this study analyzed the relationship between revealed comparative advantage (RCA)[9] and the quality of Brazilian exports from 1997 to 2016. In addition, this research sought to verify the influence of RCA on the penetration of Brazilian exports in the market of its 50 main importers or nearly 90% of the Brazilian trade. Finally, the characteristics of the importing country were related to the Brazilian trade patterns in terms of export quality.

In order to disaggregate the analysis on the subject of the research, we estimated the different factors affecting export quality by considering different sectors, product groups, income levels of importing

[5] See Brooks (2006), Verhoogen (2008), Bastos and Silva (2010), Vanderbussche (2014), Jaimovich and Merella (2015), Manova and Yu (2017).

[6] See Schott (2004), Hummels and Klenow (2005), Hallak and Schott (2011).

[7] See Hallak (2006), Fieler (2012), Crinò and Epifani (2012).

[8] For example, a country may produce the best cigars, because its soil and climate are ideal for growing tobacco. Thus, it is likely that the country has a vertical specialization in the production of cigars, resulting in a possible relationship between the quality of exports of this good and its comparative advantage (ALCALÁ, 2008).

[9] The revealed comparative advantage (RCA) attempts to quantify the advantage a country and/or sector has in the production of a given good compared to other countries and/or sectors. Further details on this variable will be provided later.

countries and quality ranges - by means of quantiles. Thus, it is possible to include, for a better understanding, several scenarios, considering different characteristics for each disaggregation.

This study sought to contribute to the formulation of public policies that focus on improving quality, as an incentive to innovation, qualified labor, among others. Therefore, by understanding the determinants of the quality of Brazilian exports, public action could be better articulated and concentrated on these main elements.

This study is structured in three other sections in addition to this introduction. The second section presents the methodology while the third shows the results and discussion. Lastly, the fourth section concludes.

2. METHODOLOGY

2.1 Quality of exports

One limitation of the studies on quality is the difficulty in defining what product quality really is. However, many authors, such as Hummels and Klenow (2005), Brooks (2006), Hallak (2006), Alcalá (2016) and Brambilla and Porto (2016), have attempted to measure the quality of products through proxies, such as the export price (unit values). However, this measure would not be adequate since, according to Hallak and Schott (2011), product prices may vary for different reasons, such as production costs or variations in the exchange rate, i.e., changes in prices may not only be associated with changes in product quality.

Considering these findings, this paper used the quality measure of Khandelwal (2010) and Khandelwal, Schott and Wei (2013), who applied the model developed by Berry (1994) to data on American foreign trade. This calculation is able to measure the quality including characteristics that are not observable to the product and/or the market. The authors assume a CES type utility function and consider that consumer preferences incorporate quality (δ), so the utility function is:

$$\mathrm{U} = \left[\int_{g\epsilon G} \left(\delta_{kijt}(g) q_{kijt}(g)\right)^{\sigma-1/\sigma} \partial g\right]^{\sigma/(\sigma-1)} \quad (1)$$

where $q_{kijt}(g)$ and $\delta_{kijt}(g)$ correspond to the quantity (kg) and quality level of the k variety exported by country i to country j in year t, respectively, while σ represents the elasticity of substitution. By maximizing the utility function, shown in equation (1), subject to the budget constraint, we obtain the demand equation given by:

$$q_{kijt}(g) = (\delta_{kijt}^{\sigma-1})(p_{kijt}^{-\sigma})(P_{kijt}^{\sigma-1})Y_{kijt} \quad (2)$$

where p_{kij} is the price of product k sold by country i to j in year t; P_{kijt} and Y_{kijt}represent the price and rent index of product k in country j in year t, respectively. By taking the logarithm in equation (2), the quality of each observation that comprises the Brazilian exports was obtained by the residual of the following equation:

$$\ln q_{kijt} + \sigma * lnp_{kijt} = \alpha_j + \alpha_k + \varepsilon_{kjt} \quad (3)$$

where q_{kijt} refers to the exported quantity (kg) of each product k from country i to country j in year t; p_{kijt} is the exported value of each product k from country i to country j in year t; σ is the elasticity of substitution; α_j and α_k are fixed effects of importing country and product, respectively. Equation (3) was estimated by Ordinary Least Squares (OLS). As in Filho, Medeiros and Albuquerquemello (2017), the average elasticity of substitution (σ) estimated by Broda, Greenfield and Weinstein (2006) was used for each importing country.

The quality of the products exported by Brazil from each product to the j-th country δ_{kj} was obtained by dividing the residual obtained in equation (3) by the elasticity of substitution minus one, as follows:

$$\text{qualidade} = \widehat{\delta_{kjt}} \equiv \hat{\varepsilon}_{kjt}/\sigma - 1 \quad (4)$$

Therefore, the measure of quality[10] of Brazilian exports of product k for each country j in period t was incorporated into the estimated equations of this study that will be explained in the following section.

2.2 Comparative advantage and quality of Brazilian exports

In order to meet the objective of analyzing the relationship between the comparative advantage in a given product and the quality of Brazilian exports to the country's main trading partners[11], the first model is based on Alcalá (2016) and is expressed as follows:

$$ln(quali._{ijkt}) = \beta_0 + \beta_1 ln(RCA_{ikt}) + \beta_2 ln(GDP_{jt}) + \beta_3 SPS_{ijkt} + \beta_4 TBT_{ijkt} + \beta_5 dist_{ij} + \beta_6 contig._{ij} + \alpha_t + \mu_z + \tau_j + \varepsilon_{ijkt} \quad (5)$$

where $quali._{jkt}$ is the indicator of the quality of exports from country i (Brazil) to country j in product k[12] in year t, obtained by equation (4), used in Filho, Medeiros and Albuquerquemello (2017), Manova and Yu (2017), Khandelwal, Schott and Wei (2013) and Khandelwal (2010).

RCA_{ikt} is the indicator of revealed comparative advantage of exports of country i (Brazil) in product k[13] in year t. Calculated according to Jaimovich and Merella (2015):

$$RCA_{ikt} = \frac{X_{ikt}/X_{it}}{W_{kt}/W_t} \quad (6)$$

where X_{ikt} is the value of exports of product k from country i in year t; X_{it} is the total value of exports of country i in year t; W_{kt} is the total value of exports of product k from the world in year t and W_t is the value of world exports in year t. One would expect to find for the variable VCR_{ikt} (β_1) a statistically significant and positive relationship. And, therefore, the hypothesis that a greater comparative advantage results in an increase in the quality of its exports would confirm. Alcalá (2008, 2016) conducted similar analyses for imports from the United States and found the same relationship.

GDP_{jt} is the gross domestic product by purchasing power parity of the importing country j in year t. It is expected that the coefficient estimated for this variable (β_2) is statistically significant and positive, which in such a case would confirm that Brazil exports higher quality products to countries with higher income. This pattern of trade specialization according to the GDP of the importing country was observed in world terms by Hallak (2006), Fieler (2012) and Crinò and Epifani (2012).

SPS_{ijkt} is the number of sanitary and phytosanitary measures applied to country i (Brazil) by country j on product k in year t. TBT_{ijkt} is the number of technical barriers to trade measures applied to country i (Brazil) by country j on product k in year t. The use of these variables is intended to verify whether the SPS and TBT measures[14] would act to improve the quality of Brazilian exports. When the country imposes SPS and TBT measures and the exporter is able to adapt to the notification requirements, the result may be the shipment of higher quality products. Such a result may be due to the need for the measures to be scientifically justified and, many cases, transformations in the production process are necessary. In addition, it is in the interest of countries to meet the requirements contained in notifications for the maintenance of trade. In the end, they can have effects similar to those of applying import tariffs. In this context, Fan, Li and Yaple (2015) found that, between 2001 and 2005, a reduction in Chinese import tariffs resulted in an increase in the quality and price of their exports in the international market. This is because

[10] According to Khandelwal (2010) and Khandelwal, Schott and Wei (2013), quality is inferred from the demand side, i.e., it is assumed that quality is any attribute that increases consumer demand, besides the price influence. This approach takes into account quality changes within the Harmonized System (HS) categories or within companies.

[11] The countries that make up the sample are Brazil's 50 main trade partners between 1997 and 2016, provided they had information on the country's income elasticity in the study of Broda, Greenfield and Weinstein (2006), necessary to calculate the quality of exports, and had imported Brazilian products throughout the period. In addition, the sample countries imported almost 90% of Brazilian exports from 1997 to 2016.

[12] It is important to note that all products of the 6-digit HS are considered in this study.

[13] At the 2-digit HS disaggregation level.

[14] These measures need to be scientifically justified and examined by the World Trade Organization (WTO). After the process of verifying the need for the measure, each country issues a notification containing the required standards and procedures, and the other countries included in the document need to adapt to the rules in order to maintain trade.

lower tariffs can contribute, for example, to facilitating access to intermediate inputs and, as a consequence, firms tend to produce higher-quality goods.

$dist_{ij}$ represents the distance, in kilometers, between the capital of each country. This is a proxy commonly used to measure transport costs between two countries, according to Mendonça (2011), Almeida *et al*. (2014) and Silva (2016). Bastos and Silva (2010) used this variable in order to show that, with the increasing distance between trading partners, only the most productive firms are able to export and produce goods of better quality. $front._{ij}$ is the dummy variable that assumes value 1 if Brazil and country j share a common border and 0 otherwise. This variable tries to capture if, because there is a lower cost of transport to countries that share a common border, Brazil exports products of better quality to these nations; α_t, μ_z, τ_j and ε_{ijkt} represent, respectively, time, industry[15] and importing country fixed effects, and the residual of the regression.

In order to meet the objective of analyzing how the comparative advantage influences the penetration of Brazilian exports in certain countries, the following equation was estimated:

$$ln(\mathrm{EP}_{jkt}) = \beta_0 + \beta_1 ln(RCA_{ikt}) + \beta_2 ln(GDP_{jt}) + \beta_3 SPS_{ijkt} + \beta_4 TBT_{ijkt} + \beta_5 dist_{ij} + \alpha_t + \mu_z + \tau_j + \varepsilon_{ijkt} \quad (7)$$

Equation (7) is based on the study of Jaimovich and Merella (2015), as well as the way to quantify export penetration. The depended variable is EP_{ijkt}, which is the penetration index of Brazilian exports of product k[16] in country j in period t obtained from:

$$EP_{ijkt} = \frac{E_{ijkt}}{E_{wjkt}} \quad (8)$$

where E_{ijkt} refers to the total value of exports from country i (Brazil) to country j of product k in year t; while E_{wjkt} refers to the total value of exports from the world w to country j of product k in year t.

The explanatory variables are the same as those used in equation (5). These variables included in the model are in accordance with the studies of Alcalá (2016) and Jaimovich and Merella (2015). The expectation is that the coefficient of the variable of interest RCA_{ikt} (β_1) is statistically significant and positive, which in such a case would confirm the hypothesis that a greater comparative advantage results in an increase in the penetration of these goods in international markets, as shown in Jaimovich and Merella (2015).

Finally, the analysis was also divided into groups of agricultural and industrial[17] products and developed and developing countries[18]. The products were then divided into 14 categories[19] in order to attempt to understand the characteristics of each group.

2.3 Empirical strategy

The studies that analyzed the quality of exports, mostly, used the technique of Instrumental Variables (IV) (HALLAK, 2006; ALCALÁ, 2008; KHANDELWAL, 2010; HALLAK; SCHOTT, 2011; ALCALÁ, 2016; CRINÒ; OGLIARI, 2017). In this study, the RCA is potentially endogenous between this

[15] The aggregation of products at the 2-digit HS level is considered an industry.

[16] At the 4-digit HS disaggregation level.

[17] It should be noted that all products of the 6-digit HS are considered in this study. These goods were grouped into two sectors: agricultural and industrialized. Agricultural products were considered all those defined as such by the Agreement on Agriculture, negotiated between WTO members in the Uruguay Round. In detail, agricultural products comprise chapters 1 to 24 of the HS, excluding chapter 3 (fish, crustaceans, molluscs and other aquatic invertebrates). In addition, some products from other chapters were included in the agreement: 29.05.4, 33.01, 35.01, 35.02, 35.03, 35.04, 35.05, 38.09.1, 38.23.6, 41.01, 41.02, 41.03, 43.01, 50.01, 50.02, 50.03, 51.01, 51.02, 51.03, 52.01, 52.02, 52.03, 53.01, 53.02. For industrialized products, the rest of the HS chapters were considered.

[18] In some estimates, the countries were divided into two groups according to the World Bank classification (2018). The first group would be the more developed countries, which had gross national income per capita (GNI) of $12,056.00 or more in 2017. For the second group, the least developed countries, it included countries with medium-high and medium-low income, ranging from $996 to $12,055. For developed countries, there were a total of 30 countries, while for developing countries there were 20 countries.

[19] The groups are formed by joining the subgroups at the 2-digit HS aggregation level, according to https://www.foreign-trade.com/reference/hscode.htm. As in Jaimovich and Merella (2015), the "Miscellaneous" and "Services" groups were excluded.

variable and the dependent variables, export quality ($quali._{jkt}$) and export penetration (EP_{ijkt}). This problem is present in this study due to the existence of data on Brazilian exports of product k to country j on both sides of equations (5) and (7), that is, in the dependent variables' quality and penetration of exports and the explanatory variable revealed comparative advantage. As demonstrated in Alcalá (2016), errors in the measurement of these data could be passed on to both sides of the equation. Thus, estimating the equation using the OLS method would deliver biased and inconsistent estimates. Therefore, the IV technique was used in order to try and correct endogeneity.

As Alcalá (2016), the instrument used to treat endogeneity is the RCA measure that excludes exports of product k to country j. This measure follows:

$$\mathrm{RCA}_{ikt}^{ex_{i,j,k}} = \frac{X_{ikt} - X_{ijkt} / X_{it} - X_{ijt}}{W_{kt} - W_{jkt} / W_t - W_{jt}} \quad (9)$$

where $X_{ikt} - X_{ijkt}$ are the Brazilian exports of product k excluding exports of product k to country j. $X_{it} - X_{ijt}$ are total Brazilian exports excluding total exports to country j. $W_{kt} - W_{jkt}$ are world exports of product k excluding exports of product k to country j. $W_t - W_{jt}$ are total world exports excluding exports to country j.

Thus, for equation (7), the 2SLS method was used. While for equation (5), unconditional quantile regression was used, considering that the relationship between the explanatory variables and the explained variable might be different when comparing different quality levels. The unconditional quantile regression was used in equation (5) in the second stage. In the first stage, in order to try to correct the endogeneity problem, the endogenous RCA was estimated in relation to its instrument RCA_{ex} and all the explanatory variables of equation (5), besides the fixed effects of year, importing country and industry (HS02). For this reason, it was used in the second stage the forecast of the Y (RCA) of the first stage. In this study, it was used, therefore, the approach of unconditional quantile regression, proposed by Firpo *et al*. (2009), for the estimates of equations that have as the dependent variable the quality of Brazilian exports. The advantage of this method is that it allows to analyze the influence of the explanatory variables used in this study in the different quality quantiles, in addition to making comparisons between the quantile results.

The approach of Firpo et al. (2009) is based on the influence function (IF). The $\mathrm{IF}(\mathrm{Y}; \mathrm{v}; \mathrm{F}_y)$ influence function of a distribution statistic $\mathrm{v}(\mathrm{F}_y)$ represents the influence of an individual variable on this distribution statistic. By adding the $\mathrm{v}(\mathrm{F}_y)$ statistic again to the influence function, it results in what is called the recentered influence funcion (RIF). This method allows for the estimation of the effect of changes in a set of covariates X in the statistical distribution that is of interest. Therefore, in this case, we are interested in the influence on the quantile distribution. Thus, the unconditional quantile regression is defined by Firpo *et al*., 2009:

$$\mathrm{v}(\mathrm{F}_y) = \mathrm{E}_x[E[\mathrm{RIF}(\mathrm{y};\ \mathrm{v}; \mathrm{F}_y)]] = E(X).\beta \quad (10)$$

It is noteworthy that the conditional quantile regression, proposed by Basset and Kroenker (1978), is different from the unconditional quantile regression, proposed by Firpo *et al.* (2007, 2009). In the conditional quantile regression, the effect found in each quantile is conditional on the characteristics of vector X of that quantile under analysis only (within-group effect) and cannot be extrapolated to the others. In the unconditional quantile regression, one can analyze the effect of the vector of covariates X throughout the distribution of the dependent variable, thus allowing to verify the effect both on the quantile (within-group effect), as between quantiles (between-group effect), which enables the performance of a more accurate analysis on the topic (FIRPO et al., 2007).

2.4 Data source

The data used in this work are annual and cover the years 1997 to 2016. Data on Brazilian exports (US$) and quantity (kg) were collected from SECEX/MDIC (Secretariat of Foreign Trade - Ministry of Development, Industry and Foreign Trade, 2018). In this database, the classification of products follows the Mercosur Common Nomenclature (NCM), with its first digits corresponding to the first digits of HS.

The United Nations Commodity Trade Statistics Database (UNCTAD, 2018) was used for information on exports and imports and allowed to calculate the RCA and EP. The Gross Domestic Product (GDP) of Brazil's main trading partners was obtained from the World Bank (World Development

Indicators, 2018). The geographical distance (distance between the capital of the importing countries selected in the sample and Brasilia, measured in km) as well as the existence of a common border between Brazil and the partners were obtained from the Center for Prospective Studies and International Information (CEPII, 2018). Notifications of SPS and TBT measures issued by Brazilian importers were collected at the WTO (2017) taking into account notifications from each industry (2-digit HS)[20].

3 RESULTS

3.1 Descriptive analysis

Table 1 presents the average RCA, quality and penetration of exports according to the partner country's income and type of product. As expected, the average RCA of agricultural products is much higher than that of industrialized products. According to Maranhão and Filho (2016), as of the 2000s, there was a large growth in the export of agricultural products motivated mainly by the increase in demand from emerging countries and high prices, which provided the boom in commodities. In addition, according to the authors, there is an expansion in competitiveness gains, these linked to technological modernization with the resulting expansion of productivity.

On the other hand, the average quality of industrialized products is higher than that of agricultural goods. As explained by Khandelwal (2010), some products have a broad quality "ladder" and this is generally more evident in industrialized products than in agriculture[21]. Thus, the quality for industrialized products tends, in most cases, to assume great values, which may explain a higher average quality for these goods, even if Brazil cannot, in general, be so competitive in these sectors.

As far as penetration is concerned, Brazilian agricultural products have a greater insertion in the markets of other countries than industrialized ones. A study by Teixeira Filho et al. (2001), in which they analyzed the activities of various sectors of Brazilian agricultural production, indicated a high degree of competition in international markets for these products. As a result, Brazilian basic products are able to reach many important international markets, such as China, the United States, the Netherlands, Germany and Russia, which import more than half of Brazilian products in this sector (BRAZIL, 2017).

Table 1 - RCA, quality and penetration average of Brazil for commercial partners

Variables/Groups	Developed countries	Developing countries	Agricultural products	Industrialized products
RCA	1.34	1.17	5.10	0.92
Quality	5.84	5.70	5.18	5.84
Penetration	0.071	0.089	0.13	0.074
Observations	600,470	397,763	83,749	914,484

Source: Own elaboration.

In relation to the level of development, Brazil exports products that have higher RCA to developed countries, but this difference is not so great in relation to developing countries. In general, the average quality of products exported to developed and developing countries assumes close values, even if the first group presents a slightly higher average.

[20] It was considered that the number of notifications does not show great variation within each industry. Products belonging to the same industry have similar characteristics. Thus, when a notification is issued, it usually covers a group of similar products and, therefore, generally affects products from the same industry in the same way.

[21] In addition to the factors already observable such as price and market power, quality is obtained through a calculation that considers its determining components, which are sometimes subjective. These components are captured by the error term of equation (7). Thus, industrialized products have more factors that enable greater quality differentiation compared to agricultural products. For example, when taking into account the quality of computers and apples, there are many more factors that are not observable and/or that are not included in the equation, which are captured by the error term, influencing in greater intensity the quality of the first good relative to the second. Khandelwal (2010) highlights this fact explaining the concept of quality "ladder", which is greater for industrialized products than for agricultural products. The quality "ladder", in this sense, corresponds to the amplitude that can assume the quality of a product, that is, the difference between the highest and the lowest value.

Brazilian exports have a greater penetration in developing countries than in developed countries. Some factors may explain this result such as, for example, the fact that richer markets have more rigorous consumers and the competition to reach them is greater, which may hinder the penetration of exports in these countries. In addition, Brazil's international strategy in recent years has focused on deepening relations with many developing countries in order to reach trade agreements, introducing a logic of rapprochement with large countries in the South, especially since 2003 (OLIVEIRA, 2012). Furthermore, proximity to Latin American countries may also explain this result. Countries that are located geographically close to Latin America have lower logistics and transport costs and, therefore, the expenses that have been saved could be used to improve production processes and, consequently, product quality.

3.2 Effects of revealed comparative advantage on the quality of Brazilian exports

This section presents the estimates of equation (5) that shows the relationship between the quality of Brazilian exports and some control variables such as distance, GDP of the importing country, among others, as well as the explanatory variable of interest, which is the revealed comparative advantage. The equation was estimated through the Unconditional Quantile Regression, Fixed Effects Panel (FE) and Two Stage Least Squares (2SLS) and the results are presented in Table 2.

Alcalá (2008, 2016) suggests the existence of endogeneity between quality and RCA. For this reason, the equation was estimated by Unconditional Quantile Regression, with the first stage obtained indirectly, in order to try to treat endogeneity. The results were obtained for the full sample, for developed and developing countries, for agricultural and industrialized products and for 14 sectors of the Brazilian economy (estimated by 2SLS). To confirm the existence of endogeneity, the Durbin-Wu-Hausman (DWH) test was performed, indicating that, in fact, the RCA is an endogenous variable. The F test was calculated and it was verified that the instruments considered are strong (the value of the calculated F is greater than 10 for all regressions). However, the analysis of this section was made based on the results of the unconditional quantile regression - with the exception of the regressions of the 14 sectors of the economy -, which incorporates the quality differentials according to the quantile. Hence, it is possible to analyze the relationship between the explanatory variables through different quality quantiles. The estimates of both FE and 2SLS were made with the purpose of comparing and testing the robustness of the results. It can be seen that the coefficient for RCA is significant and maintains the same sign in these two estimates.

As presented in Table 2, the results indicate that there is a positive relationship between the RCA and the export quality. This result was also found by Jaimovich and Merella (2015) and Alcalá (2008, 2016). Nevertheless, this relationship was not significant only for the 0.25 quantile. In addition, it can be seen that the RCA coefficient is increasing as it moves towards the highest quantile. From this result, it is possible to infer that the higher the quality of Brazilian exports, the more intensified is the connection between RCA and quality. According to Alcalá (2016), producers in a country that have an advantage in a given sector will be, on average, more efficient than producers in other countries. If greater efficiency is used to improve quality, then producers in this country and the industry will produce, on average, goods of higher quality than their competitors, because they already have an "initial advantage" - that is, a revealed comparative advantage in that industry.

Table 2 - Estimates of the Relationship between Quality and Revealed Comparative Advantage

Dependent variable: Quality					
Quality quantiles	Q(0,25)	Q(0,50)	Q(0,75)	F.E.	2SLS
$\ln(RCA\_P_{ikt})$	0.0008	0.0025***	0.0054***	0.0037***	0.013***
	(0.0006)	(0.0005)	(0.0005)	(0.0005)	(0.0002)
$contig_i$	0.8160***	0.5880***	0.6280***	0.5420***	0.4750***
	(0.0287)	(0.0228)	(0.0248)	(0.0141)	(0.0082)
$\ln(dist_i)$	0.5870***	0.4410***	0.4590***	0.3580***	0.3200***
	(0.0154)	(0.0127)	(0.0144)	(0.0223)	(0.0123)
$\ln(GDP_{it})$	-0.0070	-0.0060	0.0292***	0.0072	0.0083***
	(0.0072)	(0.0058)	(0.0063)	(0.0045)	(0.0025)
SPS_i	0.0004**	0.0002*	0.0000	-0.0000	-0.0004***
	(0.0001)	(0.0001)	(0.0002)	(0.0001)	(0.0000)
TBT_i	-0.0015***	-0.0011***	-0.0002	-0.0002*	0.0003***
	(0.0002)	(0.0002)	(0.0002)	(0.0001)	(0.0000)
constant	-3.6440***	-1.9780***	-2.7550***	-1.5350***	-1.3260***
	(0.3190)	(0.2560)	(0.2820)	(0.0889)	(0.0513)
Observations	234,833	234,833	234,833	234,833	994,505
R^2	0.391	0.429	0.396	0.599	0.462

Source: Research results.

Note: Robust errors in parenthesis. ***Significant at 1%; **Significant at 5%; *Significant at 10%. All estimates include year, importing country and industry (HS 2-digit) dummies.

The coefficient of the distance variable (Table 2) obtained the expected signal, indicating that, for more distant markets, that is, more difficult to be reached, Brazilian exports are of a higher quality. Such result was also found by Bastos and Silva (2010), Baldwin and Harrigan (2011), Verhoogen (2008) and Johnson (2012) for Portugal, the United States, Mexico and a group of 125 countries, respectively. For Bastos and Silva (2010), by considering the heterogeneity of firms, the result can be explained by the self-selection of companies between destinations, with only higher quality producers entering more distant markets[22].

In the same table, the coefficient of the variable GDP was significant, at the level of 1%, and with a positive sign only for the 0.75 quantile indicating that the higher the income of the importing country, the higher the quality of Brazilian exports in the 0.75 quantile. This result is consistent with the hypothesis that richer countries import better quality products because consumers are more demanding and demand better product.This result was found by Filho, Medeiros and Albuquerquemello (2017) who, despite not having performed a quantile analysis, also found a positive relationship between the importers' GDP and the quality of products exported by Brazil.

Regarding the SPS and TBT variables, they were significant only for the 0.25 and 0.50 quantiles. In general, the coefficients of the SPS measures had a positive sign and the TBT coefficient had a negative sign. This result suggests that the SPS measures help to increase the quality of Brazilian exports, while the TBT measures contribute negatively to the quality of exports. The measures may have ambiguous results on exports. On the one hand, they comprise changes aimed at improving hygiene, technical standards, reducing information asymmetry for consumers, among others. And, therefore, they are able to increase the quality of exported products, as verified for SPS. On the other hand, they can act as barriers to trade, given that higher quality products already have higher marginal costs[23], and an increase in these costs - due to the adequacy of the measure at some stage of the production process - would make trade in these goods unviable, reducing the quality of exported products. Moreover, the incidence of SPS measures is generally higher also for agricultural products, which have lower "initial quality" in the sample. For this reason, the initial marginal contribution of such measures on quality tends to be higher. In addition, these products reach a larger number of destinations, most of which requiring significant adjustments, which may translate into an increase in quality.

Table 3 shows the unconditional quantile regression estimates for developed (1) and developing (2) countries, as well as for agricultural (3) and industrialized (4) products. By restricting the sample for observations from developed countries, the relationship between RCA and quality intensified in the lowest quality quantile, differently from the estimation with the complete sample (Table 2). This fact can be explained by the composition of Brazilian exports to developed countries. In general, most Brazilian exports of agricultural and mineral products are sent to richer nations, products in which Brazil has higher RCA. At the same time, they are products with a lower degree of differentiation (reduced quality ladder) and can therefore influence the calculation of quality, contributing to a decrease in quality values. It is expected that in comparison to exports to more developed nations, agricultural products are present with

[22] Baldwin and Harrigan (2011) have a theoretical model that relates the quality of products to distance, based on Melitz (2003). The authors show that the highest quality products are more expensive, more profitable and can reach distant markets.
[23] See Baldwin and Harrigan (2011).

greater intensity in the lower band of the quality distribution. The relationship between RCA and quality is intensified in this quantile, corroborating the fact that the country presents significant comparative advantages in the export of the agricultural sector.

Brazil has a higher RCA in agricultural products, which may explain that the effect of this variable is more important in smaller quantiles. As one advances in higher quality quantiles, the depth of the connection between an advantage in production and its consequence in higher qualities dissipates. In the early stages of quality for these products, this relationship may be much more relevant, given the difficulty of increasing quality. However, as companies improve their production process and manage to increase the quality of their exports, this initial contribution of RCA diminishes its importance. Moreover, for developed countries, according to Table 3 (1), the same result was found, confirming the explanation.

On the other hand, with regard to the relationship between the RCA and the quality of industrialized products (4), as one moves towards lower quality quantiles, this connection becomes less pronounced. This means that this relationship is intensified in the highest quality quantiles, with the highest value of the RCA coefficient for the 0.75 quantile. This fact can be explained by Brazil's lower competitiveness in industrialized products. Having an advantage over international competitors becomes even more necessary as better-quality products are traded, i.e., they are located in the largest quantiles.

Table 3 - Estimates of the Relationship between Quality and RCA by groups of countries and products[24]

Dependent variable: Quality	(1) - Developed countries			(2) - Developing countries		
Quality quantiles	Q(0.25)	Q(0.50)	Q(0.75)	Q(0.25)	Q(0.50)	Q(0.75)
ln(RCA_P$_{jkt}$)	0.0033***	0.0028***	0.0032***	0.0011	0.0013*	0.0083***
	(0.0009)	(0.0007)	(0.0008)	(0.0009)	(0.0007)	(0.0008)
$contig_j$	-	-	-	-	-	-
	(-)	(-)	(-)	(-)	(-)	(-)
ln($dist_j$)	0.0379	0.0386	-0.1200***	-0.0355	-0.0079	-0.0033
	(0.0356)	(0.0294)	(0.0330)	(0.0265)	(0.0217)	(0.0230)
ln(GDP_{jt})	-0.0105	-0.0092	0.0379***	0.0052	-0.0047	-0.0094
	(0.0122)	(0.0101)	(0.0114)	(0.0112)	(0.0091)	(0.0096)
SPS_j	0.0004*	0.0006***	0.0005**	0.0002	-0.0014***	-0.0015**
	(0.0002)	(0.0002)	(0.0002)	(0.0003)	(0.0005)	(0.0007)
TBT_j	-0.0024***	-0.0021***	-0.0011***	0.0009***	0.0031***	0.0040***
	(0.0002)	(0.0002)	(0.0002)	(0.0003)	(0.0003)	(0.0005)
Observations	144,996	144,996	144,996	89,833	89,833	89,833
R^2	0.423	0.473	0.448	0.331	0.374	0.322
Dependent variable: Quality	(3) - Agricultural products			(4) - Industrialized products		
Quality Quantities	Q(0.25)	Q(0.50)	Q(0.75)	Q(0.25)	Q(0.50)	Q(0.75)
ln(RCA_P$_{jkt}$)	0.0200***	0.0121***	0.0048***	-0.0015**	0.0013**	0.0063***
	(0.0018)	(0.0014)	(0.0016)	(0.0007)	(0.0006)	(0.0006)
$contig_j$	0.2360***	0.3160***	0.2690***	-0.0666	-0.127*	0.392***
	(0.0289)	(0.0250)	(0.0267)	(0.0865)	(0.0683)	(0.0738)
ln($dist_j$)	-0.1840***	-0.1530***	-0.2270***	-0.161***	-0.162***	0.0413
	(0.0640)	(0.0531)	(0.0528)	(0.0332)	(0.0260)	(0.0275)
ln(GDP_{jt})	-0.0182	0.0101	0.0429***	-0.0045	-0.0069	0.0340***
	(0.0175)	(0.0146)	(0.0148)	(0.0079)	(0.0063)	(0.0069)
SPS_j	-0.0004	0.0019***	0.0022***	0.0003*	-0.0004**	-0.0005**
	(0.0005)	(0.0003)	(0.0004)	(0.0002)	(0.0001)	(0.0002)
TBT_j	0.0033***	0.0016**	0.0015	-0.0016***	-0.0010***	-0.0002
	(0.0009)	(0.0008)	(0.0011)	(0.0002)	(0.0002)	(0.0002)
Observations	42,496	42,496	42,496	192,333	192,333	192,333
R^2	0.406	0.430	0.417	0.395	0.431	0.396

Source: Research results.

[24] Robust errors in parenthesis. ***Significant at 1%; **Significant at 5%; *Significant at 10%. All estimates include year, importing country and industry (HS 2-digit) dummies. All regressions were estimated with constant, but they were removed from the table only to reduce its size.

Table 4 presents the results of the estimates that investigate the relationship between quality and the RCA for 14 sectors[25] of the economy, based on the 2SLS model. The purpose of performing such an analysis is to try to understand how this association may differ depending on the characteristics of each sector.

As shown in the table, for all sectors there was a positive relationship between the RCA and quality, with the exception of the Chemical and Related Products and Electrical Machinery and Equipment sectors. This result can be explained by the low average value of the RCA that these two sectors have and, even so, denotes a high-quality value (Table 4). This may indicate high investments in these sectors, since it is possible to generate high-quality products, even in the absence of significant comparative advantages. The chemical products sector has grown in terms of world market power over the last decade. The sector occupies a prominent position, being the ninth in the world ranking of net sales, only behind the United States, Japan, China, Germany, France, Korea, the United Kingdom and Italy and ahead of Russia, India and countries that have important companies in this sector, such as Belgium, the Netherlands, Finland and Switzerland (GALEMBECK *et al*., 2007). Nevertheless, the sector continues to present successive deficits in the trade balance, which in 1997 was 4 billion dollars and in 2018 reached 25 billion dollars (COMEX STAT, 2019). This may explain the fact that Brazil has low RCA and penetration values in other countries, resulting in a higher import for this sector. In regard to the Electrical Machinery and Materials sector, it has also showed successive deficits and reached the highest value in 2014 of 46 million dollars (COMEX STAT, 2019).

Table 4 - Estimates (2SLS) of the relationship between Quality and Revealed Comparative Advantage between sectors

Dependent variable: Quality					
Sectors	Animal & animal products	Vegetable products	Foodstuff	Mineral products	Chemical & allied industries
$\ln(RCA\_ex_{jkt})$	0.0493***	0.0200***	0.0231***	0.0391***	-0.00458***
	(0.00155)	(0.00165)	(0.000686)	(0.00194)	(0.000660)
Observations	14,204	31,388	36,718	14,487	112,870
Sectors	Plastic & rubbers	Skins, leather & furs	Wood & wood products	Textiles	Footwear
$\ln(RCA\_ex_{jkt})$	0.0241***	0.0248***	0.0154***	0.0115***	0.0407***
	(0.000726)	(0.00140)	(0.00106)	(0.00149)	(0.00152)
Observations	67,735	16,512	46,851	125,701	16,220
Sectors	Stone & Glass	Metals	Machinery & electrical	Transport	
$\ln(RCA\_ex_{ikt})$	0.00317*	0.0240***	-0.0049***	0.0517***	
	(0.00175)	(0.000565)	(0.000399)	(0.00109)	
Observations	43,341	130,736	228,797	25,800	

Source: Research results.

Note: Robust errors in parentheses. ***Significant at 1%; **Significant at 5%; *Significant at 10%. All estimates have fixed year, industry (HS 2-digit) and importing country dummies. All regressions were estimated according to equation (5), but only the variable of interest was maintained to reduce the size of the table.

[25] These sectors were used according to Jaimovich and Merella (2015).

The sector that denotes the highest value of the relationship between quality and RCA was the Transport sector, which has been growing considerably throughout the decade, mainly due to the increase in exports of airplanes and automobiles. Between 1997 and 2016, vehicle exports maintained an annual average of 10 billion dollars. Its main buyer is Argentina which, in 2016, acquired almost 60% of the cars exported by Brazil, followed by Mexico (8%), Chile (6%) and the United States (6%) (COMEX STAT, 2019). The average quality of car exports to these countries is 7.20, while the average for other countries in the sample is 6.24. It is possible to note that higher quality products are exported to those countries that have a higher market share of Brazilian goods.

Brazilian aircraft trade maintained an annual average of approximately 3 billion and 600 million dollars between 1997 and 2016. The main importer of aircraft is the United States, which, in 2016, purchased more than 65% of Brazilian exports of these products. China is also a major buyer, acquiring 7% of Brazilian aircraft exports in 2016, followed by Japan (4.5%), France (2.6%) and the Netherlands (2.2%) (COMEX STAT, 2019). The average quality of aircraft exports to these main importing markets is 12.28, higher than to other destinations, which is 10.25. In addition, the average RCA of this product for these countries is 1.23, while for the other countries is 1.12.

The second sector that presented the highest value of the relationship between the RCA and the quality of Brazilian exports was Animals and Animal Products. Within this sector, the product with the largest share is meat and offal (SH01), which has an annual average export value of 547 million dollars between 1997 and 2016. Brazil's main importer of meat and offal is Hong Kong, with 15% of Brazilian exports in 2016. Next are Saudi Arabia (10%), China (10%), and Egypt (8%) (COMEX STAT, 2019). The general quality of meat and offal is 7.58, while the quality of this product for the main importers is 8.46. In addition, the general RCA for meat and offal is 0.47, while for the main importers it is 1.07. These results indicate that the higher the RCA of a product, the higher the quality of exported goods. And, probably due to this higher quality, these products increase their market share for these countries.

3.3 Effects of the comparative advantage revealed on the penetration of Brazil's main trading partners

In this section the estimates of the relationship between RCA and the penetration of Brazilian exports are shown in Table 5. It is believed that there is endogeneity between penetration and RCA, thus, equation (7) was estimated through the 2SLS, for different groups of the sample. It is noteworthy that the DWH test indicated that, in fact, there exists an endogenous variable. The results were obtained for the full sample, for developed and developing countries, for agricultural and industrialized products, and for 14 sectors of the Brazilian economy. Based on the calculated F test, it was found that the instruments are strong[26]. In addition, equation (7) was estimated using the FE panel in order to compare the models. According to Table 5, it is possible to infer that, for all regressions, there is a positive and significant relationship between penetration and RCA, as found in Jaimovich and Merella (2015).

Based on Table 4, the association between penetration and RCA is positive for both agricultural and industrialized products. Having a higher RCA in a given product might indicate that it has a high degree of productivity when compared to other products. As presented in the previous section, this may translate into an increase in quality. As a consequence, Brazilian exports would be able to penetrate more markets, regardless of the sector considered.

[26] The value of the calculated F is greater than 10 for all endogenous variables.

The association between RCA and penetration is also positive for both groups of countries, but the coefficient was higher for developed nations. According to Jaimovich and Merella (2015), richer importers tend to increasingly specialize their consumption in varieties supplied by exporters that have a greater comparative advantage in the exported good sector. As consumers in developed countries purchase high quality varieties of each good, suppliers with higher productivity are better able to exploit their growing cost advantage when dealing with developed importers. The marketing of higher-quality products may be one of the main factors contributing to a greater penetration in the imports of Brazil's main trading partners. According to Crinò and Epifani (2012), the improvement of quality could be a prerequisite for effective access to the markets of richer countries.

In regard to the income coefficient of the importing country, the results show that the higher the GDP, the lower the market penetration of Brazil's trade partners. This result is explained by the fact that the higher the country's income, the more intense is the competition to reach these markets, making their penetration more difficult. In general, consumers in countries with higher income tend to be more rigorous and often demand more sanitary standards and/or better product specifications, which can make it difficult for Brazilian exports to enter these markets. This argument is corroborated by the result of the variable representing the SPS measures, indicating a lower penetration in their presence.

According to the study by Jaimovich and Merella (2015), the negative relationship between market penetration and distance, which represents the costs of commercial transactions, was confirmed. This association is even more negative when it comes to industrialized products, considering that the international competition of these products is already fierce. The difficulty in penetrating other markets increases even more to places with greater distances, due to the higher cost embedded in such a transaction.

As opposed to the results found for quality, the higher the number of SPS measurements, the lower the penetration. These measures tend to reduce market entry, as evidenced in the work of Fontagné *et al*. (2015), who found that SPS measures negatively affect the intensive and extensive margins[27].

On the other hand, an increase in the number of TBT measures has a positive relationship with penetration. TBT measures can enhance products in order to influence an improvement in labeling, packaging, weights and measures, among others, even if, in the estimate shown in Table 5, it does not necessarily mean an increase in quality. However, product entry into many countries requires cultural and language adaptations (related to changes in packaging and labels and even other technical modifications) in order to allow the product to be marketed in the country. This can translate into increased penetration, even if it does not modify quality. Consumers may prefer products with better technical specifications, causing an expansion of TBT measures to increase market penetration by Brazil's main trading partners. Or, even if the trading partner applied a TBT, Brazil may be able to meet the requirements of this measure and thus be able to have greater access to the main importing markets.

[27] The intensive margin refers to the value of exports and the margin extends to the number of products traded.

Table 5 - Penetration and Revealed Comparative Advantage

Dependent variable: Penetration	(1)	(2)	(3)	(4)	(5)	(6)
Variables	Full sample	Developed countries	Developing countries	Agricultural products	Industrialized products	F.E.
$\ln(RCA\_P_{jkt})$	0.752***	0.775***	0.713***	0.731***	0.745***	0.376***
	(0.0019)	(0.0024)	(0.0032)	(0.0052)	(0.0205)	(0.00425)
$\ln(dist_j)$	-3.928***	-2.770***	-2.955***	-3.289***	-3.949***	-3.147***
	(0.0459)	(0.9050)	(0.387)	(0.1742)	(0.4732)	(0.0971)
$\ln(GDP_{jt})$	-0.0624***	-0.3414***	-0.398***	-0.056	-0.068***	-0.1146***
	(0.0213)	(0.0311)	(0.0373)	(0.7892)	(0.2195)	(0.04461)
SPS_j	-0.0029***	-0.0041***	-0.0015	-0.017***	-0.0024***	-0.0106***
	(0.0003)	(0.0004)	(0.0017)	(0.0022)	(0.0003)	(0.0015)
TBT_j	0.0053***	0.0074***	0.0004	0.0062	0.0054***	0.0049***
	(0.0005)	(0.0005)	(0.0011)	(0.0045)	(0.0049)	(0.0013)
constant	32.33***	29.47***	33.59	26.55***	32.31***	28.41***
	(0.253)	(0.1227)	(0.7518)	(0.9612)	(0.2618)	(0.5460)
Observations	994,766	599,994	394,772	83,474	911,292	234,929
R squared	0.612	0.622	0.554	0.506	0.626	0.424

Source: Research results.

Note: Robust errors in parenthesis. ***Significant at 1%; **Significant at 5%; *Significant at 10%. All estimates include year, importing country and industry (HS 2-digit) dummies.

Estimates similar to those shown in Table 5 were made considering 14 sectors of the economy, as verified in Table 6. The objective of this analysis is to try to understand how the relationship between penetration and RCA can be modified due to different characteristics among the sectors of the economy. It is noted that the association between penetration and RCA was significant and positive for all sectors, even for those that presented a negative relationship between quality and RCA in Table 4. This suggests that, even with the specifics of each sector, the link between revealed comparative advantage and penetration remains, indicating that those sectors that have a higher RCA will be able to access importing markets with more intensity.

The sector of Plastics and Rubbers was the one that obtained the highest coefficient of the relationship between RCA and penetration in the importing markets. Between 1997 and 2016, the average export of this sector was 282 million dollars, reaching 495 million in 2016. The main importing country is Argentina, which imported approximately 18% of the Brazilian exports in this sector in 2016. Next are the United States (14%), the Netherlands (10%), Belgium (7%) and Colombia (6%) (COMEX STAT, 2019). Among these countries, only Belgium is not in the sample composition of this work. The average quality of exports to all trading partners of plastics and rubbers is 5.13 while the average for the main importers is 6. In addition, the average penetration of Brazilian exports of these products to all trading partners is 0.068, while the penetration for the main importers of this sector is 0.13. It is possible to perceive that, for the main importers of this sector, the products are of greater quality than the average and that greater penetration in these markets is reached. When considering the highest RCA values (greater than 3) for this sector, they are those that have a penetration above the general average (0.10) and also a quality above the general average (5.33). This suggests that products that have a higher RCA may indicate higher values of penetration and product quality.

According to data from Comex Stat (2019), the Food Products sector, between 1997 and 2016, obtained an annual export average of more than 1 billion dollars. The sector enjoys successive surpluses and, the year of 2013 was its largest contribution to the trade balance, with more than 2 billion dollars generated for the Brazilian economy. These data indicate a great advantage in the production of this sector. The main importers of Brazilian food products are the Netherlands, equivalent to 12% of exports in 2016 in this sector, the United States (6%), France (5%), Germany (5%) and Thailand (5%). The highest RCA values (greater than 30) denote an average penetration of 0.30, while the general average penetration of this sector is 0.12, corroborating the results found that a higher RCA is associated with the expansion of penetration of Brazilian exports in this sector.

The Wood and Wood Products sector showed growing trade surpluses, mainly due to the growth of China, which is currently the main importer of this sector. While its exports presented an average annual growth of 7.25%, China exposed an average growth of Brazilian imports in this sector of 153%. Besides China, which imported 25% of Brazilian exports of wood and wood products in 2016, the United States is also a major buyer, consuming 15% of Brazilian exports. Next are the Netherlands (10%), Italy (8%) and Argentina (5%). Assuming the highest RCA values (above 10), the average penetration is 0.13, while the overall average for the sector is 0.09.

The Stones and Glass sector exhibited an annual export average of 237 million dollars between 1997 and 2016. Trade surpluses have been growing over the years, showing a growing advantage in the marketing of these products. The main importers are the United States, purchasing about 28% of this sector in 2016, followed by Canada (13%), Switzerland (10%), the United Arab Emirates (8%) and Hong Kong (7%). In the case of the highest RCA values of this sector (above 8), penetration showed an average of 0.17, in turn, the overall average is 0.078. Finally, it is confirmed that, for all sectors under analysis, when considering the highest RCA values, they exhibit a penetration higher than the general average of the sector in the main Brazilian importing markets.

Table 6 - Estimates (2SLS) of the relationship between Penetration and Revealed Comparative Advantage between sectors

Dependent variable: Penetration	Animal & animal products	Vegetable products	Foodstuff	Mineral products	Chemical & allied industries
Sectors					
$\ln(RCA\_ex_{jkt})$	0.536***	0.684***	0.835***	0.597***	0.744***
	(0.0135)	(0.00787)	(0.00801)	(0.0124)	(0.00568)
Observations	14,204	31,388	36,718	14,487	112,870
Sectors	Plastic & rubbers	Skins, leather & furs	Wood & wood products	Textiles	Footwear
$\ln(RCA\_ex_{jkt})$	0.903***	0.741***	0.813***	0.679***	0.765***
	(0.00955)	(0.0120)	(0.00981)	(0.00524)	(0.0175)
Observations	67,735	16,512	46,851	125,701	16,220
Sectors	Stone & Glass	Metals	Machinery & electrical	Transport	
$\ln(RCA\_ex_{jkt})$	0.802***	0.614***	0.826***	0.731***	
	(0.00799)	(0.00660)	(0.00360)	(0.0141)	
Observations	43,341	130,736	228,797	25,800	

Source: Research results.

Note: Robust errors in parentheses. Significance: *** p<0.01, **p<0.05, * p<0.1. All estimates have fixed year, industry (HS 2-digit) and importing country dummies. All regressions were estimated according to equation (7), but only the variable of interest was maintained to reduce the size of the table.

4 FINAL CONSIDERATIONS

Brazil presented a great commercial expansion in the 2000s, but still very concentrated on products with lower added value. However, the country has little international insertion, having a small participation in world exports and imports. Thus, understanding the aspects that allow for greater international insertion and greater dynamism of exports becomes relevant, especially in the case of Brazil.

This study relates the revealed comparative advantage and the quality of exported products, in addition to the penetration in the main importing markets of Brazilian products, in the period from 1997 to 2016. The results show the relevance of the revealed comparative advantage to determine the quality standards of the products marketed. Regardless of the income of importing countries or product groups, the results suggest that there is a positive relationship between comparative advantage and the quality of Brazilian exports. However, the intensity of this relationship varies according to the income group to which the country belongs (developed or developing) or the type of products that are traded (agricultural or industrialized). The results also show greater market penetration of those products to which Brazil has the highest RCA.

In addition, it was observed that countries with higher incomes absorb products of higher quality. On the other hand, penetration in these countries is lower, due to greater competitiveness to reach these markets. Thus, an intensification in the production of goods that Brazil has higher RCA can translate into higher quality and contribute to a greater penetration in important markets worldwide. In addition, more distant consumer markets have a lower penetration, that is, they are more difficult to reach. However, better quality products can reach markets with greater distance.

Therefore, it is noted that, as in the work of Jaimovich and Merella (2015), there is an association between RCA, quality and penetration. Thus, RCA can function as a promoter of an improvement in quality, with the possibility of an expansion of penetration in more markets. With greater penetration, exports become more dynamic, there is an increase in income acquired through international trade, there is a reduction in the dependence upon few importers (making exports less vulnerable to fluctuations in world markets), among others. Therefore, it is important for the government to think about making the sectors more competitive, especially the industrial one, in order to increase the comparative advantage in the

production of these goods, since this is positively related to a higher quality of exports and a greater penetration in international markets.

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