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EFFECTS OF SANITARY AND TECHNICAL MEASURES ON BRAZIL´S BOVINE MEAT EXPORTS – A PANEL DATA GRAVITY MODEL

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Abstract: This paper aims to evaluate the impacts of both sanitary-phytosanitary (SPS) and technical (TBT) regulations on Brazil´s beef exports. It seeks to identify whether these regulations show a protectionist or standardization effect on the foreign markets for bovine meat. A gravity model was run where Brazil´s beef exports are explained by variables measuring countries´ GDP and livestock production, their distances and their SPS and TBT regulations. The first two explanatories variables are second nature and the third one is first nature variable according to the New Economic Geography and they played important role in explaining Brazil´s meet exports. Also, the non-tariff measures have acted in a way to increase exports. Then, SPS and TBT regulations have not acted as barriers to exports, more than this, SPS and TBT regulations have help to standardize Brazil´s beef exports in a way that foreign market desire them.

Key words: Meet; SPS and TBT measures; Non-trade measures; Brazilian exports
JEL codes: F13, F14, Q17

1. INTRODUCTION

Agriculture still plays a key role in the development process of the fast-growing countries, such as Brazil, whose export revenue is largely backed on agro-based products. Although the last three decades have seen progressive trade liberalization, with increasing reduction of traditional barriers to trade, such as tariff cutbacks, for example, access to the agricultural commodities market is increasingly affected by a variety of regulatory measures. Such requirements do not necessarily take the form of a traditional trade policy instrument. Many of them are the result of consumer demand for food safety and quality and the business needs agility in production chains. However, the requirements´ adequacy has been a precondition for exporting to the more developed countries. In this way, from a mercantile point of view, one of the most important aspect of these regulations is their ambiguous effect. On one hand, they raise transparency and security in the international market; but, in another hand, they act as a protectionist instrument, because their compliance cost is often uneven distributed among the countries.

Regulatory requirements include non-tariff measures (NTMs), including sanitary and phytosanitary (SPS) regulations as well as technical measures (TBT). Nicita and Goudon (2013) state that about 30% of all products traded on the international market are affected by NMTs, of which 15% correspond to SPS measures and 11% by TBT reports. One proposal of the World Trade Organization (WTO) is to encourage governments to lay down such regulations. Countries should demand their quality standards for tradable products, through standards and procedures that have scientific support and that aimed at protecting and safeguarding human, animal and plant health.

Since countries become WTO members, they are subject to the conditions proposed by the SPS and TBT Agreements as well as their institutions, which scientifically support the issues relating to the Agreement. These institutions are the Committee on Technical Barriers to

Trade, the Codex Alimentarius, the World Organization for Animal Health (OIE) and the International Plant Protection Convention (IPPC), according to Mendonça et al. (2017, p.125). In Brazil, we highlight ANVISA, what participates together with the Brazil´s INMETRO in order to ensure that the positions defended by the national delegation reflect the interests of the health area.

If a country can show that the importation of a particular good from a trade partner presents a risk of pathogen dissemination (even if the risk is low), the importation ban is endorsed until the exporting country complies with the international standards (BUREAL et al., 1998). However, it is undeniable that these retrains can adjourn or make trade unviable, what can configure themselves as disguised barriers to cut off the flow of merchandises. Given the possibility of a competitive repositioning of the countries' exports, the SPS and TBT measures can distort the market if their trade effects are protectionist (MARTINS & SILVA, 2016, p.109).

Due to their proper characteristics, meat is a product whose trade is subjected to health and technical requirements, and these requirements are defined as instruments that seek to eliminate risks from contaminants, additives, toxins, diseases, pests and disease-causing organisms (that is SPS requirements). There are also requirements about packaging, weights, measures and conformities (TBT requirements). The enforcement of these two kinds of requirements, besides promoting the standardization of products traded in the international markets, seeks to recognize a certain territory as free from diseases and pests (MIRANDA, 2001, p.11). In recent years, the beef sector in several countries has been strongly affected by the Bovine Spongiform Encephalopathy (BSE) and the Foot and Mouth Disease (FMD), which highlight consumer concerning about safety and quality of agro-food products. Therefore, importing countries have tended to set up a greater amount of health requirements on beef exporting countries, among them Brazil, where foot-and-mouth disease was a limiting factor for the sector growth in 1994 and 2001 (LYRA & SILVA, 2004). According to Silva and Miranda (2005), the SPS barriers lay down on the exporting country due to the cases of foot-and-mouth disease have led to a decrease in sales quantity as well as the reduction of product prices, consequently, causing a decrease in both domestic and foreign sales. It was also forecasted that if the FMD had been eradicated until the 2000s, the country would export more than twice the quantity of processed and fresh meat (FOZ, 2000).

Beef production has a great importance for generating income in Brazil. According to the Atlas of Economic Complexity (2018), meat and its edible offal exports accounted for 6.31% of the total Brazil´s export in 2016. Of this total, about 33.67% was referring to beef. In addition, according to the US Department of Agriculture (USDA, 2018), in 2017 Brazil stood out as the largest exporter of this commodity at the international market, answering for 19.33% of the total beef exports. In addition, the country stands as the second largest beef producer in the world, just behind the USA.

Recognizing the importance of beef sector in the Brazilian agribusiness, this paper aims to verify if the sanitary and technical requirements, imposed by the main importers of Brazilian meat, have conditioned a process of standardization and quality or if they are set up as barriers to beef exports from Brazil. In order to discover the true on this issue and identify policies to guide the Brazilian exporting sectors, an econometric analysis is necessary to identify whether the SPS and TBT measures, imposed on Brazil, have increased or reduced their beef exports.

This paper is comprised of four sections besides this introduction. In the next section, we present the theoretical framework and a literature review about papers that dealt with this paper subject. Section 3 presents the methodology and data used in the present study. In section 4, we present the results of the estimated econometric models; followed by section 5, which brings the final considerations of the article.

2. HEALTH AND TECHNICAL REQUERIMENTS AND THEIR IMPACTS ON INTERNATIONAL TRADE OF BEEF

International trade is conditioned by a variety of instruments that restrain it, such as subsidies, quotas, tariff and non-tariff barriers. As pointed out by Lima (2005), tariff policy was widely used until the 1990s as a way of protecting the countries´ domestic markets. However, after the creation of the WTO, in 1995, tariff measures were mitigated and partially replaced by other forms of protectionism. According to Andrade (2007), the use of non-tariff measures (NTM) increased by 58.5% from 1994 to 2004. At the same time, the application of tariffs on trade has decreased by 44.7%.

In order to analyze the influence of sanitary and technical barriers on Brazil´s beef exports and from its partners, this paper run a gravity model, what has been typically used in analyzing foreign trade, inclusively about meat trade. For example, Shang and Tonsor (2009) and Kramb and Herrmann (2014) use the gravity model to analyze the flow of meat to the US and European Union, respectively.

Introduced by Tinbergen (1962), the idea behind the model is based on Newton's theory of gravity, in which the attraction between two bodies is directly proportional to their masses. In parallel, the model assumes that the international trade between two countries is directly linked to their income ("economic mass") and inversely proportional to their geographic distance (CHENG; WALL, 2005).

However, the model had lacked of a solid theoretical framework until middle 1970s, turning its use for policy-makers little appreciated. Anderson (1979) has provided a microeconomic basis for the gravity equation, reinforcing the theoretical discussions about the model. The author starts from a utility function (Constant Elasticity of Substitution) to come up with a solution to the gravity equation. The author considers that the consumers of a country *i* maximize their utility subject to a budget constraint associated with the market conditions.

Based on Anderson's (1979) considerations, Anderson and Van Wincoop (2004) further developed the model, allowing it to explain the patterns of sector K-exports between two countries *i* and *j*, over the time period *t*, as show in equation (1):

$$X_{ijt}^{k} = \frac{Y_{jt}^{k} \cdot Y_{it}^{k}}{Y_{t}^{k}} \left(\frac{\tau_{ijt}^{k}}{P_{jt}^{k} \cdot \Pi_{it}^{k}} \right)^{1-\sigma_k} \tag{1}$$

where X_{ijt}^{k} are the exports from country *i* to country *j* in sector *k* over the year *t*; Y_{it}^{k}, Y_{jt}^{k} and Y_{t}^{k} are, respectively, the production in country *i*, in country *j* and the global aggregate production in the sector *k* over the year t; τ_{ijt}^{k} is the tradable cost paid by the exporters of k-sector to ship the products from country *i* to country *j* over the year *t*; σ_k is the elasticity of substitution between product groups; and finally, P_{jt}^{k} and Π_{it}^{k} represent price indexes, identified as the indexes of multilateral resistance to trade.

In equation (1), Π_{it}^{k} represents the external multilateral resistance and it mainly captures the fact that exports from country *i* to country *j* over the year *t* depend on the trade costs in all possible importing countries. In its turn, P_{jt}^{k} indicates the internal multilateral resistance and assimilates the dependence of the j-country's imports from country *i* on the trade costs of all possible suppliers in year *t*.

The inclusion of P_{jt}^{k} and Π_{it}^{k} in the model was another important contribution of Anderson and Van Wincoop (2004)´s paper. Multilateral resistance rates capture not only trade barriers between two countries, as well as the presence of these barriers between the other countries with which they keep business transactions. In other words, this variable is included into the model to indicate that bilateral trade flows depend not only on the existing trade costs between two countries, but also on trade costs with other trading partners.

The elasticity of substitution (σ_k) is a hypothetical and unmeasured parameter. Anderson and Van Wincoop (2004) concluded, through estimations, that the value of this parameter ranges between 5 and 10, and they adopted the value 8 in their paper.

The gravity model is based on two assumptions about bilateral trade costs: (1^{st}) they are defined only in terms of frontier costs and the geographical distance between two countries, that is, $\tau_{ijt}^{k} = f_{ij} {d_{ij}}^{\rho}$, where f_{ij} represents the frontier costs, d_{ij} is the bilateral distance between countries i and j; and ρ is the elasticity of the distance; (2^{nd}) the trade costs between two countries are symmetric, that is, $t_{ij} = t_{ji}$, which implies that $P_j^k = \Pi_i^k$.

Despite the Anderson and Van Wincoop (2004)´s gravity model is based on cross-section data, this paper will use panel data. Baldwin and Taglioni (2008), Bobková (2012) and Frede & Yetkiner (2017) emphasize that an adaptation in the theoretical model makes possible to estimate the gravity model using panel data. Similar procedures were also employed by Mendonça et al. (2017) and Vakulchuk and Knobel (2018) recent studies, which have used the panel-based gravity model to measure the NTM effect on the trade flows.

There are some studies that reveal the importance of SPS and TBT requirements for the international trade. In a study afforded by the United States Department of Agriculture (USDA), Roberts and DeRemer (1997) evaluated the effects of dubious technical and sanitary regulations and pointed out losses near to US$ 5 billion in US exports. The estimated effect on livestock products trade to the European Community was US$ 477.3 million. Similarly, Hufbauer et al. (1999), Spenser et al. (1999) and Staton (1999) analyzed SPS regulations and the requirements of technical standards, issued in a hasty or intentional way to create trade barriers. Hufbauer et al. (1999), based on the Organization for Economic Cooperation and Development (OECD) calculations, estimated that more than 80% of all world trade is affected by some kind of standardization. Staton (1999) has already discussed the SPS Agreement, stating that its measures can act as disguised barriers and promote limited trade among countries. In the same path, Henson et al. (1999) looked at developing economies and found their low participation in the Agreement, which contributes to countries' lack of understanding about the impacts of sanitary normalization on the well-being of nations and for the international trade.

Among the studies that evaluated the quantitative effects of NTM, Disdier et al. (2007) stand out when estimating the impact of sanitary and technical measures on international trade of agricultural products from the OECD countries toward their partners from 1995 to 2004. The results show that the regulations have a protectionist feature in the international market that negatively affect the exports. This effect was not statistically significant for OECD member countries but was statistically significant for the developing and least developed countries. The authors emphasized the importance of technical and financial support for these countries to comply with the international standards, what would allowed them to increase their share in the global food chain. The results found by Kee et al. (2008) corroborate with this issue when they find out that the lower income-level countries are those that face the greatest trade barriers to their exports.

Kassum and Morgan (2002) analyzed the health notifications of the products exported by the European Community countries, the USA, Canada, Chile, Mexico and New Zealand, identifying the meat industry among the most subjected to health reports, which represents an average of 31% of total SPS requirements in the period from 1995 to 2001. In addition, 60% of the meat requirements had the objective of ensuring animal health, most of which were related to mad cow disease and foot-and-mouth disease.

Barros et al. (2002) analyzed SPS notifications covering the countries-members of the Free Trade Area of the Americas (FTAA) between 1995 and 2001. They found that the richest countries in the group (Canada and the USA) have been focused on health-related requirements (asking regulations on waste and chemicals such as herbicides, insecticides, feed additives, mainly. The other countries notifications were focused on animal and plant health issues, mainly fruits and meat.

Schlueter and Wieck (2009) analyzed the meat industry between 1996 and 2007 and pointed out that the European Union countries, the USA and China are the most demanding for sanitary and technical requirements into the sector. Mainly, the requirements were concerned to disease and pest preventive measures as well as the tolerable levels of residues of veterinary products accepted in beef and their by-products.

Concerning to Brazil, Miranda and Barros (2009) analyzed the effects of SPS restrictions on Brazil´s beef exports toward to the European Union (EU) and the price of the commodity in the international market between 1992 and 2000. The authors pointed to the fall in the average price of exports and the quantity exported. Factors such as the real exchange rate, Brazilian supply and demand, among others, determined this result. However, focusing on trade impacts, health requirements had a negative effect on the variables under analysis. Therefore, a broader monitoring and the evaluation of SPS measures between public agencies and the private sector were suggested.

A recent study carried out in Brazil, but for the pork market, indicates that sanitary measures influence negatively the trade of this product. The technical requirements, however, had no effect on pork meat trade. Although the SPS and TBT reports theoretically aim to increase consumer welfare by raising the quality of tradable products, it is observed in fact that their use has been labelled as trade barriers (MENDONÇA et al., 2017).

This paper has a broader objective than Miranda and Barros (2009) and Mendonça et al. (2017)´s papers. The first analyzed in particular the SPS measures on beef exports to the U.S., and the second has verified the effect of NTM on pork meat exports. This article seeks to identify the effects of the SPS and TBT measures on Brazil´s beef exports considering a more recent period and for all the main buyers of this product.

3. METHODOLOGY

3.1 Empirical Model

In order to analyze the effects of non-tariff measures (both SPS and TBT notifications) on Brazil´s beef exports, initially a survey and identification of the measures that affect this market was undertook; this information will be further considered into the econometric model, along with the standard variables assumed into the gravity model.

Regression will be run considering a panel data from 2000 through 2017, what allows having a spatial dimension linked to a time period. This period was chosen due to the significant growth of Brazilian meat exports since the year of 2000 (BACHA, 2018, p. 254). Exports of beef comprises codes 0201 (fresh or chilled beef), 0202 (frozen beef), 020610 (edible offal of bovine animals, fresh or chilled) and 020620 (edible, frozen bovine offal, HS) – these codes are from United Nations Conference on Trade and Development – UNCOMTRADE. For this paper analysis, the exportations of frozen and chilled offal were added, because there are a large number of zero flows for the different kinds of bovine offal when analyzed separately.

Considering them separately would interfere at regression robustness. Therefore, the beef offal was considered as only one product, being represented by code 0206.

The flow of bilateral trade considered is among Brazil and the 34 main importers of Brazilian beef[1], which are responsible for importing 96.39% of the beef exported by Brazil in the period under analyzing. Mendonça et al. (2017) adopted the same strategy when considering pork exports.

As suggested by Anderson and Van Wincoop (2004), the following gravity model equation will be run:

$$lnX_{ijt}^{k} = c + \alpha_{ij} + \delta_t + \beta_1 \cdot lnGDP_{it} + \beta_2 \cdot lnGDP_{jt} + \beta_3 \cdot SPS_{jit} + \beta_4 \cdot TBT_{jit} + \beta_5 \cdot lnDIS_{ij} + \beta_6 \cdot PROD_{it} + \varepsilon_{ij} \quad (2)$$

Where: X_{ijt}^{k} corresponds to the values of unilateral flows of international trade of product *k* from exporter *i* to importer *j* over the year *t*; c is the constant; α_{ij} e δ_t are the fixed effects for a pair of countries and for time period *t*, respectively; GDP_{it} and GDP_{jt} are, respectively, the gross domestic product of the exporting country *i* and for the importing country *j*, at time *t*; SPS_{jit} dummy variable[2] that receives value 1 if the country *j* has already issued notifications of the SPS agreement for the beef bought from country *i* in year *t*; TBT_{jit} is a dummy variable[3] that receives value 1 if the country *j* has already issued notifications of the TBT agreement for the beef bought from country *i* in year t; DIS_{ij} is the bilateral distance, measured in kilometers, from the capital of country *i* to the capital of country *j*; $PROD_{it}$ is a proxy to indicate beef production in the exporting country *i* in year *t*, being represented by the quantity of cattle slaughtered (in tons); and, ε_{ijt} is the error term.

Equation (2) considers first and second nature variables defining by the New Economic Geography such as the distance among countries and their GDP and livestock production. Regressions were run for each category of beef, as listed above. The same procedure was used by Fassarela et al. (2011), when analyzing the effect of NTM on Brazil´s chicken meat exports.

According to Cheng and Wall (2005), the use of fixed effects (FE) is suitable for the gravity model because they capture the impact of bilateral trade flows not directly observed, what is difficult to identify or is not well specified in the model, such as geographical, historical and cultural characteristics; transport costs; among others. These issues represent the multilateral resistance variables suggested by the theoretical model. Moreover, according to Shepherd (2013), the panel data model with FE is normally employed in the international economics studies, because the heterogeneity between years and among countries is controlled, what avoid obtaining biased and inconsistent estimated coefficients.

In this paper, FE method was used to capture the characteristics of the bilateral flows for each pair of countries and for the years under consideration. The FE model can be estimated by the Ordinary Least Squares (OLS) method or by the Poisson Pseudo-Maximum-Likelihood (PPML) method. Both estimation methods will be used, as well as the Ordinary Least Squares (OLS) method, with pooled data. We try to verifying the adequacy and robustness of the FE

[1] Algeria, Angola, Arab Emirates, Bulgaria, Chile, China, Egypt, Germany, Finland, France, Hong Kong, Iran, Ireland, Israel, Italy, Jordan, Kazakhstan, Kuwait, Lebanon, Libya, Netherlands, Peru, the Philippines, Portugal, Russia, Saudi Arabia, Singapore, Spain, Sweden, Switzerland, Ukraine, United Kingdom, Venezuela and Vietnam. Despite the USA is the largest importer of beef, they buy little quantity of Brazil´s beef exportation.

[2] Only regular notifications were considered, disregarding addendums, corrections and revision. The same was adopted for TBT notifications.

[3] SPS and TBT notifications from EU countries are issued by the group and not by a specific country. Therefore, the countries of this group received a value of 1 in the SPS and TBT dummies when the block sent any sanitary or technical notification.

model. The same procedure was adopted in the Souza and Burnquist (2011) and Santos, Silva and Almeida (2017)´s papers.

Yotov et al. (2016) recommend estimating the model by the Poisson Pseudo Maximum Likelihood (PPML) method, because this method considers the heteroscedasticity and it is less sensitive to the missing values or non-existent values (which are very common in analysis with bilateral flows of international trade). Often, the absence of values is explained by information errors, rounding errors, data censorship, or even the non-existence of trade. The use of PPML is also recommended by the fact that discrepant trade flows are relevant and should be considered in the analysis to explain the individual heterogeneity of each country (SOUZA, BURNQUIST; 2011).

3.2 Data sources

Table 1 shows the data sources of the variables proposed in equation (2) as well as the expected signals of their coefficients.

Table 1 - Description and data source of the variables used in equation (2).

Variable		mensuration	Expected signal	Source of the data
X_{ijt}^{k}	Beef exports	Current US$	Dependent variable	*United Nations Conference on Trade and Development –* UNCOMTRADE
GDP_{it}	exporting country´s gross domestic product	Current US$	(+)	*World Bank*
GDP_{jt}	importing country´s gross domestic product	Current US$	(+)	
SPS_{jit}	Sanitary and phytosanitary requirement	*Dummy*	?	*World Trade Organization* - WTO
TBT_{jit}	Technical requirement	*Dummy*	?	
DIS_{ij}	Distance	Kilometers	(-)	*Centre D'Estudes Prospectives et d'Informations Internationales* - CEPII
$PROD_{it}$	Beef production	Tons of slaughtered cattle	(+)	*Food and Agriculture Organization of the United Nations* - FAO

Source: Authors' own elaboration.

Coefficients associated to NTM variables do not show previously expected signals because the purpose of this paper is just to find out the effect of these measures on Brazil´s beef exports. According to the literature, the sign of these variables is dubious: it can be positive, indicating that SPS and TBT measures act to raise the quality of products internationally traded, in other words, they stimulate exports; or its sign can be negative, what indicates that the SPS and TBT measures are acting as a disguised barrier to trade.

4 RESULTS

This section is divided into three items. Initially, in item 4.1, there is a descriptive analysis of the beef production, consumption, export and import by countries or group of countries. We look forward identifying the main exporters and importers of this product. Section 4.2 outlines the SPS and TBT notifications from 2000 thru 2017 and their purposes. It will be pursued in this item to identify if they focus the protectionism or the standardization of the tradable products. The econometric test of which of these two effects (protectionism or standardization of traded products) is presented in item 4.3, when regressions of the gravity model are presented.

4.1 World and Brazilian exports of beef

Figure 1 shows the shares of the main countries that take part in the beef sector, considering the average in the period from 2000 thru 2017. The United States stands out as the major producer and consumer of beef, and are among the countries that have most imported the commodity. Brazil is among the countries that presented the highest production, the highest domestic consumption and stays among the largest exporting countries of beef. Among the largest importing countries, besides the United States, are Russia, Japan, the European Union and South Korea.

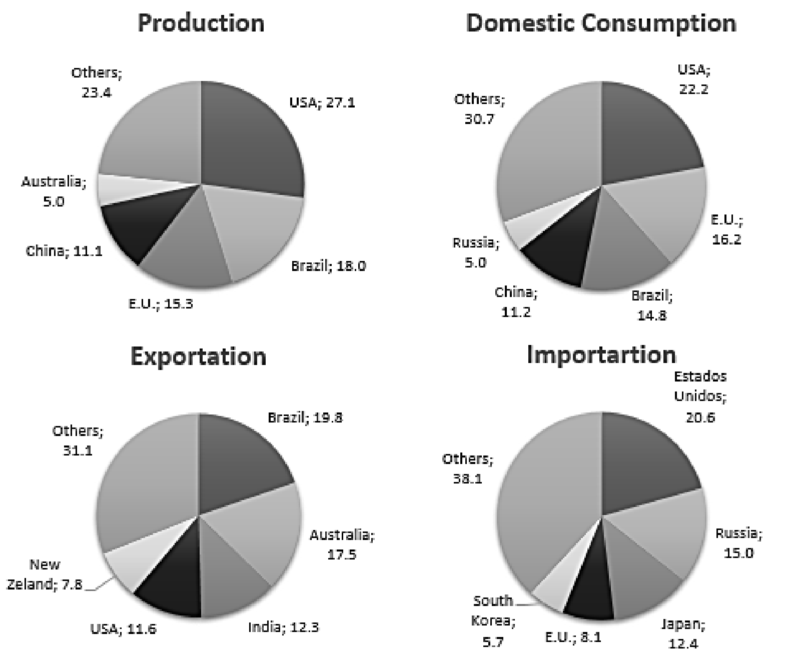

Figure 1 - Main countries acting into the beef markets, average of percentages between 2000 and 2017.
Source: *United States Department of Agriculture (*USDA*) - Foreign Agricultural Service*.

Figure 2 shows the world (excluding Brazil) and Brazil´s evolution of the beef exportation value. There is an upward tendency of both exports, with a peak in 2014, following two years of reduction and a partial recovery in 2017. Between 2006 and 2009, there was a growing world demand for beef. In the same period, the USA saw its exports declined due to the Bovine Spongiform Encephalopathy (BSE) outbreak, which explains the reduction in world production from 2008 to 2009. On the other hand, Brazilian exports grew from 2009 to 2014, due to strong beef demand growth by India (FLORINDO et al., 2015). Between 2012 and 2014, world exports were driven by increased North American and Australian production. In 2014, this growth was even more accentuated, an increase of 18% over the previous year and almost twice the amount exported in relation to the previous five years, which is even more evident for Brazilian exports, where the increase was 8% over 2013. The raise was boosted by the larger amounts sold to Egypt (raise of 14%), Hong Kong (13%), Venezuela (8%) and Russia (3%).

Still in 2014, cattle prices in Brazil hit record highs at the end of the year, reflecting relatively tight stocks.

The decline in World´s beef exports in 2015 and 2016 reflects the situation of the main importing countries in both years. They faced relatively slowdown economic growth and devaluation of their currencies, mainly due to downward oil prices. In addition, the reduction in the amount exported was partially explained by the fall in the Australian beef production. Australia stands out as a major producer and exporter of beef (as Figure 1 stands out). Australian beef sector faced a period of great herd reconstruction after a period of drought that hampered the country. The fall in Brazil´s beef exports is also justified by the appreciation of the national currency, which discourages the exports.

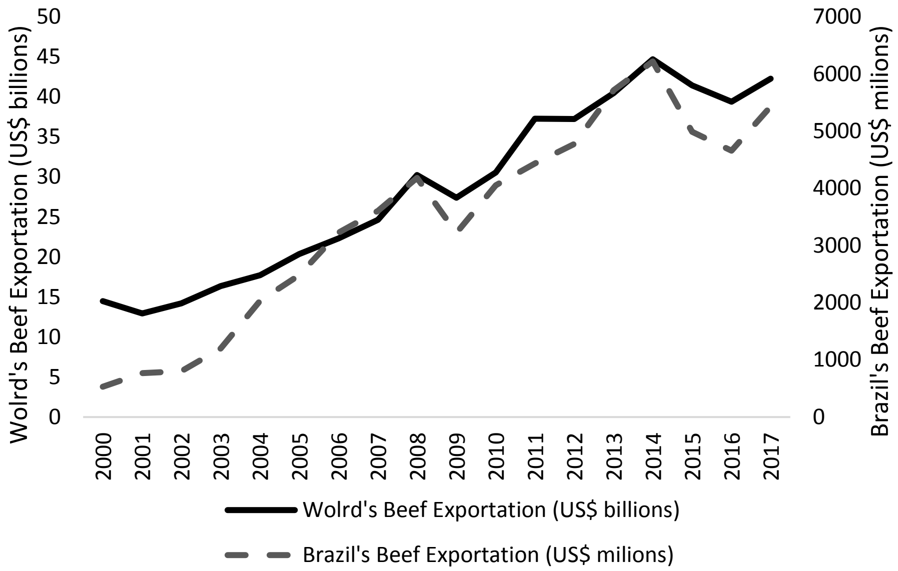

Figure 2 - Evolution of world beef exports (values on left side, measured in US$ billion and excluding Brazil) and Brazil´s beef exports (values on right side, measured on US$ million) – time period from 2000 thru 2017.
Source: *U.S. Census Bureau Trade Data*.

Otherwise, they year of 2017 showed a notable recovery in beef industry, when the world experienced an almost record amount of beef exports, the highest value reached since 2014. Brazil's beef exports followed the same pattern and the same was faced by India, the United States and Australia´s beef exports. This growth was mainly led by frozen meat trades on the international market.

Analyzing the main importing countries that buy Brazilian beef, we diagnose that 34 of them are responsible for purchasing about 96% of Brazil´s beef exports, however, a smaller group concentrated that purchase, as can be seen on Figure 3. There is a heterogeneity among the importing countries when considering their development level: 18 importing countries are ranked as higher income countries; 13 countries, including Brazil, have a medium to high average income; and the other four countries analyzed have medium to low average income. Russia absorbs a significant share of Brazil´s beef exports, answering for 19.36% of the total, followed by Hong Kong (14.37%), Egypt (9.51%), Iran (7.71%), Venezuela (6.77%) and Chile (4.81%). Together, these six countries consumed almost 63% of Brazilian beef exportation.

China has recently emerged as a large importer of Brazilian beef, ranking second in 2017 and likely to take Russia's place in the future.

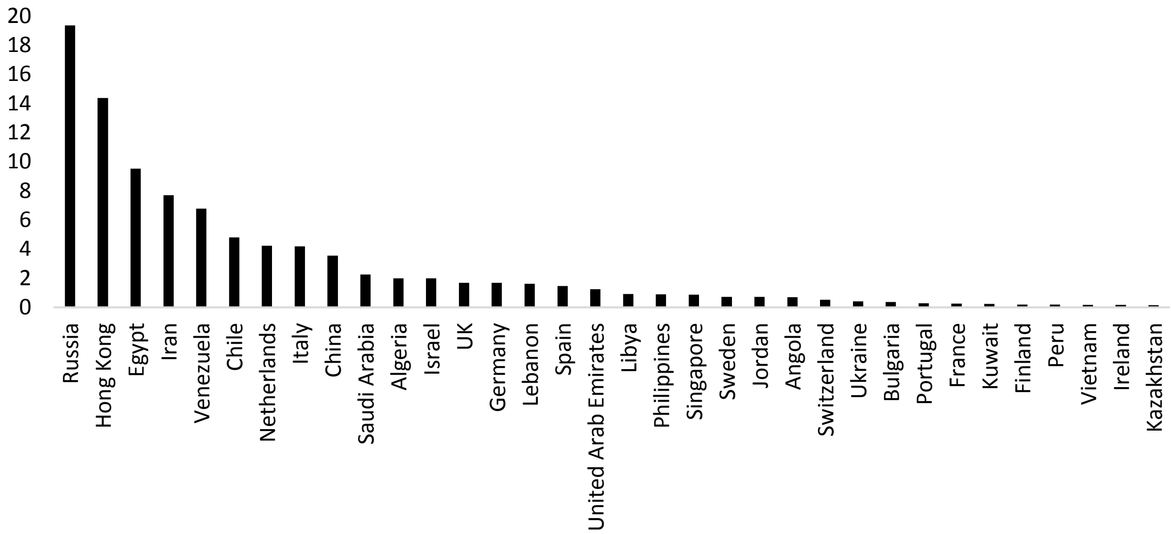

Figure 3 – Main Brazilian beef importing countries – average share from 2000 thru 2017 (values in percentages).
Fonte: *United Nations Conference on Trade and Development* - CONTRADE.

4.2 Overview of SPS and TBT notifications

Figure 4 shows the evolution of regular notifications concerning to SPS and TBT agreements among the WTO member countries from 2000 thru 2017. An amount of 13,667 sanitary notifications was issued over the period under review and more 20,722 technical notifications. The left side axis in Figure 4 expresses the number of SPS and TBT reports issued for all products and the bars show their values. The right axis in this same figure indicates the specific number of notifications issued for beef exports, and the lines (full and dashed lines) show them. It should be noted that for all products the technical requirements are generally higher than sanitary and phytosanitary requirements, but for the meat market, the TBT requirements are almost insignificant: only fifteen technical reports have been issued over the period from 2000 thru 2017. Beef SPS notifications were issued 28 per year, on average, which is justified by the specific characteristic of this product, which is highly susceptible to the spread of diseases and other substances that pose risks to human, animal and plant health.

The numbers of annual SPS and TBT notifications issued for all sectors have upward tendencies, despite oscillating throughout the period. The highest growth rates took place between 2009 and 2010 for health reports (growth of 31.84%) and between 2002 and 2003 for technical requirements (26.29%). In early 2008, the rise in commodities prices stimulated the adjustment of the countries to the requirements established by the importing countries. In addition, the middle of this year faced an economic crisis that led to the fall of world economic activity. For this reason, part of the increase in these notifications was issued in order to protect the domestic market (SILVA, ALMEIDA, 2010). This argument also finds support in the paper carried out by Heringer and Silva (2014).

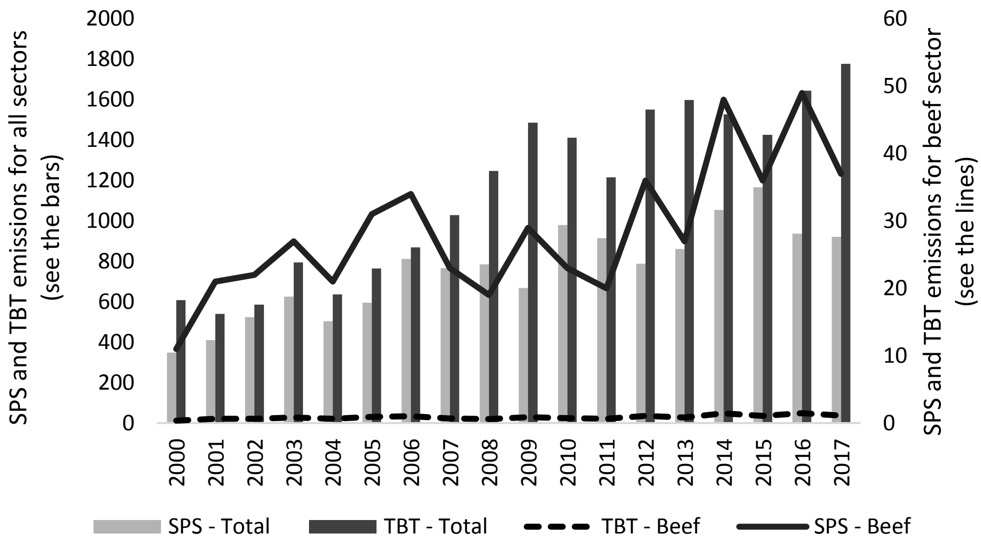

Figure 4 - Evolution of the SPS and TBT notifications issued for all products (see the bars and the left side axis) and for the beef sector (see the lines and the right side aixes) from 2000 thru 2017.
Source: *World Trade Organization* – WTO.

SPS and TBT notifications can be distinguished according to their objectives, and one notification may reach more than one objective. Figure 5 shows that most of WTO´s SPS requirement focused on food security and human health protection, both for all sectors (7,485 and 4,377 notifications, respectively) and for meat sector (341 and 156).

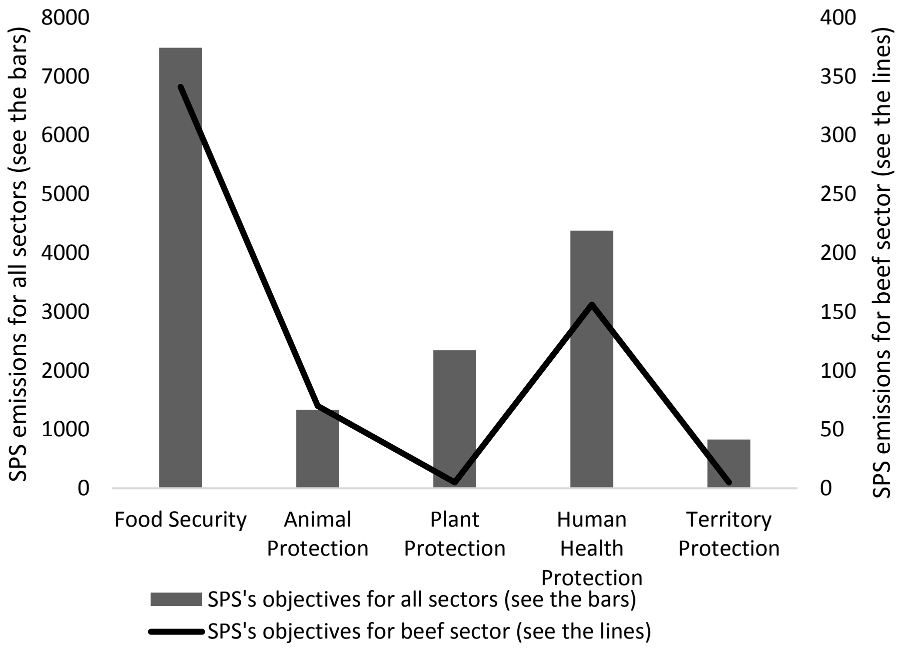

Figure 5 - Distribution of SPS notifications issued by WTO countries according to their purposes – time period from 2000 thru 2017 (left side axis measures the notifications for all sectors and they are illustrated by bar; and values on right side axis measures the notifications for meat and they are illustrated by line).
Source: *World Trade Organization* – WTO.

Regarding to the technical requirements, Figure 6 illustrates their distribution according to their objectives, which are classified such as: national security; labeling; prevention of misleading practices; protection of human health; protection of animals and plants; environmental protection; quality requirements; harmonization; easing trade bottlenecks; cost reduction; “unspecified”; and others. As shown in Figure 4, there are few technical requirements for the meats. Indeed, they had the main objective of promoting human health. In general, human health protection is the most recurrent justification for the use of TBT measures by WTO member countries, with 11,634 notifications being issued for this purpose, followed by protection against misleading practices (3,963), environment protection (3,409) and quality requirements (2,649).

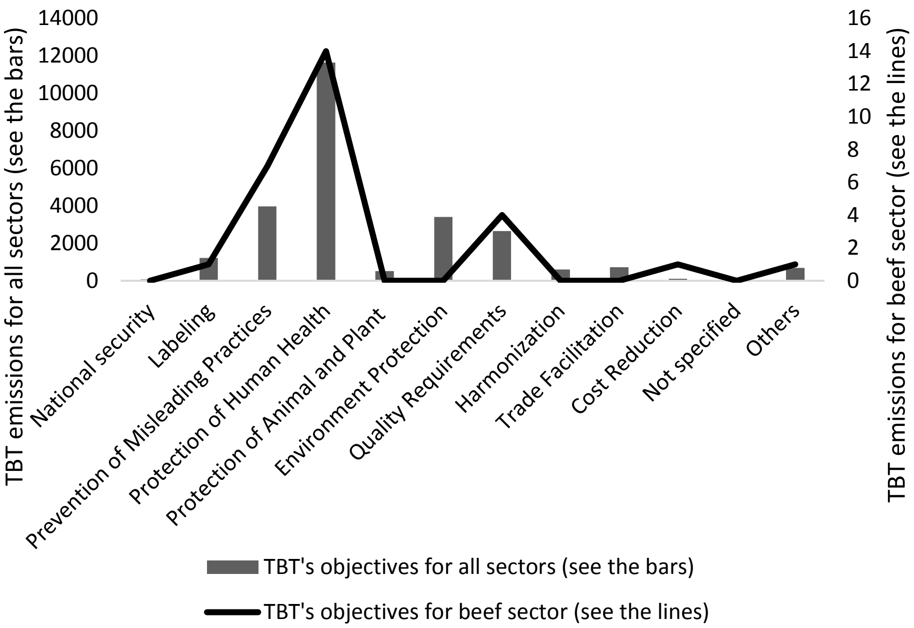

Figure 6 - Distribution of TBT notifications issued by WTO countries according their purposes – time from 2000 thru 2017 (left side axis shows values for all sectors and they are illustrated by bars; and right side axis shows values for beef notifications and they are illustrated by a line). Source: World Trade Organization – WTO.

According to Figures 5 and 6 it is clear that the greatest concern of importing countries, when issuing SPS and TBT notifications, has been with human health and food safety, what indicate a precaution regarding to the production of meat and trying to avoid possible diseases associated with this merchandise trade. In addition to the analysis of the regular measures imposed on meats, it is noteworthy that 152 emergency notifications were issued for this good between 2000 and 2017. That issue takes places when there are events that jeopardize the flows of goods in the international market. An example is the outbreak of mad cow disease in European countries, when about 60% of the 2001 notifications took place to avoid this disease spillover across countries borders. That immediately affected the international market of meat (GALLI and MIRANDA, 2008).

Sanitary and technical measures aim to promote greater transparency and stability in the patterns of international markets. It is important to mention that one of the principles behind the SPS Agreement was its regionalization, which allowed, for example, splitting up the regions of Brazil into livestock zones, according to their susceptibility for foot-and-mouth and bovine spongiform encephalopathy (BSE) outbreaks. That security measure allowed for greater control and differentiated surveillance in different regions in order to make the whole country labeled as free of foot-and-mouth disease and without the vaccination need. That label is required by importers to buy Brazilian beef in a safe way.

According to Silva et al. (2008), in order to sell at the international market and expand Brazilian exports of beef, structural changes have taken place in the beef industry, especially concerning to the use of technologies and improvement of the food industries´ logistic supply chain. These changes were supported by governmental agencies and they collaborated to suit the Brazilian beef to the importing countries´ requirements.

The previous paragraphs dealt with the SPS and TBT requirements issued by all WTO countries. Now, we move to analyze the notifications issued by the countries in focus in this paper. The notifications issued for all sectors show a trend similar to that observed in Figure 4. Specifically for beef sector, the 35 countries in focus have together issued 167 health reports, an average of 9 reports issued per year, against only three TBT notifications accounted for throughout the period under consideration. "Food safety" was used as a target for 100 SPS reports, followed by "human health protection" (62) and "animal health" (27). Within the total SPS requirements, 124 issues were requested by the European Union countries, 17 by Brazil, 8 by Chile, 9 by the Philippines, 6 by Russia, 4 by Switzerland, 3 by China, Egypt and Ukraine, 2 by Israel, the Arab Emirates and Saudi Arabia, and 1 by Jordan, Hong Kong and Vietnam. The other countries have not issued any notification. Within the total SPS requirements, 157 health requirements fall on Brazil (of these, four were sent exclusively to the country, and the others were directed to all beef exporters). The technical notifications were sent to all countries. A specific report was issued by Ukraine in 2010 aimed at preventing misleading practices, quality requirements and human protection; and the others were issued in the years of 2010 and 2011 by the European Union countries, with the objective of reducing costs and raising productivity.

After mentioning SPS and TBT measures on the beef market, it is necessary to quantify in what extension these measures limit or increase Brazil´s international trade of beef. Then, the next section shows the econometric result from running equation (2).

4.3 The effect of the SPS and TBT measures on Brazilian beef trade

In order to identify the effect of non-tariff measures on beef trade flows, the gravity equations were estimated by the OLS-pooled and fixed effect estimators (Appendix 1) and PPML. The estimates generated by the last method showed a better adjustment to the data in relation to the two others, demonstrating the importance of unobservable multilateral resistance variables in the trade flows explanation. It is also noted that the estimates from the PPML presented an overall statistical significance better than those generated by the OLS. Therefore, the following interpretation are on the coefficients estimated by the PPML with fixed effects, what is consistent with the recommendation proposed by the empirical model. The estimates are shown in Table 2.

Non-tariff measures were largely used in the international trade, being captured by the dummy variables in equation (2). The coefficients associated to the sanitary (SPS_{jit}) and technical (TBT_{jit}) measures presented different results for the three types of beef exportation. Sanitary and technical measures affected the trade of fresh or chilled meat (code 201) and offal (code 206) and only SPS notifications have affected frozen meat exports (code 202).

Table 2 - Estimates of the regression, use of the fixed-effect PPML

Product	$lnDIS_{ij}$	$lnGDP_{jt}$	$lnGDP_{it}$	$lnPROD_{it}$	SPS_{jit}	TBT_{jit}	$constant$	Number of observations	R²	Fixed Effect
Fresh or chilled beef	-0.688^{c} (-1.76)	0.426^{a} (2.44)	0.236^{a} (2.04)	1.029^{a} (10.78)	0.255^{a} (2.55)	0.331^{c} (1.79)	-11.338^{ns} (8.73)	1,182	0.7208	Pair of countries; year
Frozen Beef	-0.363^{c} (-2.19)	0.660^{a} (5.42)	0.211^{c} (2.32)	0.626^{a} (6.02)	0.492^{a} (4.06)	0.121^{ns} (1.00)	-19.071^{c} (5.948)	1,218	0.6834	Pair of countries; year
Edible, fresh, chilled or frozen beef offal	0.901^{ns} (3.58)	0.773^{a} (4.49)	0.554^{a} (4.46)	1.489^{a} (6.94)	0.277^{c} (2.08)	0.659^{a} (3.75)	-43.19^{a} (-5.10)	1,182	0.6699	Pair of countries; year

Source: equation run by the authors.

Notes: The values in parentheses are the standard errors of the estimates; superscripts ^{a} ,^{b}, ^{c} and ^{ns} indicate that *t*-statistic is statistically significance at 1%, 5%, 10%-level and no-significance, respectively.

Clearly, the effects of the SPS and TBT measures were positive in all three beef products exported and reported in Table 2. This result is important and answers the question rose in the objective of this study, about what would be the impact of non-tariff measures on beef exports: a protectionist effect or a quality adjustment effect? Indeed, it becomes possible to qualify that NTM, both the sanitary and technical requirements, have conditioned to a process of quality and standardization at an international standard, what has positively affected the beef exports. Since most of the objectives behind the measures issued are related to food safety and human health protection, it is indicated that the establishment of NTM seeks to increase consumers´ information, what has a positive impact on trade, although at an increasing cost. Recently, countries that start trade bargaining are not only seeking greater market opportunity, but also reducing uncertainties. Therefore, this result is consistent for the meat trade, considering the organic characteristics of the product and the potential for public health problems in case of contamination. Increasing health care by producers reduces the consumer´s uncertainties.

Studies about Brazil´s pork and chicken exportations have presented different results concerning to the impacts of non-tariff measures. For pork exportation, the effect was the opposite the one found for beef exports. SPS measures adversely affected trade, standing as barriers to trade flows. The technical measures were not statistically significant (MENDONÇA et al., 2017). Concerning to Brazil´s chicken meat exportation, the effects of NTM were ambiguous, as Fassarela et al. (2011) found different results considering the objectives of NTM. Labeling regulations (labeling requirements, marketing and packaging requirements) have allowed raising chicken trade, but compliance with requirements (testing, certification and inspections) may reduce the Brazil´s chicken exports. According to Fassarela et al. (2011), the effect on trade will depend on the impact of regulations on exporters' costs and on consumer´s perceptions.

Coefficient linked with the distance variable (see Table 2) were negative and statistically significant at 10%-level for frozen and chilled beef exportations, but it was not statistically significant for beef offal exportation. This result corroborates with the fact that larger the distance, greater the barriers to trade, due mainly to transport costs, what is considered as one of the biggest cost component in beef trade and with great influence on tradable beef price.

The coefficient associated with the importing country´s GDP ($lnGDP_{jt}$) has statistical significance for the three types of imported beef, as well as it presents a positive sign, what is coherent with the economic theory. This result indicates that higher levels of income allow the importation of greater amount of goods. The coefficient associated with the exporting country´s

GDP ($lnGDP_{it}$) was also statistically significant for the three kind of beef exportations, showing positive signals. However, the income of the country that exports is not necessarily the only variable to capture the impact of the exporting country on the exported amount. For this purpose, the variable "production" ($PROD_{it}$) was also considered into the regression, with this coefficient been statistically significant at 1%-level for all three types of beef exportations and with positive signals. That indicates that the country tends to export more of the good that exist in abundance, what is sound with the international trade theory.

5 FINAL REMARKS

Brazil stands out among the world's largest exporters of beef. The objective of this paper was to verify if non-tariff measures, characterized by sanitary (SPS) and technical regulations (TBT), have affected Brazilian beef exports driven to its main trading partners. In addition to the impact analysis, this paper evaluated whether SPS and TBT reports act as trade barriers or, otherwise, they have promoting more transparent and secure trade.

The descriptive analysis allows observing that both beef exports and the issuance of sanitary regulations on them have shown upward tendencies over the time. Keeping in mind these observations and by using the gravity model, it was possible to identify the effects of these measures on the exported amount over the eighteen years analyzed in the paper. In addition to the SPS and TBT non-tariff variables, defined as dummies, beef production in the exporting countries and other variables commonly used in the gravity model were also used. They are: distance and income from exporting and importing countries. Estimates of the model indicated that countries' distance, beef production and GDP have influenced on beef trade flows, as well as non-tariff measures. Sanitary and technical regulations had a positive effect on exports. Consequently, they fulfill with their objective of promoting standardization and raising the quality of internationally traded beef. This result shows that Brazil is adapting to the international requirements and have improving the quality of its beef exportation. This concern should be maintained so that the country can continue to increase its trade flows with its partner countries.

In order to enlarge the knowledge provided by this paper, another study can use the Constant Market-Share (CMS) methodology to analyze the Brazilian beef export evolution. It would be recommended in order to identify if export growth was due to the growth of world trade, if there was a larger demand by importing countries or whether Brazilian beef has become more competitive in the international market.

REFERENCES

ANDERSON, J. A Theoretical Foundation for the Gravity Equation. ***American Economic Review***, American Economic Association, Nashville, v. 69, n. 1, 1979.

ANDERSON, J. E.; VAN WINCOOP, Eric. Trade costs. ***Journal of Economic literature***, v. 42, n. 3, p. 691-751, 2004.

ANDRADE, R. L. P. de. **Consequências positivas das barreiras não-tarifárias no comércio internacional de produtos do agronegócio: o caso da cadeia de carne bovina.** 2007. 214 f. Tese (Doutorado) – Instituto de Ciências Humanas e Sociais, Universidade Federal Rural do Rio de Janeiro, Rio de Janeiro.

ATLAS OF ECONOMIC COMPLEXITY. 2018. Disponível em: http://atlas.cid.harvard.edu/ . Acesso em: set. 2018.

BACHA, C.J.C. Economia e política agrícola no Brasil. Campinas, SP. Editora Alínea, 2018.

BALDWIN, R.; TAGLIONI, D. The Rose effect: The Euro's impact on aggregate trade flows. In: Study on the impacto f the Euro on trade and Foreign Direct Investment. Org: Baldwin, R.; DiNino, V.; Fontagné, L.; Santis, R.A.; Taglioni, ***D. Economic Papers***, nº 321, 2008.

BARROS, G.S.C.; BURNQUIST, H.L.; MIRANDA, S.H.G.; CUNHA FILHO, J.H. "SPS Issues of Agricultural Trade in the Western Hemisphere". Piracicaba**. Report BID/CEPEAESALQ/USP**. May/2002. 66p.

BOBKOVÁ, B. Gravity model estimation using panel date: is logarithmic transformation advisable? 47p. Master Theses – Charles University, Prague, 2012.

BUREAU, J.C.; MARETTE, S.; SCHIAVINA, A. Non-tariff trade barriers and consumers' information: The case of the EU-US trade dispute over beef. ***European Review of Agricultural Economics***, v. 25, n. 4, p. 437-462, 1998.

CHENG, I.; WALL, H. J. Controlling for Heterogeneity in Gravity Models of Trade and Integration. ***Federal Reserve Bank of St. Louis Review***, St. Louis, v. 87, n. 1, 2005.

DISDIER, A. C., FONTAGNÉ, L. e MIMOUNI, M. The impact of regulations on agricultural trade: evidence from SPS and TBTs Agreements. ***Working Paper 2007-04 - Center D`Études Prospectives Et D`Informations Internationales (CEPII)***, fev. 2007.

FASSARELLA, L. M., SOUZA, M. J. P. D., BURNQUIST, H. L.Impact of sanitary and technical measures on Brazilian exports of poultry meat. ***Agricultural and Applied Economics Association***, 2011.

FLORINDO, T. J., DE MEDEIROS, G. I. B., DA COSTA, J. S., RUVIARO, C. F. Competitividade dos principais países exportadores de carne bovina no período de 2002 a 2013. **Revista de Economia e Agronegócio**, Viçosa, v. 12, n. 1/2/3, 2015.

FOZ, I. Aftosa: uma história que não acabou. **Revista FUNDEPEC**, v. 6, n.10, p6, jul. 2000.

GALLI, F.; MIRANDA, S. H. G. A regulamentação sobre o comércio de carne bovina no contexto do acordo SPS. **Cepea (Centro de Estudos Avançados em Economia Aplicada)–ESALQ/USP**, Piracicaba, 2008.

HERINGER, L.M.; SILVA, O. M. As notificações de emergência no comércio internacional: origens e efeitos. **Perspectiva Econômica**, v. 10, n. 1, p. 14-28, 2014.

HUFBAUER, G.; KOTSCHWAR, B.; WILSON, J. Trade policies, standards, and development in Central Amer-ica. Geneve: World Bank. 1999. 50 p.

KASSUM, J.; MORGAN, N. The SPS Agreement: livestock and meat trade. 2002.

KEE, H. L., NICITA, A. e OLARREAGA, M. Estimating trade restrictiveness indices, 2008.

KRAMB, M.; HERRMANN, R. Quais são os impactos comerciais das medidas SPS? Um modelo gravitacional do comércio de carne bovina da UE. Agrarwirtschaft , v. 58, n. 4, p. 187-197, 2009.

LIMA, R. C. A. **Medidas sanitárias e fitossanitárias na OMC**: neoprotecionismo ou defesa de objetivos legítimos. São Paulo: Aduaneiras, 2005.

LYRA, T. M. P.; SILVA, J. A. **A febre aftosa no Brasil, 1960-2002**. Arq. Bras. Méd. Vet. Zootec. v. 56, n. 5, 2004, p. 565-576.

MARTINS, M. M. V.; SILVA, O. M. As Notificações aos Acordos SPS e TBT pelos Países do BRICS: uma análise comparativa. **Reflexões Econômicas**, v. 2, n. 1, p. 105-122, 2016.

MENDONÇA, T.G.; DE CARVALHO, D.E.; REIS, M.P.O.. Exportações brasileiras de carne suína Medidas técnicas, sanitárias e fitossanitárias. **Revista de Política Agrícola**, v. 26, n. 3, p. 124-141, 2017.

MIRANDA, S. H. G. **Quantificações dos efeitos das barreiras não-tarifárias sobre as exportações brasileiras de carne bovina**. 2001. Tese (Doutorado em Economia Aplicada). Escola Superior de Agricultura "Luiz de Queiroz", Universidade de São Paulo, São Paulo. 2001.

MIRANDA, S. H. G. e BARROS, G. S. C. The application of intervention models to non-tariff trade barriers: a case study of Brazilian beef exports. ***Journal of International Agricultural Trade and Development***, New York, v. 5, n. 2, p. 255-272, 2009.

NICITA, A.; GOURDON, J. A preliminary analysis on newly collected data on non-tariff measures. Policy Issues in International Trade and Commodities, Study Series n. 53. 2013.

ROBERTS, D.; DE REMER, K. Overview of foreign technical barriers to US agricultural exports. Commercial Agricultural Division, ***Economic Research Service, USDA, Staff Paper number AGES-9705***, Washington, DC. 1997.

SANTOS, M.O.; DA SILVA, O.M.; DE ALMEIDA, F.M. Uma Análise Das Restrições Comerciais No Mercado Internacional De Algodão. **Revista de Estudos Sociais**, 2017.

SCHLUETER, S. W. e WIECK, C. Regulatory SPS Instruments in Meat Trade. In: IATRC Annual Meeting "Private Standards and Non-Tariff Barriers: Measurement, Impacts, and Legal Issues", 2009, Fort Myers, Florida.

SHANG, X.; TONSOR, G. Os impactos dos incidentes de segurança alimentar no comércio de carne bovina dos EUA: uma abordagem do modelo de gravidade. In: **Reunião Anual de 2014**, 1 a 4 de fevereiro de 2014, Dallas, Texas . Associação de Economia Agrícola do Sul, 2014.

SHEPHERD, B. The gravity model of international trade: A user guide. ARTNeT Books and Research Reports, 2013.

SILVA, F.A. **Desenvolvimento do sistema financeiro e exportações brasileiras: uma análise para o período de 1995 a 2014**. 2016. Tese (Doutorado em Economia Aplicada). Universidade Federal de Viçosa, Minas Gerais. 2016.

SILVA, L. G.; MARION FILHO, P. J.; CAMPOS, I. A dinâmica das exportações brasileiras de carne bovina (1994 – 2005). **Revista de Estudos Sociais**, ano 10, n. 19, v. 1, 2008.

SILVA, O. M.; ALMEIDA, F. M. A incidência das notificações aos acordos sobre medidas SPS e TBT da OMC nas exportações agrícolas do Brasil. In: Notificações aos Acordos de Barreiras Técnicas (TBT) e Sanitárias (SPS) da OMC: transparência comercial ou barreiras não tarifárias? Cap. 5. Viçosa: Editor Orlando Moreira da Silva, 2010.

SILVA, O. M.; ALMEIDA, F. M. Equivalência Tarifária das Medidas SPS e TBT nas Exportações Agrícolas e de Carnes do Brasil. 49º Congresso da Sociedade Brasileira de Economia, Administração e Sociologia Rural. 2011. **Anais...**2011.

SILVA, T. G. R.; MIRANDA, S. H. G. **A febre aftosa e os impactos econômicos no setor de carnes**. Centro de Estudos Avançados em Economia Aplicada – ESALQ/USP. São Paulo, 2005.

SOUZA, M.J.P. de; BURNQUIST, H,L. Facilitação de comércio e impactos sobre o comércio bilateral. **Revista Estudos Econômicos**, v. 41, n. 1, 2011.

SPENSER, H.; LOADER, R.; SWINBANK, A. The impact of sanitary and phytosanitary measures on developing countries exports of agricultural and food products. ***In The Conference on Agricultural and The New Trade Agenda in the WTO 2000 Negotiations. Geneve: World Bank/WTO***, Oct. 1999. 21 p. (Draft for Discussion).

STANTON, G. Review of the operation of the SPS Agreement. In: Conference of Agriculture and The New Trade Agenda in the WTO 2000 Negotiations. Genève: World Bank/WTO, Oct./1999. 9 p. (Draft for Discussion).

TINBERGEN, J. Shaping the World Economy: Suggestions for an International Economic Policy. Nova York: Twentieth Century Fund, 330 p., 1962.

UNITED NATIONS CONFERENCE ON TRADE AND DEVELOPMENT, **Anais…**, 2013.

UNITED STATES CENSUS BUREAU TRADE. 2018. **Data**. Disponível em: <https://apps.fas.usda.gov/gats/ExpressQuery1.aspx>. Acesso em set. 2018.

UNITED STATES DEPARTMENT OF AGRICULTURE FOREIGN AGRICULTURAL SERVICE – USDA. 2018. **Data.** <https://apps.fas.usda.gov/psdonline/app/index.html#/app/downloads>. Acesso em set. 2018.

VAKULCHUK, R.; KNOBEL, A. Impact of non-tariff barriers on trade within the Eurasian Economic Union. ***Post-Communist Economies***, v. 30, n. 4, p. 459-481, 2018.

WORLD INTEGRATED TRADE SOLUTION (WITS). **Database**. Disponível em: <https://wits.worldbank.org/> Acesso em: set. 2018.

WORLD TRADE ORGANIZATION (WTO). **Database**. Disponível em: <http://spsims.wto.org/en/Notifications/Search >. Acesso em: set. 2018.

YOTOV, Y. V.; PIERMARTINI, R.; MONTEIRO, J.A.; LARCH, M., An Advanced Guide to Trade Policy Analysis: The Structural Gravity Model. World Trade Organization, Geneva, 2016.

Appendix 1

Table 3 - Results of regressions

Econometri method	Product	$lnDIS_{ij}$	$lnPIB_{jt}$	$lnPIB_{it}$	$lnPROD_{jt}$	SPS_{jit}	TBT_{jit}	$constant$	Observações	R²	Fix Effect
Pooled	Fresh or chilled beef	-2.379^{a} (-5.53)	1.864^{a} (13.33)	-0.923^{a} (-6.31)	0.203^{a} (4.42)	2.181^{a} (5.62)	2.579^{ns} (1.90)	-2.328^{ns} (-0.34)	1218	0.2799	-
	Frozen Beef	0.168^{ns} (0.39)	2.300^{a} (16.12)	-1.680^{a} (-11.87)	0.284^{a} (6.17)	3.198^{a} (7.10)	0.944^{ns} (0.70)	-15.91^{c} (-2.31)	1218	0.4286	-
	Edible, fresh, chilled or frozen beef offal	0.770* (2.07)	1.450^{a} (11.77)	-0.983^{a} (-7.87)	0.185^{a} (4.65)	-0.182^{ns} (-0.48)	3.981^{c} (2.52)	-18.13^{b} (-3.01)	1218	0.2574	-
FE – MQO	Fresh or chilled beef	Omitted	-0.347^{ns} (-0.92)	0.900^{c} (2.37)	0.0340^{ns} (1.06)	-0.0109^{ns} (-0.04)	-2.324^{b} (-2.68)	-10.23^{ns} (-1.70)	1218	0.2314	Importing country
	Frozen Beef	Omitted	-0.17 ^{ns} (-0.41)	0.967^{c} (2.29)	0.0948^{b} (2.71)	0.673^{ns} (1.39)	0.267^{ns} (0.29)	-15.76^{c} (-2.37)	1218	0.1913	Importing country
	Edible, fresh, chilled or frozen beef offal	Omitted	-1.539^{a} (-4.60)	2.052^{a} (6.02)	0.0234^{ns} (0.84)	-0.0244^{ns} (-0.07)	3.026^{b} (3.02)	-10.01^{ns} (-1.84)	1218	0.3361	Importing country
AE	Fresh or chilled beef	-2.538^{c} (-2.22)	1.265^{a} (5.77)	0.599^{b} (-2.67)	0.0566^{ns} (1.73)	0.123^{ns} (0.40)	-2.169^{c} (-2.43)	9.585^{ns} (0.80)	1218	0.3228	Importing country
	Frozen Beef	-0.128^{ns} (-0.10)	1.852^{a} (7.53)	1.046^{a} (-4.18)	0.117^{a} (3.30)	1.131^{c} (2.39)	0.117 (0.12)	-15.32^{ns} (-1.14)	1218	0.5713	Importing country
	Edible, fresh, chilled or frozen beef offal	0.730^{ns} (0.61)	0.588^{b} (2.76)	-0.0937^{ns} (-0.43)	0.0384^{ns} (1.34)	0.257^{ns} (0.72)	3.419^{a} (3.32)	-16.49^{ns} (-1.36)	1218	0.3157	Importing country

Source: equation run by the authors.

Notes: The values in parentheses are the standard errors of the estimates; superscripts ^{a} ,^{b}, ^{c} and ^{ns} indicate statistical significance at 1%, 5%, 10%-level and no-significance, respectively.

Appendix 2

Table 4 – Econometric Tests

Chow test	Fresh or chilled beef	31.52[a]
	Frozen Beef	22.01[a]
	Edible, fresh, chilled or frozen beef offal	29.37[a]
Breusch-Pagan test	Fresh or chilled beef	3253.95[a]
	Frozen Beef	2538.43[a]
	Edible, fresh, chilled or frozen beef offal	3317.89[a]
Hausmann test	Fresh or chilled beef	18.70[a]
	Frozen Beef	43.24[a]
	Edible, fresh, chilled or frozen beef offal	65.32[a]

Source: values estimated by the authors.
Note: superscript [a] indicates statistical significance at 1%-level.