EFFECTS OF TRADE BARRIERS ON BRAZILIAN SOYBEAN AND MEAT: The cases of China, EU and US embargoes

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Abstract

Brazilian trade flows have increased in recent years, even with high tariffs and non-tariff trade barriers. The present study evaluated the effects of embargoes imposed on Brazilian meat and cereals (grains and oilseeds). Specifically, the Brazilian regional trade and its main indicators such as production, prices of commodities and factors, gross domestic product (GDP), and welfare were analyzed. The analytical model was based on a computable general equilibrium model - General Equilibrium Analysis Project for the Brazilian Economy (PAEG), which enables Brazilian regions and their relations with other countries or economic blocks to be analyzed using the GTAP 9.0 database. The results showed that the Chinese embargo on Brazilian grains (soybean and others) would lead to a decrease in their consumption in China of around US$ 750 million. Regarding Brazilian regions, a reduction in exports (-US$ 250 million) was observed in Central West, while an increase in exports was detected in Southeast (US$ 690 million), mainly of manufactured products and clothing. As to embargoes of the European Union (EU) and the United States (U.S.) on Brazilian meat, impacts were lower than those resulting from the Chinese embargo on Brazilian grains. The U.S. embargo would lead to greater damages than the European one. The United States would face welfare losses, becoming more sensitive than the EU in relation to Brazilian meat.

Keywords: embargo, PAEG, MPSGE, meat, soybean.

1 Introduction

Brazil has stood out due to its trade flows, with export surplus every year. Although exports have increased, it has still faced some problems regarding trade barriers.

Several works have analyzed the potential for trade gains with changes in trade policy, mainly from the named “rounds” of the World Trade Organization (WTO), e.g. The Doha Round. Among such studies, those of Gurgel (2001), Harrison et al. (2003), Cline (2003), Conforti and Salvatici (2004), Antimiani, Conforti, and Salvatici (2006), Ferreira Filho and Horridge (2005), Polaski (2006), and Pereira, Teixeira and Raszap-Skorbiansky (2010) can be mentioned.

Thus, the research problem is related to changes in trade policy that can influence the trade flow between Brazilian regions and the rest of the world. More liberal trade integration policies can favor some sectors in preference to others, as analyzed in above-mentioned works, regardless of generating gains for the Brazilian economy as a whole.

An analysis involving separation among Brazilian macro-regions enables effects among sectors and among regions to be investigated, leading to a better explanatory power. In this sense, the present study analyzed protectionist policies on Brazilian soybean and meat once barriers are restrictions to trade and can be classified into tariff, non-tariff and technical

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ones. They have been often imposed arbitrarily by nations in order to benefit a specific group. Such an issue is complex because health concerns can be related to the legitimacy of health protection, but they can also be used in an opportunistic manner as a trade barrier, representing protection of the local market.

Bender Filho (2007) stated that non-tariff barriers have been hampering international trade relationships since they have been unilaterally applied for health safety instead of trade protectionism. Tariff and non-tariff barriers imposed by economic blocks on specific products have hampered the competitiveness of some sectors.

Non-tariff barriers affect some variables such as price, quantity, trade, production, consumption, income, employment, and welfare. These variations lead to direct or indirect effects on all countries, including those that impose them. Non-tariff barriers have been often applied on products already subjected to tariff ones and, in this case, they increase the protection of such products. They are difficult to quantify, have costs for producers, consumers and exporters, and are not totally transparent and discriminatory. Furthermore, they lead to a distortion between domestic and international prices, which makes that sometimes the household industry is not affected by changes in world prices (LAIRD, 1996).

Barros et al. (2002) mentioned that health measures aim at promoting food safety for consumers, besides preventing the dissemination of pests and diseases among plants and animals. However, according to Silva, Triches and Malafaia (2011), Brazil does not have a reliable certification tracking system. Frequent changes have been observed in rules of the certification system, making Brazil dependent on non-tariff barriers imposed by importing countries. This indicates that any Brazilian health problem will result in an embargo. Measures related to health and human, animal and plant lives are based on the SPS (Sanitary and Phytosanitary) Agreement and the standards of the World Organisation for Animal Health (OIE). Some countries, however, can apply measures based on their own standards, supported by scientific justifications. Thus, a counterpoint between measures based on legitimate purposes and protectionist barriers has been observed.

Aggarwal and Evenet (2009) stated that a biased state intervention has been observed in favor of specific economic sectors. Thus, non-tariff barriers have been tendentiously applied to such sectors.

According to Lima and Barral (2007), non-tariff barriers have increased since tariff ones have decreased. Then, the great challenge of SPS and TBT (Technical Barriers to Trade) Agreements of WTO is to prevent that health measures, embargoes or technical barriers are applied unjustifiably.

Some embargoes on Brazilian products can be mentioned such as the Chinese embargo on Brazilian soybean in 2004 once the latter might be contaminated with fungicides (Captan and Carboxin), resulting in losses to Brazilian exporters. Furthermore, the relative embargo on Brazilian meat in 2004 and 2011 can also be mentioned, when Russia suspended Brazilian meat imports, leading to negative effects on this sector, with a decrease in exports. In the area of preferential agreements, Thorstensen and Ferraz (2016) considered Brazil as a whole, not disaggregating its macro-regions. Thus, the present study contributes to the analysis of specific sectors like grains and meats in Brazilian macro-regions.

The general purpose of this work was to evaluate the effects of embargoes imposed on Brazilian soybean, corn and other cereal grains, and meat on economic growth, welfare and trade flow. Specific purposes were: a) to identify the effects of a possible Chinese embargo on Brazilian grains and oilseeds; b) to identify the effects of a possible embargo of the European Union (EU) and the United States (separately) on Brazilian animal products; and c) to analyze economic impacts based on gross domestic product (GDP), household consumption, investments, public finances etc. due to the purposes (a) and (b).

Contributions to the economic literature are related to the application of a computable general equilibrium model involving multiple Brazilian regions and countries in order to evaluate changes in trade barriers. Thus, scenarios and their effects on each Brazilian region and on several countries/economic blocks of interest were investigated.

2 Methodology

This work applied computable general equilibrium models (CGEMs) as observed in similar studies (Santos, 2006; Magalhaes, 2009). The proposed CGEM is the General Equilibrium Analysis Project for the Brazilian Economy (PAEG) of Gurgel, Pereira and Teixeira (2013). The PAEG model is based on the GTAPinGAMS structure, which performs a nonlinear mixed complementarity optimization (Rutherford and Paltsev, 2000; Rutherford, 2005; Lanz and Rutherford, 2016). The Mathematical Programming System for General Equilibrium analysis (MPSGE) provides a simplified representation for systems of nonlinear inequalities that are typical of general equilibrium models (Rutherford, 1999).

Currently, the PAEG model has used a database from the GTAPinGAMS model version 9.0, base year 2011, according to Gurgel (2016). The PAEG model has the advantage of enabling the original structure of the GTAP model to be changed as desired purposes, considering regions/countries/economic blocks and sectoral aggregation. The GTAP 9.0 database has input-output matrices for 140 regions, 57 sectors and 5 primary factors. The PAEG model covers 2 factors, 19 sectors and 12 regions, including the five Brazilian regions as shown in Table 1. Agents are Families, Productive Sectors, Government and the Rest of the World.

The present study followed the PAEG model of Gurgel, Pereira and Teixeira (2013) and Pereira (2011). Brazil was disaggregated into its regions individually and the static, multi-regional and multisectoral model also included other 7 regions/countries. Namely, the model has 12 regions in total: Brazil (North, Northeast, Central West, Southeast, and South), Rest of Mercosur, USA, Rest of Nafta, Rest of America, European Union, China, and Rest of the World. Each region is represented by a structure of final demand, and the model seeks to optimize consumer welfare subjected to budget constraint, in addition to the minimization of costs related to productive sectors, given the technology.

Agribusiness is disaggregated into sectors – paddy rice (pdr); corn and other cereal grains (gro); soybean and other oilseeds (osd); sugarcane and sugar industry (sgr);meats and live animals (oap); milk and dairy (rmk); other agricultural products (agr); and food products (foo). Sectors of manufactured products are disaggregated into: textiles (tex); Wearing apparel and leather products (wap); paper, cellulose and publishing products (ppp); chemicals, rubber industry and plastics (crp); and other manufactured products (man). Lastly, service sectors is disaggregated into: Electricity, gas, manufacture distribution and water (siu); construction industry (cns); trade (trd); transport (otn); and other services (ser).

Household income brackets of Brazilian regions were disaggregated as follows: F1 = Bracket 1 -- up to R$ 400.00; F2 = Bracket 2 -- more than R$ 400.00 up to R$ 600.00; F3 = Bracket 3 -- more than R$ 600.00 up to R$ 1000.00; F4 = Bracket 4 -- more than R$ 1000.00 up to R$ 1200.00; F5 = Bracket 5 -- more than R$ 1200.00 up to R$ 1600.00; F6 = Bracket 6 -- more than R$ 1600.00 up to R$ 2000.00; F7 = Bracket 7 -- more than R$ 2000.00 up to R$ 3000.00; F8 = Bracket 8 -- more than R$ 3000.00 up to R$ 4000.00; F9 = Bracket 9 -- more than R$ 4000.00 up to R$ 6000.00; F10 = Bracket 10 -- more than R$ 6000.00. Disaggregation into income brackets was described by Wolf (2016).

Table 1. Regional and sectoral description of the PAEG database.

Regions	Activities
1- Northern Brazil (NOR)	1- Paddy rice (pdr)
2- Northeastern Brazil (NDE)	2- Corn and other cereal grains (gro)
3- Central-western Brazil (COE)	3- Soybean and other oilseeds (osd)
4- Southeastern Brazil (SDE)	4- Sugarcane, sugar beet (c_b)
5- Southern Brazil (SUL)	5- Meat and animal products (oap)
6- Rest of Mercosur (MER)	6- Raw milk (rmk)
7- United States (USA)	7- Other agricultural products – wheat, fibers, fruits, plants etc. (agr)
8- Rest of Nafta (NAF)	8- Food products (foo)
9- Rest of America (ROA)	9- Textiles (tex)
10- European Union (EUR)	10- Wearing apparel and leather products (wap)
11- China (CHN)	11- Wood and furniture (lum)
12 - Rest of the World (ROW)	12- Paper, cellulose and publishing products (ppp)
	13- Chemicals, rubber and plastics (crp)
	14- Manufactured products: non-metallic minerals, metalworking, mining, several industries (man)
	15- Electricity, gas, manufacture distribution and water (siu)
	16- Construction (cns)
	17- Trade (trd)
	18- Transport (otp)
	19- Services (ser)

Source: Pereira et al. (2013, p. 34).

Database consists of trade flows among countries and regions, transport costs, import tariffs and taxes (or subsidies) on exports. The notation is similar to that of the GTAP project, as follows: m for market prices (market) and w for international ones (world), as mentioned by Rutherford (2005).

The household production (vom_{ir}) is distributed among exports ($vxmd_{irs}$), international transport services (vst_{ir}), intermediate demand ($vdfm_{ijr}$), private consumption ($vdpm_{ir}$), investment ($vdim_{ir}$), and government consumption ($vdgm_{ir}$). Accounting identity in the database, represented by social accounting matrices regarding household production, is shown by equation (1).

$$vom_{ir} = \sum_{s} vxmd_{irs} + vst_{ir} + \sum_{j} vdfm_{ijr} + vdpm_{ir} + vdgm_{ir} + v\dim_{ir} \quad (1)$$

The domestic market of r acquires the imported good i through its different consumers (families, companies and government). For each agent, import values are represented by $vipm_{ir}$, $vifm_{jir}$ and $vigm_{ir}$ for families, companies and government, respectively. Equation (2) shows the accounting identity of such flows:

$$vim_{ir} = \sum_{j} vifm_{ijr} + vipm_{ir} + vigm_{ir} \quad (2)$$

The production of Y_{ir} includes intermediate inputs (household and imported), free-mobility production factors (vfm_{fir}, $f \in m$), within each region, belonging to the set m = {skilled work, unskilled work and capital}), and consumption by the public agent ($vigm_{ir}$). The income of production factors is distributed to the representative agent. The equilibrium in factor markets is given by an identity that relates the payment amount of factors to their income (Equation (3)).

$$\sum_{i} vfm_{fir} = evom_{fr} \quad (3)$$

For international markets, demand and supply equilibrium conditions require that exports of the good i by the region r (vxm_{ir}) are equal to its imports by all trade partners ($vxmd_{irs}$), as shown in equation (4).

$$vxm_{ir} = \sum_{s} vxmd_{irs} \quad (4)$$

Likewise, equilibrium conditions are also applied to international transport services. The aggregate supply of the transport service j, vt_j, is equal to the amount of transport services in exports vst_{jr} as shown in expression (5).

$$vt_{j} = \sum_{r} vst_{jr} \quad (5)$$

For the market of transport services, demand and supply equilibrium equals the supply of such services to the sum of bilateral flows of transport services acquired in imports of goods ($vtwr_{jisr}$) expressed in equation (6).

$$vt_{j} = \sum_{r} vtwr_{jisr} \quad (6)$$

Tax and transfer revenues are indicated by the letter R. Tax flows consist of indirect taxes on production and export ($\Re_{ir}^{Y}$), consumption ($\Re_{r}^{C}$), government demand ($\Re_{r}^{G}$), and imports ($\Re_{ir}^{M}$). Government income also includes direct taxes on the representative agent ($\Re_{r}^{HH}$), in addition to overseas transfers (vb_r). The government budget constraint can be represented by expression (7).

$$vgm_{r} = \sum_{i} \Re_{ir}^{Y} + \Re_{r}^{C} + \Re_{r}^{G} + \sum_{i} \Re_{ir}^{M} + \Re_{r}^{HH} + vb_{r}. \quad (7)$$

The budget constraint for the representative agent relates the income of production factors, deducted from tax payments, to consumption expenditure and private investment, as shown in equation (8).

$$\sum_{f} evom_{fr} - \Re_{r}^{HH} = vpm_{r} + vi_{r}. \quad (8)$$

Two conditions are observed for the consistency of the database contained in input-output and social accounting matrices - market equilibrium, in which supply equals demand for all goods and production factors, and income balance, in which net income equals net expenditure. A third set of identities refers to net operating profits in sectors of the economy. PAEG and GTAP models consider perfect competition and constant returns to scale, so that costs with intermediate inputs and production factors equal production value, and economic profits equal zero. This condition is applied to each productive sector and activity, as shown in equations (9) to (15) as follows.

$$Y_{ir}: \sum_{f} vfm_{fir} + \sum_{j} \left(vifm_{jir} + vdfm_{jir} \right) + \Re_{ir}^{Y} = vom_{ir} . \quad (9)$$

$$M_{ir}: \sum_{s} \left(vxmd_{isr} + \sum_{j} vtwr_{jisr} \right) + \Re_{ir}^{M} = vim_{ir} . \quad (10)$$

$$C_{r}: \sum_{i} \left(vdpm_{ir} + vipm_{ir} \right) + \Re_{ir}^{C} = vpm_{r} . \quad (11)$$

$$G_{r}: \sum_{i} \left(vdgm_{ir} + vigm_{ir} \right) + \Re_{ir}^{G} = vgm_{r} . \quad (12)$$

$$I_{r}: \sum_{i} v\,\mathrm{dim}_{ir} = vim_{r} . \quad (13)$$

$$FT_{fr}: evom_{fr} = \sum_{i} vfm_{fir} \quad f \in s . \quad (14)$$

$$YT_{j}: \sum_{r} vst_{jr} = vt_{j} = \sum_{irs} vtwr_{jirs} . \quad (15)$$

Economic model variables are defined in Table 2.

Table 2 - Endogenous variables representing activity levels and prices of goods and factors.

Variable	Description
C_r	Aggregate demand of private agents
G_r	Aggregate demand of the public sector
Y_{ir}	Production
M_{ir}	Aggregate imports
FT_{fr}	Transformation of factors
YT_J	International transport services
PC_r	Private consumption price index
PG_r	Government provision price index
PY_{ir}	Household supply price, gross price of indirect taxes on production
PM_{ir}	Import price, gross price of taxes on exports and tariffs on imports
PFF_{fr}	Price of factors for labor, land and natural resources
PFS_{fir}	Primary factor price in the sector
PT_J	Marginal cost of transport services

Source: Gurgel et al. (2013, p. 20).

Variables represent the levels of activities that define an equilibrium and variables of relative prices of goods and factors. The model determines values for all variables, except for international capital flows, which can be endogenously determined in an intertemporal model. Model equilibrium conditions define relative prices instead of nominal ones. Each equilibrium price is associated with a market equilibrium condition.

Productive sectors minimize their costs restricted by technology. The production Y_{ir} arises through the choice of inputs minimizing unit costs as equation (16). Decision variables correspond to initial reference data (also known as benchmarks), represented by the initial letter "d" instead of "v".

Thus, $vdfm_{jir}$ represents the initial data of the intermediate demand of the good j in the production of the good i in the region r, while $ddfm_{jir}$ represents intermediate demand, which corresponds to the equilibrium of the production-decision problem (GURGEL et al., 2013).

$$\min_{difm,ddfm,dfm} c_{ir}^{D} + c_{ir}^{M} + c_{ir}^{F}$$

$$\text{subjected to: } c_{ir}^{D} = \sum_{j} py_{jr}(1+t_{jir}^{fd})ddfm_{jir}\ .$$

$$c_{ir}^{M} = \sum_{j} pm_{jr}(1+t_{jir}^{fi})difm_{jir}\ . \qquad (16)$$

$$c_{ir}^{F} = \sum_{f}(pf_{fr\setminus f\in m} + ps_{fir\setminus f\in s})(1+t_{fir}^{f})dfm_{fir}\ .$$

$$F_{ir}(ddfm, difm, dfm) = Y_{ir}\,.$$

The model closure considers that the total supply of each production factor does not change, but they are mobile among sectors within a region. The factor land is specific to agricultural sectors, while natural resources are specific to some sectors (extraction of mineral resources and energy). Furthermore, the model does not consider unemployment and, then, the prices of factors are flexible. In turn, regarding demand, investments and capital flows are fixed, as well as payment balance. Thus, changes in real exchange rate should occur to accommodate alterations in export and import flows after shocks. Government consumption can change due to alterations in prices of goods, as well as the revenue from taxes will be subjected to changes in activity level and consumption (GURGEL et al., 2013).

The algorithm MPSGE represents a general equilibrium model through blocks of equations of production function, demand function and specific constraints. Then, the algorithm converts such information into algebraic equations, which are processed by the software GAMS. Equations generate zero profit conditions for production, demand and supply equilibrium in markets and the definition of income for consumers in the model as a mixed complementarity problem as described by Rutherford (1995).

A set of three non-negative variables should be determined to solve such a mixed complementarity problem: prices, quantities (activity levels in MPSGE) and income brackets (Gurgel, 2010, 2016). The zero profit condition for production indicates that any activity should obtain zero profit, i.e. input values should be equal to production ones. Associate variable is the activity level y for productive sectors with constant returns to scale. Thus, for a positive y value, economic profit should be equal to zero or the profit will be negative, not occurring production (Gurgel, 2010, 2016). Demand and supply equilibrium establishes that any good with a non-zero price should present a demand and supply equilibrium. On the other hand, any good with oversupply should have a price of zero. Income balance condition requires that income value is equal to that of allocations of factors and tax revenues for each agent.

The model works with Constant Elasticity of Substitution (CES) functions calibrated by the share (Rutherford, 2002), using initial equilibrium values for demands, prices, production, costs, portions, and elasticities of substitution to obtain expressions calibrated by the portion. Such a procedure considerably reduces the demand for information to run the model.

Elements constituting a general equilibrium model in MPSGE can be briefly summarized as follows, according to Gurgel (2010): a) Declaration of parameters and values; b) Declaration of the model; c) Declaration of sectors, commodities, consumers, auxiliary variables; d) Detailing of production blocks; e) Detailing of demand blocks; f) Detailing of constraint equations; g) Declarations of commands for inclusion and optimization solution (include and solver); and h) Calculations of output parameters and display statements.

Specifically, the importance of international trade for Brazilian macro-regions has been diverse. In this sense, agribusiness trade balance has great relevance for Central West, while sectors of manufactured products and other industries stand out in the trade tariff of regions like Southeast, for instance, frequently as exporters and other times as importers.

The studies of Santos (2006) and Magalhães (2009) applied computable general equilibrium models to investigate taxation (the former) and regional trade flows (the latter). Regarding taxation, the author emphasized taxes on domestic trade flows instead of those on international ones. In the second case, the author focused on observing flows among Brazilian regions and their effects on efficiency, competitiveness and economic growth.

Perobelli et al. (2008) mentioned the importance of trade for regional growth and highlighted the need to observe inter-regional flows, which lead to quite distinct effects among regions and economic sectors. The study did not observe effects through a computable general equilibrium model, but it indicates the need for studies clarifying such effects of trade flows.

Several studies have used tariff reduction for Brazilian agricultural products traded with some countries, especially the EU and the USA. In the present study, scenarios cover an increase in non-tariff barriers, i.e. in case of the USA, China and the EU completely block exports of Brazilian soybean and meat for arbitrary reasons.

Scenarios proposed in the present study are based on Chinese embargoes on Brazilian soybean, embargoes of the EU on Brazilian meat and the U.S. embargoes on Brazilian meat. Thus, three scenarios were elaborated:

1) Chinese embargoes on Brazilian grains (sectors ‘osd’ and ‘gro’)
2) Embargoes of the EU on Brazilian meat (sector ‘oap’)
3) The U.S. embargoes on Brazilian meat (sector ‘oap’)

For implementation of such effects into the PAEG model, an extreme increase in import tariff (rtms(i,s,r)) was used for those countries on Brazilian products in order to block (cancel) Brazilian exports of such products for selected countries.

The present study was proposed to relate trade flows among regions and among countries from changes in trade policies to scenarios of economic integration. Thus, a contribution to the economic literature and policymakers is expected in order to obtain better results regarding growth and economic welfare.

3 Results

3.1 Analysis of Chinese embargoes on Brazilian grains

Table 3 shows results concerning welfare and GDP gains from embargoes. Welfare was measured by equivalent variation (EV) obtained through the difference in consumption before and after shock and the percentage variation of aggregate utility. This indicator enables welfare to be evaluated in economies of different sizes, considering welfare levels from changes in utility. The Chinese embargo on Brazilian soybean led to negative effects for China, a loss of US$ 1.493 billion, i.e. 0.114% welfare losses in relation to benchmark. In Brazil, welfare gains were observed in North and Southeast, but losses were detected in other regions in relation to benchmark. The welfare gain of the Rest of Mercosur (US$ 0.205 billion) must be emphasized, i.e. a gain of 0.057% in relation to benchmark. This fact can be due to a redirection towards Brazilian soybean competitors in the Chinese market.

Table 3: Changes in welfare and gross domestic product (%) due to the Chinese embargo on Brazilian grains.

Region	Equivalent Variation		GDP
	Δ %	ΔUS$ billion	Δ%
Northern Brazil	0.020	0.014	-0.015
Northeastern Brazil	-0.067	-0.105	-0.013
Central-western Brazil	-0.193	-0.190	0.009
Southeastern Brazil	0.011	0.062	0.006
Southern Brazil	-0.091	-0.190	0.026
Rest of Mercosur	0.057	0.205	0.006
United States	0.003	0.340	-
Rest of Nafta	-	0.006	-0.001
Rest of America	-	-	-
European Union	-	-0.023	-
China	-0.114	-1.493	-0.069
Rest of the World	-	-0.033	-

Source: Research results.

The impacts of embargoes on GDP were small. The two losing Brazilian regions would be North (NOR) and Northeast (NDE). Other world regions presented null variations, in addition to small negative variations for China (-0.069%) and the Rest of Nafta (0.001%).

Table 4 shows the main results regarding changes in production values of soybean, corn and other cereal grains for Brazilian regions due to the Chinese embargo on Brazilian soybean. The latter would suffer expressive decreases in production value, from 10% in South to 29% in North. A great part of this value is redirected to the Rest of Mercosur and the United States, which are Brazilian soybean competitors. The three largest world soybean producers are the USA, Brazil and Argentina. In case Brazil loses market with China, such a market will be gained by the USA and Argentina as has been observed. China has a gain higher than 7% due to an increase in production motivated by a domestic price rise. Corn would also have losses, lower than 1% but with an increase of 0.012% in Central West.

Table 4: Percentage variations in the gross production value of soybean, corn and other cereal grains in regions due to the Chinese embargo on Brazilian products.

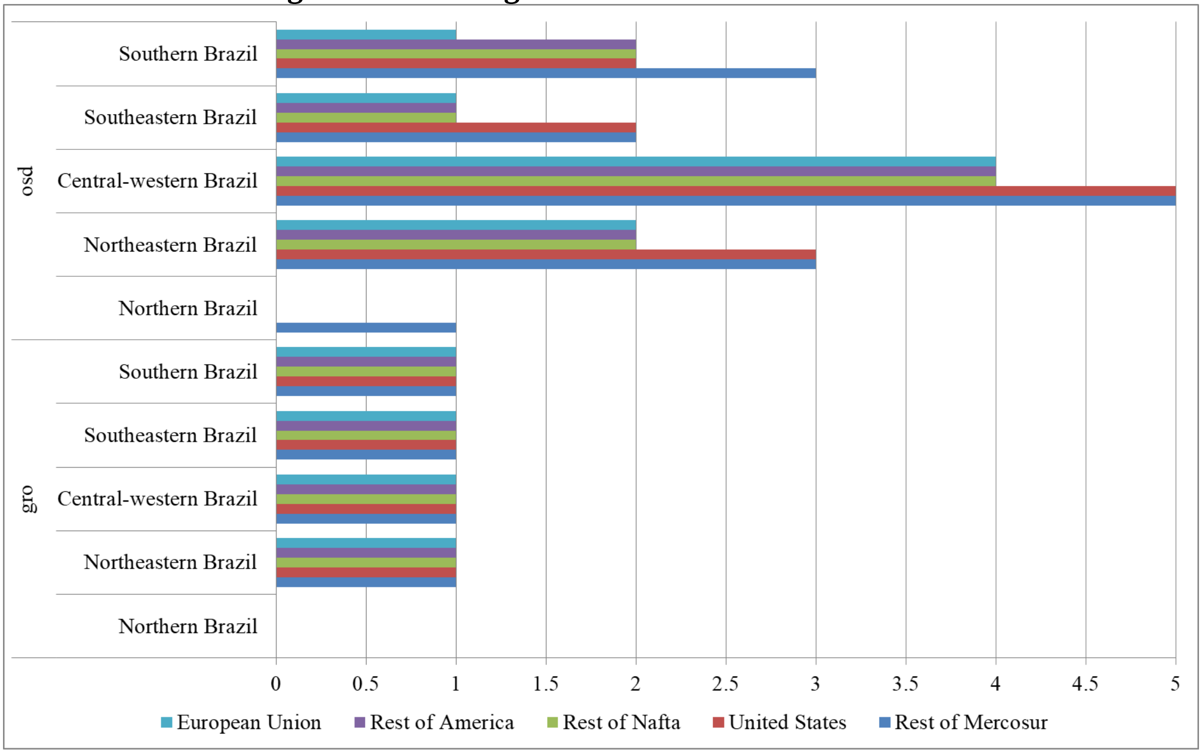
Region	Corn and other cereal grains (gro)	Soybean and other oilseeds (osd)
Northern Brazil	-0.953	-29.513
Northeastern Brazil	-0.447	-25.860
Central-western Brazil	0.012	-18.284
Southeastern Brazil	-0.283	-28.588
Southern Brazil	-1.430	-10.411
Rest of Mercosur	-0.326	10.085
United States	-0.010	7.187
Rest of Nafta	0.013	3.462
Rest of America	0.013	0.562
European Union	-0.021	-0.132
China	-0.153	7.122
Rest of the World	-0.001	0.111

Source: Research results.

Figure 1 shows percentage variations in the flow of soybean exports from Brazilian regions to other evaluated ones.

The central-west region of Brazil (COE) showed the highest soybean flow to other regions. In other words, although China is not buying, other regions increased their participation in the purchase of soybeans from COE, with emphasis on the Rest of Mercosur (RMS) and the USA. Thus, soybeans from Brazilian regions no longer goes to China, but they migrated to other regions worldwide.

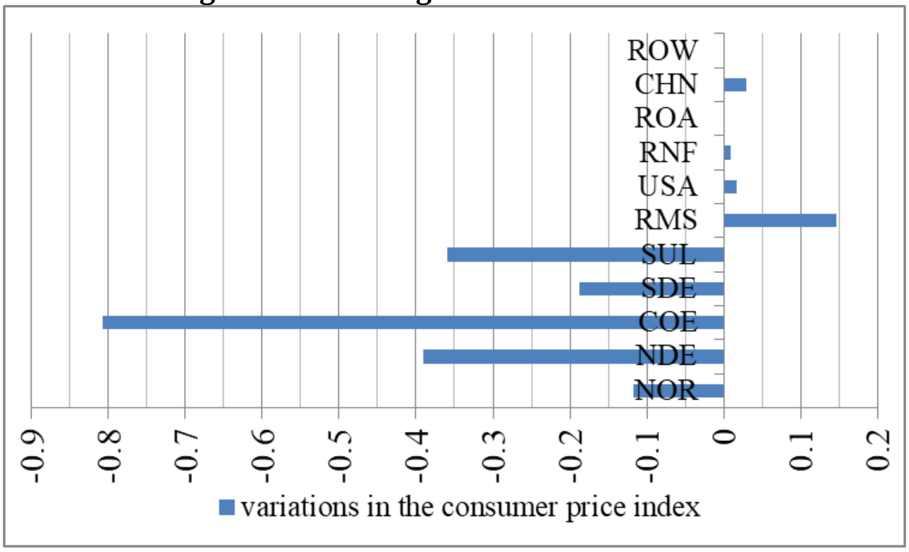
Figure 1: Percentage variations in the flow of Brazilian soybean exports to regions due to the Chinese embargo on Brazilian grains.



Source: Research results. Note: corn and other cereal grains (gro), soybean and other oilseeds (osd).

Figure 2 shows that the consumer price index (in real terms) had a small negative variation for all Brazilian regions. Other evaluated regions presented positive variations, especially RMS. Since China has imposed a very high tariff on Brazilian soybean import, soybean price has increased in the Chinese market.

Figure 2: Percentage variations in the consumer price index (in real terms) per region due to the Chinese embargo on Brazilian grains.



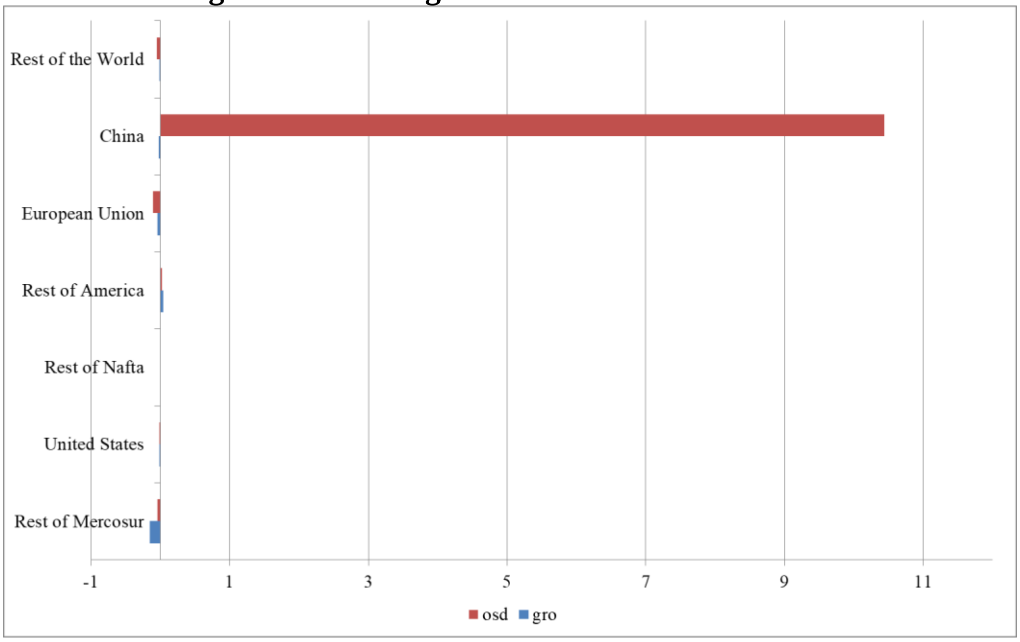
Source: Research results.

China had a decrease of 0.06% in prices of the production factors capital and labor. In turn, the Rest of Mercosur had an increase by around 0.06% in the price of labor.

Soybean import price indicates an increase of 10.4% in China, showing the effect of the embargo on Brazilian soybean in the Chinese market. Regarding Brazilian regions, a decrease in soybean import price was observed in North, Northeast and Southeast, since soybean supply was higher for Brazilian regions and export to China did not occur. South and Central West showed slight increases in such prices, lower than 0.5%. The Rest of Mercosur also showed a small decrease in soybean price (0.037%) (Figure 3).

An increase in soybean import price in relation to the domestic one can be due to Chinese government policies. Another reason for this result consists in soybean imported from Brazil represents around 50% total of soybean imported by China in 2015 - this percentage was equal to 41% in 2011. Thus, the impact on domestic price is lower than that of imported one. Furthermore, as the database of the Food and Agriculture Organization of the United Nations (FAO, 2017), 84% domestic soybean supply in China during 2013 was composed of imported product.

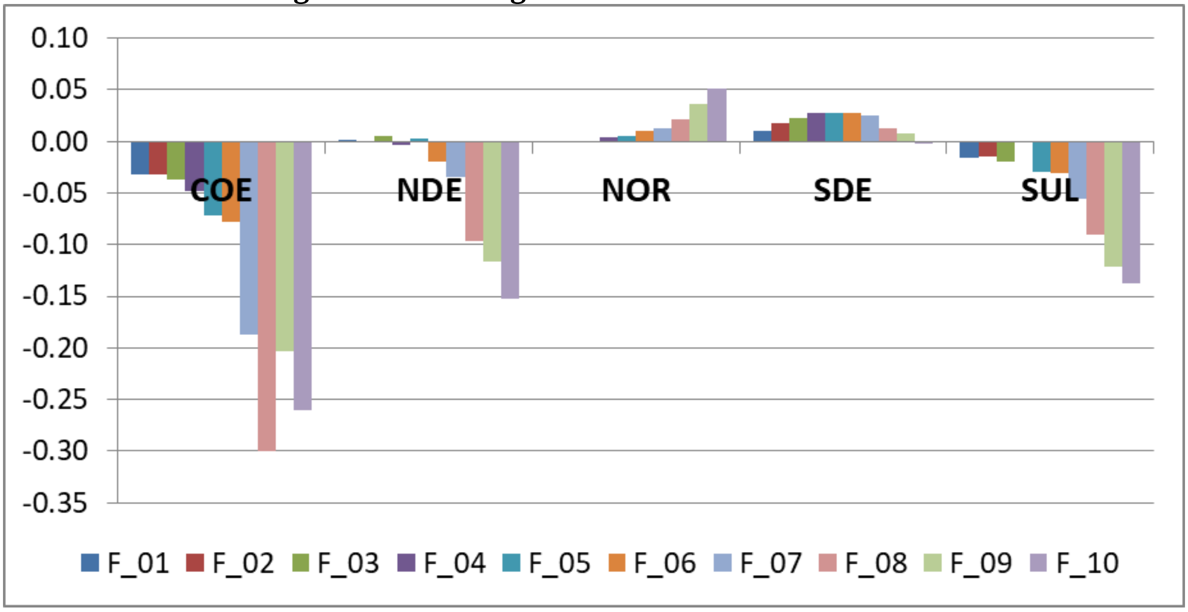
Figure 3: Variations in soybean import price (in real terms) per region due to the Chinese embargo on Brazilian grains.



Source: Research results. Note: corn and other cereal grains (gro), soybean and other oilseeds (osd).

Figure 4 shows household welfare per income bracket and Brazilian region. Gains were observed for Northern families, especially those of upper classes, which would reach gains by up to 5%. Northeast would have losses by up to 15% in welfare mainly for upper classes. Losses would also be significant for Central-western (by up to 26%) and Southern (by up to 13.7%) families. Southeastern families would gain welfare, mainly those of the middle class (2.7%).

Figure 4: Variations in household welfare per income bracket and Brazilian regions due to the Chinese embargo on Brazilian grains.



Source: Research results. Note: COE – Central West; NDE – Northeast; NOR – North; SDE – Southeast; SUL – South. F1 = Bracket 1 -- up to R$ 400.00; F2 = Bracket 2 -- more than R$ 400.00 up to R$ 600.00; F3 = Bracket 3 -- more than R$ 600.00 up to R$ 1000.00; F4 = Bracket 4 -- more than R$ 1000.00 up to R$ 1200.00; F5 = Bracket 5 -- more than R$ 1200.00 up to R$ 1600.00; F6 = Bracket 6 -- more than R$ 1600.00 up to R$ 2000.00; F7 = Bracket 7 -- more than R$ 2000.00 up to R$ 3000.00; F8 = Bracket 8 -- more than R$ 3000.00 up to R$ 4000.00; F9 = Bracket 9 -- more than R$ 4000.00 up to R$ 6000.00; F10 = Bracket 10 -- more than R$ 6000.00.

3.2 Analysis of embargoes of the European Union on Brazilian meat

Table 5 shows welfare gains and variation (%) in GDP after the embargo of the European Union on Brazilian meat (oap).

Table 5: Changes in welfare and gross domestic product (%) due to the embargo of the European Union on Brazilian meat

Region	Equivalent Variation		GDP
	Δ %	ΔUS$ billion	Δ%
Northern Brazil	0.001	0.000	0.000
Northeastern Brazil	-0.002	-0.002	-0.001
Central-western Brazil	-0.004	-0.004	0.000
Southeastern Brazil	0.000	-0.002	0.000
Southern Brazil	-0.002	-0.004	0.001
Rest of Mercosur	0.000	0.001	0.000
United States	0.000	0.001	0.000
Rest of Nafta	0.000	0.000	0.000
Rest of America	0.000	0.001	0.000
European Union	0.000	-0.040	-0.001
China	0.000	0.001	0.000
Rest of the World	0.000	-0.001	0.000

Source: Research results.

Northeast, central-west and south regions of Brazil would have welfare losses, while North and Southeast would have null results. The same can be observed for variations in GDP. Regarding Brazilian regions, a decrease in consumption was detected in Central West, but with gains in exports (0.006%).

Table 6 indicates losses in production values for all Brazilian regions, especially for Southeast, which presented the greatest losses (-0.508%). Other world regions had gains in production values, especially the EU (+0.113%).

Regarding results obtained due to soybean embargo in the previous scenario, small variations were observed in the gross production value of meat under the embargo of the EU. This fact is due to Brazilian meat consumption represents 80% in relation to meat production (FAO, 2017). Thus, in a comparison between soybean and meat, the former has a greater effect on production values due to its lower household consumption.

Table 6: Percentage variations in the gross production value of meat for regions due to the embargo of the European Union on Brazilian meat.

Region	Meats and other animal products (oap)
Northern Brazil	-0.111
Northeastern Brazil	-0.290
Central-western Brazil	-0.261
Southeastern Brazil	-0.508
Southern Brazil	-0.149
Rest of Mercosur	0.008
United States	0.004
Rest of Nafta	0.005
Rest of America	0.003
European Union	0.113
China	0.002
Rest of the World	0.005

Source: Research results.

All Brazilian regions showed a decrease in the cost of capital (-0.003% on average). The price of labor would not change. Regarding income brackets, Central-western families would be the most affected by the embargo, but with losses in welfare lower than 0.5%.

3.3 Analysis of the U.S. embargoes on Brazilian meat

Table 6 shows welfare gains and variations (%) in GDP after the U.S. embargo on Brazilian meat. Regarding Brazilian regions, minimum welfare gains were observed in North and Southeast, in addition to losses between 0.002 and 0.004% in other regions. These results were similar to those concerning the embargo of the EU on Brazilian meat. All non-Brazilian regions would present neutrality for welfare, similarly to the scenario involving the embargo of the EU on Brazilian meat. Likewise, minimal changes in GDP were detected (0.001% to zero) for all regions, even for Brazilian ones.

For the USA, their embargo on Brazilian meat led to losses of US$ 50 million in consumption and US$ 30 million in exports. Regarding Brazilian regions, losses in consumption were observed in Southeast, but with gains in exports of equal magnitude.

Table 6: Changes in welfare and gross domestic product (%) due to the U.S. embargo on Brazilian meat.

Region	Equivalent Variation		GDP
	Δ %	ΔUS$ billion	Δ%
Northern Brazil	0.001	0.000	0.000
Northeastern Brazil	-0.002	-0.003	-0.001
Central-western Brazil	-0.004	-0.004	0.000
Southeastern Brazil	0.000	-0.002	0.000
Southern Brazil	-0.002	-0.004	0.001
Rest of Mercosur	0.000	0.001	0.000
United States	0.000	-0.049	-0.001
Rest of Nafta	0.001	0.008	0.000
Rest of America	0.000	0.000	0.000
European Union	0.000	0.001	0.000
China	0.000	0.002	0.000
Rest of the World	0.000	0.001	0.000

Source: Research results.

A small change (1%) would be observed in the price of the product imported by the USA. Macroeconomic aggregates (consumption, investment, government expenditure) would present changes smaller than 0.5% in all regions. Regarding income brackets, Central-western families would be the most affected by the embargo, but with losses in welfare lower than 0.5%.

4 Conclusions

The concern with embargoes on Brazilian exports reflects an insecurity in some markets that are more dependent on external trade. A related diversification of tariff combined with the importance of domestic market in addition to the possibility of redirecting exports to other regions has contributed to the reduction of external dependence, although several researchers still contest the existence of some independence, assuming that Brazil has a little diversified tariff.

Evaluated scenarios - the Chinese embargo on Brazilian grains and oilseeds, embargoes of the EU and the USA on Brazilian meat - showed small impacts on Brazilian general welfare.

Regarding the Chinese embargo on Brazilian soybean, China and Brazil would have welfare losses, so that gains would only be observed in Northern and Southeastern Brazil. Small effects were observed on GDP for all Brazilian regions. Production values of soybeans and oilseeds had a gain higher than 7% for China, since it has been motivated to produce.

As to trade flows, Brazilian soybean that is no longer exported to China migrated to other regions worldwide, not affecting Brazil with great losses.

A decrease of US$ 1.4 billion in Chinese consumption was observed. Brazilian regions had a smaller impact than that of China, but with an increase in their exports. Thus, a Chinese embargo on Brazilian soybean would result in more severe effects on the former.

Concerning embargoes on Brazilian meat, small impacts were observed on welfare and GDP for all regions. The importance of meat for household consumption certainly lead to small effects of external embargo, reversing gains from a higher household supply into lower prices for Brazilian consumers. Regarding trade flows in the meat sector, Brazil had small impacts also due to its household consumption. Therefore, the Chinese embargo on Brazilian soybean is more worrisome than embargoes on Brazilian meat.

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