Brazilian agricultural exports: How quality matters?

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Abstract: The general objective of this paper was to analyze the relationship between product quality and Brazilian agricultural exports. In addition, it set out to identify the effects of the exporters' income and distance, and the SPS and TBT measures on the quality of exported products. Brazilian agricultural export data (HS 4-digit) for the main trading partners during the 1997-2016 period were used. The results obtained from analyses in relation to trade with new markets included the identification of negative effects of quality on both the probability of accessing new markets and the share of trade transactions involved. For the intensive margin, the value exported to existing partners, the estimated coefficients showed that the increase in quality is associated with greater quantity exported. In addition, this research showed that quality was positively affected by income and distance, and that the income effect grows as different levels of quality are considered. Finally, the issuance of SPS and TBT measures by Brazilian importers also led to an improvement in the quality of Brazilian agricultural exports.
Keywords: product quality; agricultural exports; intensive margin.

Resumo: O objetivo geral deste trabalho foi analisar a relação entre a qualidade dos produtos e as exportações agrícolas brasileiras. Além disso, buscou identificar os efeitos da renda, da distância dos exportadores e das medidas SPS e TBT sobre a qualidade dos produtos exportados. Foram utilizados dados das exportações agrícolas brasileira (HS 4 dígitos) para os principais parceiros comerciais no período de 1997 a 2016. Os resultados obtidos da análise em relação ao comércio com novos mercados, incluíram a identificação de efeito negativo da qualidade tanto na probabilidade de acesso a novos mercados quanto na parcela de comércio transacionado. Para a margem intensiva, o valor exportado para os parceiros existentes, os coeficientes estimados mostraram que o aumento da qualidade está associado à maior quantidade exportada. Além disso, esta pesquisa mostrou que a qualidade foi afetada positivamente pela renda e pela distância, e que o efeito renda cresce à medida que diferentes níveis de qualidade são considerados. Finalmente, a emissão de medidas SPS e TBT pelos importadores brasileiros também levou a uma melhoria na qualidade das exportações agrícolas brasileiras.
Palavras-chave: qualidade dos produtos; exportações agrícolas; margem intensiva

Área 7: Economia Internacional

JEL codes: Q17, F1, F14.

1. Introduction

Recent research points to the relevance of the quality of exported products as a determinant of comparative advantage and the international standard of competition, or in other words, how differences in quality affect the way in which the products of countries compete with each other (BASTOS; SILVA, 2010; BRAMBILLA, PORTO, 2016; FLACH, 2016; KHANDELWAL, 2010). The main results show that higher quality products are shipped to more distant trading partners and to countries with higher income levels.

When dealing with the quality of exported products and comparative advantage, Alcalá (2008, 2016) emphasizes that companies in a country with comparative advantage in a given sector tend to be more productive in world terms and, as a consequence, are able to produce better quality goods. Jaimovich and Merella (2015) argued that a country's comparative advantage is strengthened by improving product quality. They found that comparative advantage and quality contributed positively to the penetration of imports from a group of countries, and that this effect was relatively higher for importers with higher income levels.

Countries have different perceptions of quality, and in general, more developed and higher income economies tend to value higher quality products more than others. Consequently, countries seeking to successfully enter such markets should constantly strive to improve the quality of their exports in order to meet more demanding requirements (BRAMBILLA, PORTO, 2016).

To achieve higher levels of quality, changes in production processes and the use of an ever more skilled labor force are required, which in turn, demand higher wages. However, such changes are often costly and not always achievable in less developed countries. As suggested by Falvey (1981) and Falvey and Kierzkowski (1987), differences in countries' factor endowments could be one of the determinants of product quality differences. Hence, countries which are capital-abundant specialize in the production of higher quality goods, while less developed nations (labor-abundant) specialize in lower quality goods.

According to Leamer (2006), improvements in the quality of goods would have implications for trade, wages and the level of output of an economy. Therefore, the exportation of higher quality products is a major issue, especially for nations more dependent on international trade.

In Brazil, the performance of the external sector, especially agricultural exports, exerts a great influence on the economic aggregates. According to 2017 data from the MIDC (*Ministério do Desenvolvimento, Indústria e Comércio Exterior* - Ministry of Development, Industry and Foreign Trade), agricultural exports in recent years accounted for 40% of Brazil's total exports, thereby making a major contribution to a more favorable balance of trade. Therefore, an in-depth analysis of the export quality of agricultural products contributes to a better understanding of this crucially important sector of the Brazilian economy.

With that in mind, the general objective of this paper was to analyze the relationship between the quality of products and Brazilian agricultural exports. More specifically, it sets out to analyze the effect of export quality on access to new markets, on the share exported to the new market in relation to total volume exported and on the total value of exports to existing partners. In addition, the study seeks to identify the effects of exporters' income and distance, and SPS and TBT measures on the quality of products exported.

An analysis of the Brazilian export market from the point of view of quality of products exported is relevant as, trading higher quality products is a necessary condition for the successful inclusion of such goods in importing countries (Khandelwal, 2010). Given that quality depends on the perception of these importers and considering that more advanced countries tend to consume higher quality products, a more detailed analysis of the implications of quality for the dynamics of international trade is crucial. These questions are even more

critical in developing countries, as they do not always have a strong credit market, a quality institutional environment, investments in technology or other conditions which facilitate the production and export of higher quality goods.

Differently from other papers on this theme (BASTOS; SILVA, 2016; FLACH, 2016; BRAMBILLA; PORTO, 2016)[1], the present research focuses on the agricultural sector. In the case of Brazil, an analysis of export quality is even more appropriate given the emphasis placed by the external sector on the generation of foreign exchange, especially in agriculture, which has been responsible for a favorable balance of trade in recent years. In addition, Brazilian farming has always played a leading role in economic growth and in the generation of employment and income. This paper makes the added contribution of separately considering the effect that the quality of exports can have on entry into new markets as well as on existing markets.

It is noteworthy in terms of advances in relation to the literature that the second part of this paper investigates the influence of sanitary and phytosanitary (SPS) and technical (TBT)[2] measures on product quality. Various studies on international trade address the effect of these measures on the trade flow of countries, and ambiguous results have been found depending on their restrictive nature[3]. However, in addition to the standard analysis of these notifications, this paper presents another hypothesis, namely, that when a country imposes SPS and/or TBT measures and the exporter is capable of adapting to the requirements, then the result could be the exportation of higher quality products. This research also contributes with its analysis which considers different levels of quality of agricultural exports. It is, thus, possible to carry out a more detailed study of the effect of certain explanatory variables on different quality ranges, through an analysis of different quantiles.

A greater understanding of the effects of quality of agricultural exports on Brazil's trade relations can help in drafting and improving policies applied to the sector, so that the country can maintain and increase the value of its exports and intensify the dynamism of its sales to the foreign market.

This study is divided into five sections, in addition to this Introduction. The second section presents a brief Literature Review on the topic in question. The third presents the Methodology used, while section 4 presents the Data. Section 5 covers the presentation and discussion of the Results, and finally, the sixth section presents the Final Comments.

2. Literature Review

Bastos and Silva (2010) analyzed the factors influencing the export quality of Portuguese firms, while considering different product categories and destination markets for the year 2005. They used panel data for 16,541 exporting firms, 7,591 product categories exported and 220 trading partners. The results indicated that FOB (proxy for export quality) unit values increased with distance and tended to be higher when trade was carried out with wealthier countries. It was also seen that the productivity of the company extended the positive effect of distance, which suggests that companies of high productivity and top quality were able to serve

[1] These and other papers are presented in more detail in section 2.

[2] According to World Trade Organization (WTO, 2017), the SPS agreement aims to prevent justified measures for the protection of human, animal and plant health from being barriers to trade, while the TBT agreement seeks to prevent technical measures such as standards, regulations for production, labeling and conformity assessment procedures from acting in the same manner (FREITAS, *et al.*, 2015).

[3] The positive consequences of imposing SPS and TBT measures involve increasing product quality, human, animal and plant safety, and the harmonization of international regulations and standards. These advantages are gained when the cost of adaptation to such requirements is reasonable and is compensated by the greater flow marketed. On the other hand, measures can be interpreted as barriers to trade if the adjustment generates significant costs in the production process and commercialization of the product.

potentially more difficult commercial partners. Brambilla and Porto (2016), when dealing with income levels of destination countries, and quality of exports and wages, set out to investigate whether industries exporting products to high-income trading partners paid higher average wages. They used panel data for 82 countries from 1990 to 2000 and estimated an instrumental variable model. The results showed that industries which export products to higher income markets tend to trade higher quality products. This means that richer countries demand higher quality products. The study also indicated that the production of quality products is costly and requires more intensive use of skilled labor with higher wages. Thus, higher quality products tend to create higher wages.

Flach (2016) using 1997-2000 data on Brazilian exporting firms, set out to check if companies segment the markets and if the characteristics of the destination country affected the quality and price of the product. The main results indicated market segmentation based on quality, in which firms increased quality and prices to the high-income partners. Robustness analyses have confirmed the hypothesis that price differences in all export destinations can be driven by investments in product quality and high-quality demand.

Fan, Li and Yeaple (2015) analyzed the effect of tariff reduction on the quality of goods exported by Chinese firms from 2001 to 2006. The results suggested that a reduction in import tariffs, which could facilitate access to intermediate inputs, tends to induce producers to improve the quality of products and increase their prices in foreign markets.

Verhoogen (2008) proposed a new approach linking trade and wage inequality in developing countries through the quality improvement mechanism and analyzed its empirical implications for manufacturing firms in Mexico. The results indicated that the most productive firms produce higher quality goods and pay higher wages. Only the most productive firms are capable of entering the export market and tend to produce higher quality goods for the external than for the domestic market. In addition, it was found that a devaluation of the exchange rate led the more productive firms to increase exports, improve the quality of their products and pay higher wages when compared to the less productive firms within the same industry. Evidence indicated that quality improvement, induced by a currency shock (the 1994 Mexican peso crisis) increased wage inequality.

Filho, Medeiros and Albuquerquemello (2017) analyzed the quality of Brazilian exports between 1997 and 2014, at interstate and sectorial levels and according to the degree of technological content. They considered Brazilian processing industry exports to 193 commercial partners. In the aggregate analysis, it was found that the quality of products exported by the country was practically constant over time. In the disaggregated analysis, they found that for the technology-intensive sectors (medium and high technological intensity), in 17 of the 27 units of the federation and in 17 of the 23 classes of product considered, there was an improvement in the quality of exported goods. They also found evidence that wealthier Brazilian states exported higher quality products.

Hallack (2006) conducted an empirical analysis to see if product quality plays a relevant role in determining trade patterns. He used 1,995 data on bilateral flows at sectoral level for 60 countries. Overall, the results confirmed the theoretical prediction that higher income countries import more from trading partners producing higher quality goods. Manova and Zhang (2012) analyzed Chinese exporting firms from 2003 to 2005, considering a total of 243 trading partners and 7,526 products. It was seen that the most successful exporters used higher quality inputs to produce higher quality goods. In addition, firms varied the quality of their products in all target markets, using inputs of different quality levels.

Anwar and Sun (2018) analyzed the relationship between foreign direct investment and improvement in the quality of exports from the Chinese manufacturing sector from 2005 to 2007. The results indicated that the greater presence of foreign firms in the sector analyzed contributed to an increase in the quality of Chinese exports. It was also found that the inclusion

of firms from the Hong Kong, Macao and Taiwan regions led to an even greater increase in the quality of products exported by China.

3. Methodology

3.1.Export Quality

The quality indicator of the exported products used in this study was based on the approach of Khandelwal (2010) and Kandelwal, Schott and Wei (2013). The model specified by the authors supposes a utility function of the CES type considering that the preferences of the consumers incorporate quality (δ):

$$U = \int_{g \in G} [\delta(g)q(g)]^{\sigma-1/\sigma} \quad (1)$$

By maximizing the utility function (1) subject to budget constraint, we arrive at the following demand equation:

$$U = (\delta_{kj}^{\sigma-1})(p_{kj})P_{kj}^{\sigma-1}Y_j \quad (2)$$

Applying the logarithm in (2), the quality for each observation related to the sectors which constitute Brazilian agriculture, can be obtained as the residue of the expression:

$$lnq_{kj} + \sigma * lnp_{kj} = \alpha_j + \alpha_k + \varepsilon_{kj} \quad (3)$$

where q_{kj} refers to the quantity exported (kg) in each sector for j-th country, p_{kj} is the exported value of agricultural products and σ is the elasticity of substitution. α_j and α_k represent the fixed effects of importing country and sector[4], respectively. Equation (3) was estimated by Ordinary Least Squares, after assuming a given value for σ. As in the case of the study by Filho, Medeiros and Albuquerquemello (2017), the median elasticity of substitution estimated by Broda, Greenfield and Weinstein (2006) for each country was also used in this study.

The quality of agricultural products exported by Brazil to each sector in j-th country (δ_{kj}) can be obtained by dividing the residue obtained in (3) by the elasticity of substitution minus one:

$$quality = \hat{\sigma} \equiv \hat{\varepsilon}_{kj}/\sigma - 1 \quad (4)$$

Thus, the measure of the quality of Brazilian exports of agricultural products obtained in (4) was incorporated into the estimated equations of the model.

3.2. Empirical specification

[4] The sectors considered in this study refer to the agricultural product groups for the 2-digit codes of the Harmonized System (HS): 01 - Live animals; 02 - Meat and edible meat offal; 03 - Fish and crustaceans, molluscs and other aquatic invertebrates; 04 - Dairy produce; birds' eggs; natural honey; edible products of animal origin, not elsewhere specified or included; 05 - Products of animal origin, not elsewhere specified or included; 06 - Live trees and other plants; bulbs, roots; cut flowers etc.; 07 - Edible vegetables and certain roots and tubers; 08 - Edible fruit and nuts; peel of citrus fruit or melons; 09 - Coffee, tea, mate and spices; 10 – Cereals; 11 – Products of the milling industry; malt; starches; inulin; wheat gluten; 12 - Oil seeds and oleaginous fruits, miscellaneous grains, seeds and fruit, industrial or medicine plants, straw and fodder; 13 - Lac; gums, resins and other vegetable saps and extracts; 14 - Vegetable plaiting materials; vegetable products not elsewhere specified or included; 15 – Animal or vegetable fats and oils and their cleavage products etc.; 16 - Preparations of meat, fish or crustaceans, molluscs etc.; 17 - Sugars and sugar confectionery; 18 - Cocoa and cocoa preparations; 19 – Preparations of cereal, flour, starch or milk; pastrycooks' products; 20 - Preparations of vegetable, fruit, nuts or other parts of plants; 24 – Tobacco; 52 – Cotton.

In order to meet the different objectives proposed in this study, after obtaining the export quality indicator, it was possible to estimate the following empirical models:

$$Y_{ijkt} = \beta_0 + \beta_1 \ln(\text{qual.}_{ijk}) + \beta_2 \ln(\text{GDP}_{it}) + \beta_3 \ln(\text{GDP}_{jt}) + \beta_4 \ln(dist._{ij}) + \beta_5 \ln(\text{cont.}_{ij}) + \beta_6(TBT_{jkt}) + \beta_7(SPS_{jkt}) + \alpha_t + \mu_k + \gamma_j + \varepsilon_{ijkt} \quad (5)$$

The dependent variables were defined as: (i) New Market: dummy variable which receives a value of 1 if a particular commercial transaction between Brazil and the *j-th* country occurred after three consecutive years without negotiations between such countries, and 0 otherwise[5]; (ii) Share: share of the volume marketed by country *i* (Brazil) of product k with the new market j of the total volume traded (US$), in year *t*; (iii) value of exports from country *i* of product *k* to *j-th* country, with which Brazil already trades (already existing market), in year *t* - intensive trade margin measure, where *j* represents the 97 main Brazilian trading partners of agricultural products over the 1997-2016 period; *k* corresponds to all HS 4-digit products from the 22 HS 2-digit sectors, representing the agricultural products considered in the sample. It is important to highlight that the export data (US$ and Kg) refer to the 8-digit Mercosur Common Nomenclature (NCM) products, with the first six digits of that nomenclature corresponding to the first six digits of the HS.

$qual._{ijk}$ refers to the quality indicator of exports from country *i* (Brazil) to the *j-th* country in sector *k*, according to section 3.1; GDP_{it} and GDP_{jt} are the respective GDPs of country *i* and *j* in year *t* (nominal GDP – US$), used to indicate the income of Brazil and the importing countries; $dist._{ij}$ indicates the distance between country *i* and country *j*, measured by the distance (km) between the most populous city of each country. As these cities represent a greater participation in the economic and export activity of the country, studies use this *proxy* to measure the distance between the countries (BASTOS, SILVA, 2010, BITTENCOURT, MATTOS, LIMA, 2016); $contig._{ij}$ is a *dummy* which assumes 1 if country j is bordered by Brazil, and 0 otherwise; TBT_{jkt} and SPS_{jkt} are the notifications related to the TBT and SPS agreements issued by Brazil's main trading partners of agricultural products in the year t; α_t, μ_k and γ_j refer to the fixed effects of time, product and importing country, respectively. Finally, ε_{ijkt} is the error term.

To estimate the first dependent variable (i), despite its dichotomous nature, the Ordinary Least Squares (OLS) method was used, instead of non-linear probability models (probit or logit). This choice was made because including a significant number of fixed effects can generate the problem of the incidental parameter (BEENSTLOCK; FELSENSTEIN, 2007). For the estimations considering the variables specified in (ii) and (iii), the OLS and Pseudo Poisson-Maximum-Likelihood (PPML) methods were used in the context of gravitational equations. The presence of null flows in the dependent variables of the respective models and the heterogeneity of trade patterns can lead to biased estimates when obtained by Ordinary Least Squares. Thus, the PPML method was used to deal with these limitations, and to obtain consistent estimates (SANTOS SILVA; TENREYRO, 2006). However, both methods were estimated to test robustness.

The second group of estimated models, based on equation (6), aims to analyze the effect of the variables exporter income, distance between countries and the imposition of SPS and TBT measures on the quality of agricultural products exported by Brazil, and can be expressed as follows:

[5] Situations in which Brazil did not trade with the importing country in an interval of 1 or 2 years were not considered as a new market, as very short periods may not be considered as a total exit of Brazil from that market.

$$\ln(quali._{ijkt}) = \beta_0 + \beta_1 \ln(\text{GDP}_{it}) + \beta_2 \ln(dist._{ij}) + \beta_3(TBT_{jkt}) + \beta_4(SPS_{jkt}) + \alpha_t + \mu_k + \gamma_j + \varepsilon_{ijkt} \quad (6)$$

The dependent variable and the independent variables of model (6) were defined and explained as previously presented in the specification of equation (5). To obtain the estimates of this model, the OLS method was used with the inclusion of fixed effects of time, product and importing country.

With a view to identifying if there are differences in the effects of the variables considered (GDP, Distance, SPS and TBT notifications) on different points of the quality distribution, model (6) was also estimated using the unconditional quantile regression method, proposed by Firpo et al. (2009). This approach uses the concept of Recentered Influence Function which, according to Silva and França (2016), allows for the identification of the relative effect (influence) of an individual observation on certain statistics of interest. That is, for a distribution statistic $\upsilon(F_y)$, the influence of each observation on $\upsilon(F_y)$ is given by the influence function $IF(y;\upsilon,F_y)$. By adding the statistic back into the influence function, the result is the so-called Recentered Influence Function – RIF, specified as $RIF(y;\upsilon) = \upsilon(y) + IF(y;\upsilon)$. In the present research, the analyzed statistic refers to the quantum of the distribution of the quality of Brazilian exports (Q_τ).

Considering the presence of a covariate vector *X*, it is assumed that the conditional expectation of the RIF can be modulated as a function of *X*, i.e., $E\lfloor RIF(y;\upsilon,F_y) \mid X = x \rfloor$, and can be presented as a linear regression as a function of *X*, i.e., $RIF(y;\upsilon,F_y) = X\beta + \varepsilon$. Thus, given the hypothesis $E[\varepsilon \mid X] = 0$ and applying the Law of Iterated Expectations, the estimated unconditional quantile regression can be specified as:

$$RIF(quali._{ijkt}; Q_\tau) = \beta_0 + \beta_1 \ln(\text{GDP}_{it}) + \beta_2 \ln(dist._{ij}) + \beta_3(TBT_{jkt}) + \beta_4(SPS_{jkt}) + \alpha_t + \mu_k + \gamma_j + \varepsilon_{ijkt} \quad (7)$$

The problem of the endogeneity of the variables is constantly pointed out in the literature on international trade (SILVA et al., 2016; FONTAGNÉ et al., 2015; FLACH, 2016; BASTOS; SILVA, 2010). Thus, it is crucial to recognize that the explanatory variables related to the quality of exports, GDP and SPS and TBT measures could be potentially endogenous, due to their simultaneity with the dependent variable. The use of instrumental variables would be the appropriate procedure to correct such endogeneity. However, as suitable instruments are hard to find, it should be considered that the results found in this research could contain this possible bias of endogeneity.

4. Data

The data used in this research are annual, covering the 1997-2016 period.

Exports: information on the value of Brazilian exports (US$) and quantity exported (kg) were collected from SECEX/MDIC (Secretariat of Foreign Trade – *Secretaria do Comércio Exterior* / Ministry of Development, Industry and Foreign Trade – *Ministério do Desenvolvimento, Indústria e Comércio Exterior*, 2017). In this database the classification of products follows the Mercosur Common Nomenclature (NCM), with its first digits corresponding to the first digits of the Harmonized System (HS), allowing for the use of SECEX data.

Gross Domestic Product (GDP): the indicative variable of income in Brazil (exporter) and the main trading partners was obtained from the World Bank (*World Development Indicators, 2017).*

Distance (dist) and contingence (contig): the geographic distance between the most populous city of the selected importing countries in the sample and São Paulo (measured in Km) and the existence of a common border between Brazil and the partners, were obtained from the *Centre D'Estudes Prospective et d'Informations Internationales* (CEPII, 2017).

SPS and TBT: notifications to the SPS and TBT measures issued by Brazilian importers, with regard to agricultural products from the 2-digit HS, were taken from the 2017 WTO Documents online page.

5. Results

This section presents and discusses the results of this study. First, there is a brief description of the data and an analysis of the quality indicator of the agricultural sector exports for each 2-digit HS code considered, during the 1997-2016 period. Then, the estimates of the quality effect on Brazilian commercial relations are presented.

5.1.Descriptive analysis

Before presenting the results of the estimates made in the research, a descriptive analysis of the data is done (initially) to identify certain characteristics of the sample selected. According to Table 1, the average value exported by Brazil's agricultural sector to the main trading partners between 1997 and 2016 was approximately US$200,000, while the average exported volume was 378 tons.

Table 1 – Descriptive analysis of the variables used in the research

Variable	Mean	Sd	Min.	Max.
Exported Value (US$)	200217	1513826	0	1.380e+08
Exported Quantity (Kg)	378027	3649855	0	2.240e+08
GDPi (US$ billion)	1452	731.4	508.0	2616
GDPj (US$ billion)	1407	3253	0.487	18625
Distance (Km)	7917	4622	1135	18550
Contig.	0.235	0.424	0	1
TBT	0.0172	0.130	0	1
SPS	0.0966	0.295	0	1
New Market	0.216	0.412	0	1
Quality	5.200	1.487	-2.654	14.91
Nº Obs.		143381		

Source: Research results.

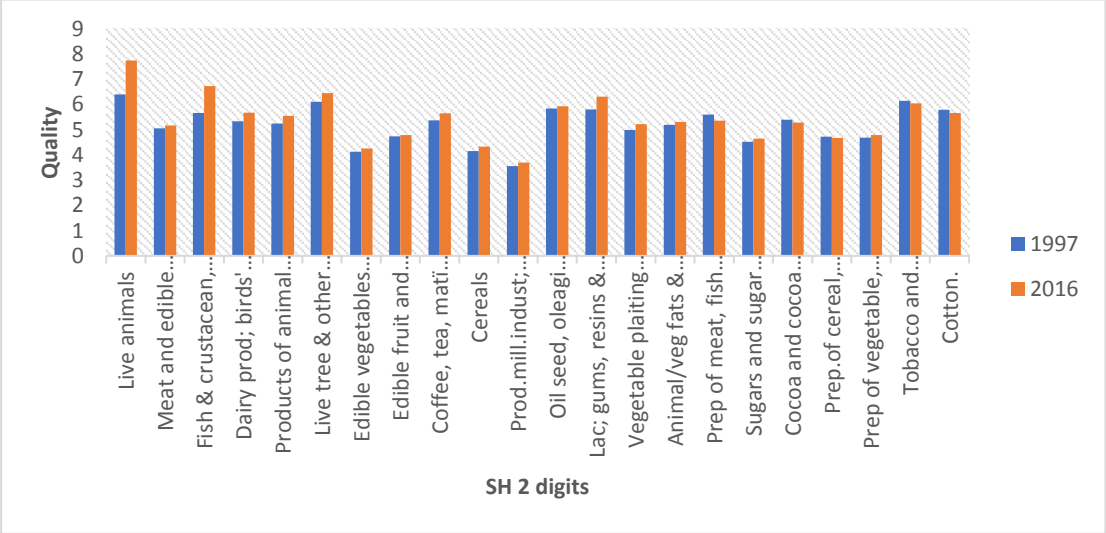
The average of the representative variable of Brazil's income (GDPi) in the period considered was US$ 1.45 trillion. For commercial partners, the average value of GDP was US$ 1.41 trillion. In addition, 23% of the trade transactions between Brazil and the main destination markets for agricultural exports in the 1997-2016 period occurred with countries sharing a common border. The average distance between the most populous Brazilian city and those of the other partners was 7,917 Km.

As regards the variables representative of the non-tariff measures used in the present study, it was seen that only 1.7% of exports received some technical notification (TBT). For sanitary and phytosanitary notifications (SPS), about 10% of commercial relations occur under the issuance of such measures. It is also worth noting that 21.6% of transactions involve a new market, that is, exports were made to partners who did not import the Brazilian product three years previously.

The indicator referring to the quality of exported agricultural products (Quality), as specified in section 3.1., presented an average value of 5.2, while the maximum value (14.91) was seen for exports of "live animals and other animal products" (HS 01). The lowest value of the indicator was found for "cereals" (HS 10), whose exports are usually characterized by products with lower added value.

Figure 1 shows the mean quality per sector considered in the study (HS 02) for the 1997 - 2016 period, to analyze the evolution of the indicator over this period. In general, there were no substantial changes in the quality of agricultural exports. For most sectors, the indicator increased, especially that of exports of "live animals and other animal products" (HS 01), where average quality increased from 6.4 to 7.8, and that of exports of "fish and crustaceans, molluscs and other aquatic invertebrates" (HS 03), where average quality increased from 5.7 to 6.7. This increase in quality was expected given the perishability of these products. They require greater investment in quality to ensure that they arrive at their destination in adequate conditions for consumption. On the other hand, the sectors "preparations of meat, fish or crustaceans, molluscs or other aquatic invertebrates" (HS 16), "tobacco" (HS 24) and "cotton" (HS 52) presented a slight reduction in average export quality.

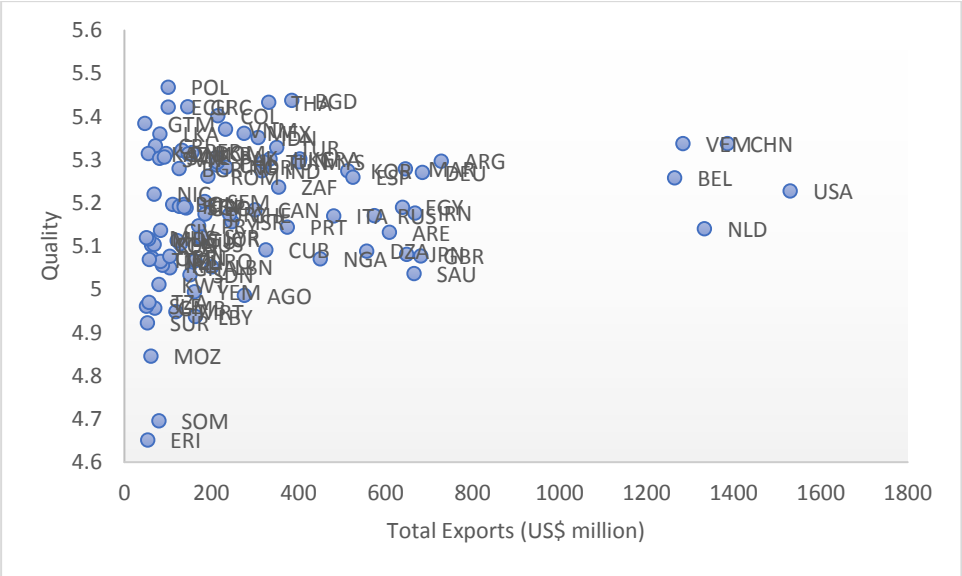
Figure 1 – Average quality by product, 1997 and 2016



Source: Research results.

Figure 2 shows the relationship between average quality of products and the total amount exported to Brazil's main trading partners over the 1997-2016 period. This figure shows that countries with consolidated markets, such as China and the United States, imported products with above average quality (Table 1), as expected. However, on average, higher quality products have also been traded with countries with less relative participation in total Brazilian exports, such as Poland, Greece, Thailand and others.

Figure 2 - Average quality and total volume exported (US$ million) by destination (1997-2016).



Source: Drafted by researchers.

5.2.Effects of the quality of agricultural exports on Brazilian international trade

With a view to analyzing the effect of the quality of agricultural exports on Brazilian trade relations over the 1997-2016 period, three main models were estimated using the following questions as a basis: (i) what is the effect of export quality on access to new markets? (model 1); (ii) what is the effect of quality on the share traded with the new market in terms of the total quantity exported? (models 2 and 3); (iii) what is the effect of quality on the value exported to existing partners (intensive margin measure)? (models 4 and 5). The results of these different estimates are presented in Table 2.

Table 2 – Effects of the quality of agricultural exports on Brazil's international trade

	(1)	(2)	(3)	(4)	(5)	(6)
	New Market	Share (OLS)	Share (PPML)	Exported Value (ln) (OLS)	Exported Value (ln) (PPML)	Exported Value (ln) (PPML)
Lnquali.ijk	-0.127***	-0.0227***	-0.135***	3.151***	0.347***	0.3471***
	(0.0258)	(0.00327)	(0.0206)	(0.353)	(0.0397)	(0.039)
LnGDPi	-0.795***	-0.00540***	-0.958***	0.836***	0.1000***	-
	(0.00954)	(0.00115)	(0.196)	(0.0973)	(0.0111)	
LnGDPj	-0.0119**	-0.00114	-0.141	0.133***	0.0160***	-
	(0.00480)	(0.000699)	(0.102)	(0.0493)	(0.00564)	
Lndistij	-0.0703	-0.00196	-1.852**	3.010***	0.243***	0.367***
	(0.0635)	(0.00265)	(0.917)	(0.699)	(0.0706)	(0.0522)
Contig.ij	-0.134*	-0.00902**	-0.307	0.447	-0.00616	0.0466
	(0.0790)	(0.00457)	(0.850)	(0.411)	(0.0448)	(0.0408)
TBTjk	-0.00230	-0.000186	0.0411	0.00468	0.00171	0.00202
	(0.00835)	(0.00144)	(0.189)	(0.0725)	(0.00760)	(0.00759)
SPSjk	0.0168***	0.00208***	0.141	-0.0357	-0.00410	-0.00412
	(0.00496)	(0.000683)	(0.0942)	(0.0397)	(0.00430)	(0.00430)
Constant	24.32***	0.263***	43.74***	-48.06***	-3.594***	-1.435***
	(0.631)	(0.0382)	-9.668	-6.585	(0.666)	(0.460)
Observations	142341	142341	142341	111537	111537	111537
Country effects	Yes	Yes	Yes	Yes	Yes	Yes
Year effects	Yes	Yes	Yes	Yes	Yes	Yes
Product effects	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.174	0.033	0.023	0.242	0.245	0.244
Loglikelihood	-62044	237483	-3397	-255441	-261916	-261923
r-squared	0.174	0.0327	0.0226	0.242	0.245	0.244
Adjusted r-squared	0.174	0.0317		0.241		
F statistic	605.8	3.193		61.32		

Robust standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1

The results presented in Table 2 indicated important adjustment of the models estimated, in which the null hypothesis of joint insignificance of the variables was statistically rejected in accordance with the values of the F statistic obtained. In addition, it must be stressed that the cluster procedure (at product level) was performed to obtain robust standard errors, thus solving the possible bias caused by heteroscedasticity. All estimates were made considering fixed effects for country, year and product, as in studies by Flach (2016), Bastos and Silva (2010), Martin and Mejean (2014) and others.

Estimated model (1) shows that the increase in quality of agricultural exports is associated with a reduction in the probability of Brazil accessing a new market. That is not surprising given that a small consolidated group of countries, such as the United States, China, the Netherlands and others, absorbs the largest share of Brazilian exports, despite their access to a significant number of partners. Thus, higher quality products can be directed to such countries, to the

detriment of new markets, with the aim of intensifying existing trade relations. In addition, higher quality can also imply higher priced goods, which could hinder the acquisition of such products by new commercial partners, thereby explaining the negative signal of the variable representing the quality of Brazilian agricultural exports.

In terms of exporting country income (GDPi) it was found that the increase in GDP is related to less access to new trading partners. The literature usually points to a positive effect of the country's income on exported value (BASTOS; SILVA, 2010). According to information in section 5.1., about 77% of commercial transactions carried out over the period occurred with existing partners. Thus, even if higher income generates a greater volume exported, it is probable that in the Brazilian case this larger volume will be directed to already consolidated markets, which could explain the negative effect of income on access to new destinations. A similar result was found for the indicative GDP variable of the importing countries considered in the sample.

The estimated coefficient for the distance variable between Brazil and the main traders had no statistically significant effect on the probability of accessing a new market. For the border variable (*contig*), the signal found indicated that the fact that the country has a common border reduces access to new markets. It should be noted that the variable for access to new markets refers to those situations where a country has not traded with Brazil for at least 3 consecutive years. However, the sample countries which border Brazil are not classified as new partners, as they were frequent importers during the period considered (that is, they did not spend 3 consecutive years without trading with Brazil). As a consequence, the border implies a lower probability that the commercial transaction performed represented a new market.

On the question of the effect of TBT notifications on the probability of Brazil accessing new markets, the variable coefficient presented no statistical significance. In the case of SPS notifications, the result found indicated that the application of a sanitary and phytosanitary measure by the sample importers increased the probability of Brazil entering new markets. It should be stressed that these measures can act as trade reducers if the costs involved in complying with such requirements hinder exports. Therefore, when faced with the imposition of an SPS, Brazil would have an incentive to access new markets which could have less restrictive measures (FREITAS *et al*., 2016; BURNQUIST; SOUZA, 2010).

Estimates for the remaining models (columns 2-5) were obtained by OLS and PPML. As argued in section 3.2, PPML is more appropriate for making consistent estimates because of the presence of null flows and heteroscedasticity. Therefore, the results generated by PPML are discussed, while OLS estimates are only presented to test robustness.

Model (3) set out to estimate the effect of quality on the share of volume traded with new markets. The coefficient of the indicator of the quality of agricultural products indicated that the increase in quality is related to a smaller share marketed with new partners, which confirms the result obtained in model (1). In the same way, the variable representing Brazilian income negatively affected the proportion of the volume traded with new markets when compared with that traded with the others. Income from importing countries, unlike model (1), was not statistically significant.

Distance between Brazil and its main trading partners showed a negative and significant coefficient, which indicates that the more distant the importers, the less the share of trade with new markets. The coefficients obtained for the other variables were not statistically different from zero, so inferences about their effects on the share of trade relative to new destinations cannot be made.

The third model estimated (columns 4-6) deals with the relationship between the quality of agricultural products and the value exported (US$) for the partners with which Brazil regularly

trades[6]. As regards the interest variable, the results show that the higher the quality of the product, the value exported to such markets tends to increase. That result was expected, as higher quality can imply higher product prices which, in turn, can increase the value transacted even in situations where the quantity traded is maintained or reduced, as the variation in price is higher.

The income variables of the countries selected also positively affected the value exported to existing Brazilian trading partners, as is commonly found in the literature on the subject (BASTOS; SILVA, 2010; BITTENCOURT; MATTOS; LIMA, 2016). It should be noted that a recent study points to the non-use of GDP in the estimation of gravitational equations (FIGUEIREDO, LIMA, SCHAUR, 2016; BALTAGI et al., 2014; ANDERSON, 2011). The rationale behind this is that GDP is measured on the basis of value added, that is, it does not take intermediate consumer goods into account, while trade variables are given on a gross basis of sales (SILVA et al. 2016). Thus, the results of column (6) are presented, withdrawing the income of the countries of the models estimated. It can be seen that there were no changes in the signals or statistical significance of the variables considered. In terms of the variables border and TBT and SPS, the estimated coefficients indicated that they did not affect the value exported to existing markets.

For the variable indicating the distance between countries (*lndist*), the estimated coefficient pointed to a direct relation with the value exported. Although this result was not expected, it is known that the largest volumes traded occurred with trading partners relatively more distant from Brazil, such as China, the United States, the Netherlands, among others (see section 5.1). Therefore, in this case it was expected that distance would not negatively affect export value. It is also important to note that, as argued by Novy (2008), caution should be exercised when using distance as the only variable to represent transport costs between countries. According to Bastos and Silva (2016), and Kugler and Verhoogen (2008), higher quality products are directed to more distant markets[7]. In this sense, the higher price obtained (consonant with higher quality) can compensate for transport costs, and thus, the distance coefficient would not negatively affect the volume of Brazilian agricultural exports.

5.3.Export quality, income, distance and SPS and TBT measures

This section presents the results of the models estimated to analyze the relationship between the quality of agricultural products exported by Brazil, the income of the exporting country, the distance between the partners and the issuance of SPS and TBT notifications by the main importers. Different empirical models were estimated, as shown in Table 3 (columns 1-7) as a means of testing robustness. In general, the results were satisfactory where the estimated coefficients presented statistical significance and signals similar to those presented by other studies dealing with the theme (BALDWIN; HARRIGAN, 2011; JOHNSON, 2012; BASTOS; SILVA, 2010; HALLACK, 2006).

[6] It should be noted that even if a country fails to trade with Brazil for up to 2 consecutive years, it is still considered a regular partner and is not classified as a new market.

[7] These issues were dealt with in greater depth in section 4.3.

Table 3 – Effects of income, distance and SPS and TBT measures on the quality of Brazilian agricultural exports.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
LnGDPi	0.0211***	-	-	0.0211***	0.0205***	-	0.0205***
	(0.00257)	-	-	(0.00257)	(0.00257)	-	(0.00257)
Lndistij	-	0.0620***	-	0.0620***	-	0.0623***	0.0623***
	-	(0.00287)	-	(0.00287)	-	(0.00287)	(0.00287)
TBTjk	-	-	0.0197***	-	0.0197***	0.0197***	0.0197***
	-	-	(0.00523)	-	(0.00523)	(0.00523)	(0.00523)
SPSjk	-	-	0.0134***	-	0.0134***	0.0134***	0.0134***
		-	(0.00268)	-	(0.00268)	(0.00268)	(0.00268)
Constant	1.328***	1.362***	1.919***	0.766***	1.341***	1.355***	0.777***
	(0.0716)	(0.0218)	(0.00804)	(0.0742)	(0.0717)	(0.0219)	(0.0742)
Obs.	142341	142341	142341	142341	142341	142341	142341
Country Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Product effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.475	0.475	0.475	0.475	0.475	0.475	0.475
loglikelihood	3776	3776	3797	3776	3797	3797	3797
r-squared	0.475	0.475	0.475	0.475	0.475	0.475	0.475
Adjusted r-squared	0.474	0.474	0.474	0.474	0.474	0.474	0.474
F statistic	1661	1661	1649	1661	1649	1649	1649

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

According to all the models estimated, the Brazilian GDP coefficient was positive and statistically significant at 5%. It was seen that positive changes in the income of the exporting country positively affected the quality of Brazilian exports of agricultural products. Thus, the results were consistent with the hypothesis that the higher the income of countries, the greater the quality of their exported products, because they can make better investments in products, processes, and human capital etc. In this context, a study by Filho, Medeiros and Albuquerquemello (2017), using data on exports from the Brazilian manufacturing industry to 193 commercial partners over the 1997-2014 period, also found results showing the positive effect of GDP on the quality of exported products.

In terms of the distance variable, the estimated coefficients were statistically significant and positively related to the quality of exports of Brazilian agricultural products. These results are corroborated by Baldwin and Harrigan (2011), Johnson (2012) and Bastos and Silva (2010) and indicate that higher quality agricultural products were allocated to more distant trading partners.

For the SPS and TBT notifications on agricultural products issued by the main trading partners, the estimated coefficients were positive and statistically significant. The results showed that countries imposing such measures import higher quality agricultural products. This positive effect could be related to the fact that, when notified with SPS and TBT measures, Brazilian exporters were informed about these requirements and their benefits in terms of safety and quality of products. They were thus able to adapt and this resulted in the export of higher quality products.

Table 4 - Effects of income, distance and SPS and TBT measures on quality levels – unconditional quantile regression.

	q25	q50	q75
LnGDPi	0.00908**	0.0156***	0.0164***
	(0.00462)	(0.00346)	(0.00435)
Lndistij	0.111***	0.0423*	0.0282***
	(0.0114)	(0.0242)	(0.00528)
TBTjk	0.0160***	0.0106*	-0.0162***
	(0.00520)	(0.00610)	(0.00577)
SPSjk	0.0107***	0.0127***	0.0118***
	(0.00292)	(0.00287)	(0.00375)
Constant	0.422***	1.011***	1.342***
	(0.160)	(0.238)	(0.127)
Obs.	142341	142341	142341
Country Effects	Yes	Yes	Yes
Year effects	Yes	Yes	Yes
Product effects	Yes	Yes	Yes
R-squared	0.4541	0.466	0.3773
Adjusted r-squared	0.4536	0.4665	0.3767
F statistic	1190.02	2012.45	885.82

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4 presents the results of the unconditional quantile regression. The results for the *GDP* variable indicate that there are statistically significant differences of the income effect of the exporting country (Brazil) along the distribution of export quality. The effect of income increases when higher levels of quality are considered, which indicates that as Brazilian incomes grow, larger investments are made in the agricultural sector, leading to the production and export of products of even higher quality. These products, in turn, are mostly absorbed by trading partners who have a consumer market with purchasing power and a preference for product baskets of higher quality. These results confirm those found, in studies, such as those of Bastos and Silva (2010) and Jaimovich and Merella (2015).

The estimated results for the distances of the countries (*lndist*) confirmed the positive effect on the quality of exports identified in the previous estimation. The highest coefficient was seen for the lowest quality quantiles (q25), which indicates that, for those products grouped at the bottom of the quality distribution, distance exerts even greater influence. Products such as "cereals" and "products of the milling industry; malts; starches; inulin; wheat gluten", identified in the sample with the lowest average quality index, make up a large share of Brazil's exports and are generally directed towards more distant markets, such as Asia and United States, and could explain the coefficient obtained.

For the SPS notifications, the results showed that the emission of such notifications was related to the higher quality of products along the distribution, and this effect was relatively greater for the median. As for the estimated coefficients for TBT notification, a greater effect was identified at the bottom of the quality distribution. For quantiles referring to the highest quality exports (q 75), the results pointed to a reduction in the quality of exports to countries which issued TBT notifications. That is not surprising, as such products already have a high level of quality and, therefore, investments to comply with the new requirements of technical measures tend to represent a significant increase in production costs which could restrict the country's capacity to maintain exports at the same quality level.

6. Final Comments

The main objective of this research was to analyze the quality of Brazilian agricultural exports in the light of three issues: (i) what is the effect of export quality on access to new markets?; (ii) what is the effect of quality on the share traded with the new market in relation to the total volume exported?; (iii) what is the effect of quality on the value exported to existing partners (intensive margin measure)?

Among the results obtained for the analyses relating to trade with new markets, negative effects of quality were identified both for the probability of accessing new markets and for the share of trade transactions involving them. For the intensive margin, the value exported to existing partners, the estimated coefficients showed that the increase in quality is associated with a higher level of exportation. This research confirms hypotheses raised by studies analyzing the relationship between quality and international trade, namely, it showed that income and distance have a positive effect on quality, and that this income effect grows as different levels of quality are considered. In addition, the issuance of SPS and TBT measures by Brazilian importers also led to an improvement in the quality of Brazilian agricultural products exported.

The present study highlights the relevance of investment in the quality of agricultural products if Brazil is to maintain and increase the value of its exports to those countries who are consolidated partners and responsible for absorbing the greater part of its exports directed to the international market. However, as the results have shown that product quality reduces entry into new markets, it is also important to draft policies to facilitate for these products, possibly in terms of better prices, to access different markets and thus make the Brazilian export agenda more dynamic.

In terms of future research, sample disaggregation at the Brazilian exporting firm level is suggested. This could lead to the generation of more plausible estimates and thereby eliminate the possible bias caused by the aggregation of information at the product level. Different measures of product quality could also be considered as a means towards analyzing the robustness of the results.

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Appendix A

List of Brazilian importers included in the sample: Algeria; Angola; Arab Rep.; Argentina; Australia; Bangladesh; Belgium; Bulgaria; Bolivia; Canada; Chile; China; Colombia; Congo, Rep.; Costa Rica; Cote d'Ivoire; Croatia; Cuba; Denmark; Dominican Republic; Ecuador; Egypt, Eritrea; Finland; France; Gambia; Georgia; Germany; Ghana; Greece; Guatemala; Hong Kong; India; Indonesia; Iran; Iraq; Ireland; Israel; Italy; Japan; Jordan; Kazakhstan; Kenya; Korea; Korea; Kuwait; Lebanon; Libya; Lithuania; Madagascar; Malaysia; Mauritania; Mauritius; Mexico; Morocco; Mozambique; Netherlands; New Zealand; Nicaragua; Nigeria; Norway; Oman; Pakistan; Paraguay; Peru; Philippines; Poland; Portugal; Puerto Rico; Romania; Russian Federation; Saudi Arabia; Senegal; Sierra Leone; Singapore; Slovenia; Somalia; South Africa; Spain; Sri Lanka; Sudan; Suriname; Sweden; Switzerland; Syrian Arab Republic; Tanzania; Thailand; Trinidad and Tobago; Tunisia; Turkey; Ukraine; United Arab Emirates; United Kingdom; United States; Uruguay; Venezuela; Vietnam; Yemen, Rep.