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Impacts of integration of Brazil with the European Union through a general equilibrium model

Impactos da integração do Brasil com a união europeia através de um modelo de equilíbrio geral

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Abstract

This study analyses the bilateral trade between Brazil and the European Union (EU) in the period 2002–2012, examining the trade opportunities based on a full integration process. It employs a computable general equilibrium model from the Global Trade Analysis Project (GTAP), aiming at identifying the sectors that would benefit most from the agreement, according to their technological intensity. The results show that Brazil benefits most from the agreement in terms of welfare and would also increase the country's exports of primary products. However, it would cause a decrease in production and exports of products with higher technological intensity, increasing the country's imports from the EU, in line with their comparative advantages.

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Resumo

Este estudo investiga a evolução do comércio bilateral Brasil-União Europeia (UE) no período 2002–2012 e identifica oportunidades de comércio a partir de simulações de integração econômica do Brasil com o referido bloco. É utilizado o modelo de equilíbrio geral computável *Global Trade Analysis Project* (GTAP), a fim de mensurar os resultados da integração Brasil-UE, buscando identificar os setores mais beneficiados de acordo com sua intensidade tecnológica. Os resultados apontam que, apesar do Brasil ser o maior beneficiado em termos de ganhos de bem estar, a criação do bloco aprofundaria a recente tendência de aumento

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das exportações de produtos primários. No entanto, haveria uma queda da produção e da exportação do país de produtos de maior intensidade tecnológica, com o respectivo aumento das importações do bloco europeu, seguindo as suas vantagens comparativas. © 2016 National Association of Postgraduate Centers in Economics, ANPEC. Production and hosting by Elsevier B.V. All rights reserved.

Palavras-chave: Integração econômica; Brasil; União Europeia; GTAP

1. Introduction

The European Union (EU) is an important trade partner of Brazil, representing 22.5% of Brazilian total trade in 2012, according to [MDIC \(2014b\)](#). However, since 2014 Brazil no longer benefit from the EU's generalized scheme of preferences (GSP), losing preferential tariff treatment granted to developing countries exports, as it was classified as an upper middle income country. As Brazil resumed talks on a possible EU–Mercosur agreement in 2013,¹ opening the possibility of individual negotiations among Mercosur members, the formation of a preferential trade agreement could reverse the loss of this GSP preferential treatment with the European block.

This paper investigates the evolution of the Brazil-EU bilateral trade in the period 2002–2012 and identifies trading opportunities resulting from a trade agreement of Brazil with the EU. The paper employs a computable general equilibrium model, using the 8th version of the standard Global Trade Analysis Project (GTAP)² database, based on perfect competition and constant returns to scale. The simulation measures the impacts of the agreement on welfare, trade and production on both regions and the rest of the world. With initial equilibrium in 2007, the original 57 aggregated sectors were classified according to the technological intensity to perform the simulation in which the import tariffs between Brazil and the EU were removed.

The period covered by this study, 2000–2012, justifies itself by a greater role of the so-called emerging economies, including Brazil, in the world economic scenario. Such role has been boosted mainly, by higher economic growth of these economies in the period. Alongside, the decade was marked by a strong recovery in commodity prices, the main component of Brazil's export, accounting, in 2012, according to [MDIC \(2014b\)](#), by approximately 45% of total exports.

The paper is organized as follows: The second section presents an analysis of the evolution of Brazil's trade with the EU for 2000–2012, with emphasis on technological intensity of bilateral trade. The third section presents the computable general equilibrium model, as well as empirical studies that deal with the theme of this research. In the fourth section the methodology adopted is exposed and the results are analyzed. Finally, the last section concludes.

2. Brazil–EU trade

The European Union (EU) origin dates back to 1957, when the creation of the European Economic Community (EEC), by the Treaty of Rome, established the free trade of goods, services and labor between country members.³ In 1994, with 15 country members, the block became known as the EU. The European block, currently with 28 nations, is Brazil's second largest trading partner. In 2012, 61.3 per cent of EU trade was intra-block, according to [MDIC \(2014b\)](#), and the main EU partners outside the block were the United States of America (USA), accounting for 6.2% of EU trade volume, and China with 3.2%.

[Table 1](#) shows that in the period 2000–2012, trade between Brazil and the EU has more than tripled, moving from, approximately, USD 30 billion in 2000 to nearly USD 97 billion in 2012.

According to [Carvalho \(2009\)](#), Brazil is the EU's main economic partner in Latin America. However, [Hoffmann \(2012\)](#) points out the fact that Brazil is responsible for less than 1% of total European exports and imports, suggesting that there is still great potential in commercial relationships by Brazil. The EU exports largely, capital goods and services in exchange for Brazilian commodities. While Brazil is a major supplier of raw materials and food, European

¹ Negotiations began in 1995 between the Southern Common Market (Mercosur) and the EU for the formation of a free trade zone between them.

² [Hertel \(1997\)](#).

³ There were agreements between the previous partners to this block, especially the Treaty of Coal and Steel, in 1952.

Table 1
EU–Brazil trade exchange in the period 2000–2012 (billions of USD).

Year	Exports	Imports	Results	
	(A)	(B)	Trade balance (A – B)	Current of trade (A + B)
2000	15.370	14.537	0.834	29.907
2002	15.638	13.497	2.142	29.135
2004	24.746	15.991	8.754	40.737
2006	31.133	20.214	10.919	51.347
2008	46.595	36.191	10.403	82.786
2010	43.324	39.151	4.173	82.475
2012	49.102	47.716	1.386	96.818

Source: MDIC (2014a).

companies meet the Brazilian demand for machinery, equipment and chemical products.⁴ It must be stressed the fact that, although approximately 50% of Brazilian exports of goods to the EU are commodities, Brazil also exports to Europe machinery, aircraft, iron, steel, among other manufactured goods (HOFFMANN, 2012).⁵

In the period studied, it is clearly noted the evolution in trade relations. Despite predictions that there is still room for growth in trade with the EU, Tomazini (2009) discusses the fact that Brazil is part of Mercosur, which prevents it, for example, from taking unilateral trade liberalization measures.⁶ However, the author highlights the fact of negotiations between Mercosur and the EU are taking place, which, according to the author, would ensure Brazil greater trade opportunities with the European block. The recent loss of the GSP preferential treatment with the European block is forcing Brazil to accelerate negotiations with the EU.

Using a classification based on technological intensity, Negri (2012) points out that approximately 50% of Brazilian total exports to the EU are primary products, followed by products of average-technological intensity, with 20% of the total. In comparison, the participation of commodities in world exports is only 13%.

Table 2 presents the Brazilian trade and the trade balance with the rest of the world by technological intensity, as well as the percentage variation for the period 2000/2012. As it is observed, during the period of the study, the country increased its exports of primary products in almost 1000%, while the exports of high-technological intensity grew only 48%. Imports, on the other hand, showed a similar growth for all sectors, except those of high-technology, which grew a little less, or approximately 200%.

The evolution of the Brazil's trade directly reflects the increasing importance of primary products on the export side, while imports rely mostly on capital-intensive products. As a result, there have been occurring successive deficits in average and high technology sectors and surpluses in primary products. The trade deficit in goods of average-high and high technology have grown significantly since 2006 and reached USD 83.5 in 2012. However, the trade surplus still remained due to the performance of exports of primary products, which ended up compensating the deficits caused by the imports of products intensive in technology.

Brazilian increasing trade deficit in industrial sectors is driven by many factors, some related to macroeconomic policies, such as exchange rates, and other are structural. According to World Bank (2008), a country's technology absorption depends on skilled workforce, investment climate that stimulates investment and permits the expansion of firms using higher-technology techniques, and adequate public sector institutions to promote the diffusion of technologies where market forces are not adequate.

In Table 3 it is observed Brazil's exports to the EU by technological intensity. The data reveal a rise in the participation of primary products by 8.07 percentage points in total exports during the period studied, and accounted, in 2012, by

⁴ According to MDIC (2014b), 90% of Brazilian imports from the EU amounted to manufactured products, among which, there are means of transportation machinery, chemical products, and products with high technological intensity.

⁵ Massuquetti et al. (2014) point out that Mercosur would have earned in the case of an inter-regional association, in which its country members would broaden the access for their agricultural products in the European market and the EU searches better conditions for its industrial products exports for service companies with interests on Mercosur.

⁶ Thorstensen and Ferraz (2014) point out that Brazil has been losing market access of several of its trade partners, due to preferences accorded by them to other countries, through the negotiation of trade agreements.

Table 2
Exports, imports and trade balance of Brazil with the world by technological intensity in the period 2000–2012 (billions of USD).

Sectors	2000	2002	2004	2006	2008	2010	2012	Variation 2000/2012 (%)
Exports								
Primary	9.118	11.709	19.339	30.150	56.053	73.565	93.051	921.52
Low	16.152	19.132	29.384	38.300	51.389	53.318	60.027	271.64
Average – low	10.227	10.650	18.847	27.252	38.870	29.417	38.816	279.54
Average – high	12.751	12.935	22.295	32.403	40.123	36.299	40.525	217.82
High	6.838	5.935	6.610	9.364	11.507	9.316	10.158	48.55
Imports								
Primary	6.714	6.590	11.210	16.281	30.012	22.546	28.612	326.15
Baixa	4.716	3.651	4.060	6.216	11.232	13.878	18.565	293.66
Average – low	8.793	6.671	8.665	14.339	29.221	34.129	41.719	374.46
Average – high	21.446	19.870	24.743	33.311	69.292	75.282	92.998	333.64
High	14.180	10.460	14.158	21.203	33.439	35.813	41.276	191.09
Trade balance								
Primary	2.404	5.119	8.129	13.869	26.041	51.019	64.439	–
Low	11.436	15.481	25.324	32.084	40.157	39.440	41.462	–
Average – low	1.434	3.979	10.182	12.913	9.649	–4.712	–2.903	–
Average – high	–8.695	–6.935	–2.448	–0.908	–29.169	–38.983	–52.473	–
High	–7.342	–4.525	–7.548	–11.839	–21.932	–26.497	–31.118	–

Source: MDIC (2014c).

37.42% of total exported to the block. The only sector which also increased its participation of exports to the European block was the average-low technological intensity, reaching 15.76% of the exports at the end of the period.

On the other hand, there is a drop in the participation of average-high, high and low technological intensity sectors in Brazilian exports. In the case of high and average-high technology sectors, the reductions were 3.60 and 1.77 percentage points, respectively. It is noteworthy that both sectors had a participation of only 5.45% and 12.16%, respectively, in 2012 in Brazil's total exports to the block.

The tendency toward increasing the primary products share of Brazilian exports to the rest of the world, as mentioned by Negri (2012) and Vogel and Azevedo (2012), is also found in Brazil-EU trade. Lamoso (2010) and Negri and Alvarenga (2011) also reported a variation in the Brazilian export structure, with the country focusing on commodity exports. The expansion of these exports is explained by the increase in prices and quantities exported, as highlighted by Souza and Veríssimo (2013), with emphasis on Chinese imports. On the other hand, Nassif (2011) states that the

Table 3
Exports from Brazil to the EU by technological intensity in the period 2000–2012 (billions of USD and % of total).

Sectors	2000	2002	2004	2006	2008	2010	2012	Variation 2000/2012 (% e p.p.)
Billions of USD								
Primary	4.510	5.050	7.665	10.095	17.185	16.986	18.372	307.37
Low	5.526	6.161	9.118	10.543	15.024	13.214	14.340	159.51
Average – low	1.800	1.726	3.527	4.039	5.913	4.885	7.739	329.82
Average – high	2.142	2.166	3.338	5.016	6.748	5.766	5.972	178.80
High	1.392	0.535	1.098	1.440	1.724	2.472	2.678	92.48
% of total								
Primary	29.34	32.29	30.97	32.43	36.88	39.21	37.42	8.07
Low	35.95	39.40	36.85	33.86	32.24	30.50	29.21	–6.75
Average – low	11.71	11.04	14.25	12.97	12.69	11.28	15.76	4.05
Average – high	13.94	13.85	13.49	16.11	14.48	13.31	12.16	–1.77
High	9.05	3.42	4.44	4.62	3.70	5.71	5.45	–3.60

Source: MDIC (2014a).

favorable performance of commodity exports has been accompanied by the loss of competitiveness of the industrial sector, particularly, the most intensive technological products.

The previous analysis showed that bilateral trade between Brazil and the EU presents a very clear pattern of specialization, with Brazil concentrating their exports in primary products, while the European block in products of higher technological intensity. The CGE model employed in this paper examines whether this trade pattern, based on comparative advantages, will be reinforced in a trade agreement between Brazil and the EU.

3. Computable general equilibrium model

Computable general equilibrium models have been widely used to assess the impact of trade agreements on country members and non-members. Many studies have already specifically addressed the effects of a trade agreement between Mercosur and the EU using CGE models, such as [Bichir et al. \(2001\)](#), [Curzel \(2007\)](#), [Gurgel et al. \(2002\)](#) and [Philippidis and Sanjuán \(2007\)](#). All of them have found benefits for both Brazil and the EU, in terms of increased trade and welfare gains.

[Bichir et al. \(2001\)](#) adopted the CGE model MIRAGE in order to evaluate two commercial scenarios for Mercosur, the creation of the Free Trade Area of the Americas (FTAA) and an agreement with the EU. The model used the GTAP database and incorporated imperfect competition, foreign direct investment and dynamic elements. The simulation that eliminated trade barriers between Mercosur and the EU would result in an overall increase in exports and imports of Mercosur and, to a lesser extent, an increase in exports and imports from the EU. Furthermore, there was a decrease in imports and exports of Mercosur and the EU with other regions of the world, including NAFTA.

[Gurgel et al. \(2002\)](#), using 3rd version of GTAP database, simulated the implementation of the EU–Mercosur agreement with constraints of the Uruguay Round and maintenance of subsidies to domestic production, except among Mercosur members. The results show that trade increases in line with comparative advantages, with Mercosur's countries commodities exports rising while in the EU manufactured goods. All countries involved in the agreement also benefit from welfare gains, especially Brazil and the EU. [Philippidis and Sanjuán \(2007\)](#) used the 6th version of GTAP database and found that the EU–Mercosur agreement resulted in welfare gains, due to the removal of non-tariff barriers, on the order of ten times more than considering only the implementation of the FTAA. Finally, [Curzel \(2007\)](#) employed the 6.2th version of GTAP database to assess policies of trade liberalization to Mercosur as the formation of FTAA and the creation of an agreement with the EU. The author points out that the results obtained from 20 simulations showed the highest gains in welfare for Mercosur with an agreement with the EU (US\$ 9.3 billion), supposing the removal of import tariffs and subsidies to domestic production and exports in all sectors.

Source	Objectives	Countries/Blocks	Methodology	Results
Bichir et al. (2001)	Evaluate two commercial scenarios for Mercosur: the FTAA creation and the agreement with the EU.	Mercosur, FTAA, NAFTA and EU	GTAP 3, incorporating imperfect competition, foreign direct investment and dynamic elements, seven regions and 19 sectors.	Mercosur gets the biggest gains (in terms of trade and economic growth) in the case of an agreement with the EU and FTAA.
Gurgel et al. (2002)	Investigate the effects of the implementation of the FTAA for Mercosur and the creation of an Agreement with the EU, having maintained the restrictions of the Uruguay Round.	Mercosur, FTAA and EU	GTAP 3, ten regions and nine sectors of activity.	Trade creation in all countries and blocks involved.
Philippidis and Sanjuán (2007)	Assess the impacts of the implementation of the FTAA and exclusion of tariff barriers.	Mercosur and FTAA	GTAP 6, 21 products and five regions	Gains in welfare for all economies involved.
Curzel (2007)	Evaluate policies of trade liberalization to Mercosur and FTAA agreement with the EU.	Mercosur, FTAA and EU	GTAP 6.2, 87 regions and 57 sectors of activities.	Gains in welfare for Mercosur with the FTAA or with an agreement with the EU, or both together.

Chart 1. Summary of empirical studies.

Source: Authors.

Chart 1 presents a summary of these studies. These, given their important findings and results, corroborate the assertion of [Haddad \(2007\)](#) on the importance of computable general equilibrium models for the exercise of simulations of economic environments, and for the implementation of economic policies that maximize welfare gains.

As seen in this subsection, several studies were conducted to measure results of trade agreements between Mercosur and the EU, helping to anticipate the effects and guide decision making. All studies show welfare gains from the trade agreement. This paper, besides using a more recent database, differ from the other studies by examining an agreement between Brazil, not Mercosur, and the EU, as the recent talks are creating the possibility of individual negotiations among Mercosur members and the European block.

An interesting point to note is the trade-off between the magnitude of empirical results obtained from approaches based on different phases and the confidence in the understanding of these different effects, as suggested by [Allen et al. \(1996\)](#) and [Hoekman et al. \(1998\)](#). On the one hand the size of results of approaches based on scale, competition and growth are greater than the gains obtained by models based on static efficiency and terms of trade changes. On the other hand, models based on perfect competition involve policy changes of known magnitude and robust analytical methods, while models from the second and third generation involve inference from a body of theory with plenty of controversy in relation to issues such as the extent of scale economies and the estimation of price-cost margins in imperfectly competitive industries.

4. Brazil–EU integration

4.1. The model

This paper uses the Global Trade Analysis Project (GTAP) model, based on perfect competition and constant returns to scale, to perform an applied general equilibrium evaluation of welfare and trade pattern changes in both members and non-member countries caused by the EU–Brazil agreement. It was developed by the Center of Analysis for Global Trade from the Agricultural Economics Department at Purdue University in the United States ([Hertel, 1997](#); [Hertel and Tsigas, 1997](#)). Its 8th version, used in this study, consists of a broad base of data for 129 regions and 57 sectors, a standardized modeling framework and software for data manipulation and implementation of simulations ([Hertel, 1997](#)). As all computable general equilibrium models, one can understand the GTAP as being composed of three core modules ([Ferraz, 2013](#); [Horridge, 2003](#)):

- a. A database with input–output matrices, social accounting and tax matrices etc., which provides the empirical basis of the model;
- b. A nested structure formed by traditional microeconomic functions (cost minimization, profit maximization, equilibrium conditions etc.), which implements the database for the simulation, creating channels of action of the shocks;
- c. A macroeconomic closure that determines the endogenous and exogenous variables in order to make feasible the resolution of structural equation model.

It is possible to conclude, then, according to [Lamounier \(1998\)](#), that if the prevailing assumptions that all markets are in equilibrium, all companies operate with zero profits and all families are on their budget constraint, the global investment should be equal to global savings, satisfying Walras' law.⁷

The GTAP model uses a nested structure of three levels in the specification of the production function. At the top, the production function assumes zero substitutability between primary factors of production and intermediate inputs (Leontief technology). Thus, the optimal mix of primary factors is independent of the prices of intermediate inputs, while the optimum mix of intermediate inputs does not vary according to the price of primary factors. The second level involves a constant elasticity of substitution among both inputs as among the factors of production. It is assumed that the imported inputs are differentiated by origin, as well as domestic inputs are discriminated against imported. That is, companies initially determine the optimal mix of domestic and imported inputs and, only then, decide about the

⁷ For more information about GTAP, see [Hertel \(1997\)](#).

Regional aggregation
<ul style="list-style-type: none"> ▪ European Union (EU28): Germany, Austria, Belgium, Bulgaria, Cyprus, Croatia, Denmark, Slovakia, Slovenia, Spain, Estonia, Finland, France, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, United Kingdom, Czech Republic, Romania, Sweden. ▪ Brazil. ▪ NAFTA: USA, Canada and Mexico. ▪ BRICS: Russia, China, India and South Africa. ▪ Mercosur: Argentina, Uruguay and Venezuela (except Brazil). ▪ Rest of the World: Australia, New Zealand, Rest of Oceania, Hong Kong, Japan, Korea, Taiwan, Rest of East Asia, Indonesia, Malaysia, Philippines, Singapore, Thailand, Vietnam, Rest of Southeast Asia, Bangladesh, Sri Lanka, Rest of South Asia, Rest of North America, Colombia, Peru, Rest of Andean Pact, Rest of Europe, Chile, Rest of South America, Central America, Rest of FTAA, Rest of the Caribbean, Switzerland, Albania, Rest of the former Soviet Union, Turkey, Rest of Middle East, Morocco, Tunisia, Rest of north Africa, Botswana, Rest of the south of Africa, Malawi, Mozambique, Tanzania, Zambia, Zimbabwe, Rest of SADC, Madagascar, Uganda, Rest of Sub-Saharan Africa.
Sectoral aggregation
<ul style="list-style-type: none"> ▪ Primary: rice, wheat, cereal, fruits and vegetables, oilseeds, sugarcane and sugar beets, fiber and other crops, live animals, animal products, milk and wool, forestry, fishing, coal, oil, gas, other minerals, meat, vegetable oils and fats. ▪ Low Technology: , dairy products, processed rice, sugar, other processed food products, beverages and tobacco, textiles, wearing apparel, Leather products, wood products, paper products. ▪ Average-Low Technology: petroleum and cool products, ferrous metals, metal products, other metals, other mineral products. ▪ Average-High Technology: motor vehicles, automotive parts and transport equipment, chemical products. ▪ High Technology: machinery and equipment, electronic equipment, other manufactures. ▪ Services: electricity, gas distribution, water, construction, trade, sea, air and other transportation, communication, financial services, insurance, business services, recreation, public administration, defense, health, education and housing.

Chart 2. Regional and sectoral aggregation.

Source: GTAP 8 (Database).

origin of imports (Armington hypothesis). The lowest level of the nest also assumes a constant elasticity of substitution between imported inputs from different sources (Azevedo, 2008).

Regarding the utility function, the model uses a structure in four levels. The highest level of final demand is governed by an aggregate Cobb–Douglas utility function, where income is allocated to private consumption, government spending, and savings. Therefore, each of these categories has a fixed participation in total income. Since the change in spending was determined, the next step is to allocate them among aggregated goods. This is done on the second level of the demand, where government spending is dictated by a Cobb–Douglas function, as aggregate private spending are modeled by a non-homothetic functional form, the constant difference elasticity (CDE). This form of the utility function implies that successive increases in private consumption of certain goods or services do not, necessarily, generate equiproportional improvements in economic welfare. Once the aggregate demand for imports is determined, the rest of the trees of utility of both government and private sector are analogous to the second and third levels of demand by companies for intermediate inputs, based on this demand in a utility function with constant elasticity of substitution. The only difference between the aggregate demand for imports of companies and households are their respective participation in imports. As a result, the sectors (and households), more intensive in the use of imports will be the most affected ones by changes in import tariffs.

4.2. Regional and sectoral aggregation

The 129 regions and 57 sectors of the 8th version of this software were grouped into six regions and six sectors to enable the measurement of the impacts of the EU–Brazil integration on trade and welfare of participants and non-participants of the agreement. In order to determine the regional aggregation, which can be seen in Chart 2, key trading partners involved in the experiment were included: the 28 members of the EU⁸; the BRICS countries (except Brazil), and Brazil. It was also included in the experiment NAFTA and the other members of Mercosur, given their high participation in the Brazilian trade, and the rest of world.

On the other hand, the sectoral aggregation was created in order to visualize the effects of agreements on sectors according to their technological intensity. For this purpose, the sectors were organized according to the classification of the Organization for Economic Cooperation and Development (OECD). According to Furtado and Carvalho (2005)

⁸ Includes Croatia, which became an EU member in July 2013.

and Markwald (2004), the current OECD classification is based on the indicator of Research & Development (R&D) (Expenditure on R&D/added value, or spending on R&D/production), divided into four categories:

- a. High technological intensity: aerospace, pharmaceutical, information, electronics, telecommunications and instruments;
- b. Average-high technological intensity: electrical material industries, motor vehicles, chemicals (excluding pharmaceuticals), rail way, transport equipment, machinery and equipment;
- c. Average-low technological intensity: shipbuilding sectors, rubber and plastic products, coke, and refined metal products, basic metal and metal products;

Low technological intensity: other sectors and recycling, wood, cellulose and paper, publishing and printing, food, beverages and tobacco, textile clothing, leather and footwear.

Primary products are those that do not present any direct technological content, such as grains, fishing and meat. They were separated out from the processed foods, which are classified as low-technological intensity products (Chart 2). However, authors like Nakahodo and Jank (2006), stress that many technological intensity inputs, like genetic adapted seeds, machines and transport equipment, are employed to produce commodities. Thus, even a grain, like soybean would present some indirect technological content. This indirect technological content is not taken into account in this paper, given the GTAP aggregation. The results, in this context, should be considered with precaution.

4.3. Scenario

The evaluation of the integration between Brazil and the EU is carried out assuming the elimination of all tariff barriers⁹ in trade between Brazil and the EU, according to the database of the 8th version of GTAP, which refers to the year 2007. As the objective is to measure the effects of trade liberalization between the EU and Brazil, the experiment involves only changes in import tariffs adopted by country members, without reciprocity from non-member countries. In order to capture the main allocative effects in the evaluated preferential agreement, the simulation was performed using the standard GTAP closure, which considers perfect intersectoral mobility of labor and capital and imperfect mobility of land and natural resource factors. The national aggregated supply of the production factors is exogenous for each region, as well as the firm production technology.¹⁰

Before proceeding to the simulation it is worth examining the protection structure in force in the simulation performed in this chapter. Bilateral tariffs at the GTAP level of aggregation are set up by aggregating applied MFN tariff rates from tariff lines, at HS 06 or 08-digit level, to the GTAP commodity groups using bilateral import value weights. Thus, the model provides bilateral tariff rates that reflect composition differences in tariffs and trade in 2007. Using as an example, the aggregation employed in this research, each of the six regions presents five different import tariffs for each of the six sectors. Following the scenario set, a shock was applied eliminating import tariffs in force between Brazil and the EU.¹¹

Table 4 shows the average intra-block tariff reduction for each region. It is noteworthy that only the variations in these regions (Brazil and EU) are presented. In the EU, there is a significant reduction in import tariffs on low technological products and primary commodities, which reaches 8.3% and 7.4%, respectively. In other industrial products, the drop is much lower, reflecting the lower degree of protectionism prevailing in these sectors before the creation of the agreement. In Brazil, the largest declines are concentrated in industrial sectors, especially those from low (12.4%) and average-high technological intensity (9.9%).

⁹ The simulation does not include the elimination of non-tariff barriers (NTBs) mainly due to the difficulty in quantifying regulatory measures.

¹⁰ The closure of a scenario can be considered as a special way of selection of endogenous and exogenous variables in the model. For the model resolution to reach a conclusion, it is necessary that the number of equations is equal to the number of endogenous variables. As the number of variables is generally greater than the number of equations, some variables should be selected to be exogenous to the model (Feijó and Steffens, 2013).

¹¹ The numerical method of Gragg was employed, in order to reduce the distortions contained in the linear method of Johansen. It is the default method used for solving the GTAP model, with extrapolation. In this case the model is solved several times, each time with a successively finer grid. An extrapolated solution is formed based on these results (Hertel et al., 1992).

Table 4
Variation in simple rate import tariffs (%).

Sectors	Brazil	EU28
Primary	-7.27	-7.42
Low	-12.36	-8.25
Average – low	-8.39	-1.00
Average – high	-9.87	-1.98
High	-8.96	-0.10
Services	0.00	0.00

Source: GTAP Database.

Table 5
Elasticities of substitution.

Sectors	ESUBVA	ESUBD	ESUBM
Primary	0.28	3.94	10.24
Low	1.20	2.82	6.2
Average – low	1.26	2.91	6.11
Average – high	1.26	3.10	6.18
High	1.26	4.13	8.32
Services	1.36	1.94	3.86

Source: GTAP Database.

However, the direction and magnitude of the effects of a change in trade policy depend not only on the size of the shock. It is also necessary to examine the elasticities of each sector, which reflect the size of the impact that a change in price has on demand. Table 5 shows the values of the elasticity of substitution between primary factors (ESUBVA), between domestic and imported goods of the Armington structure of aggregation (ESUBD), and among imports from different sources (ESUBM).¹² Thus, larger tariff reductions coupled with higher elasticities of substitution can be deduced, in advance, that the most significant variations in domestic production, imports, and welfare will occur in primary and high technology intensive products. Conversely, less expressive impacts are expected in other industrial sectors, given the smaller tariff reduction, especially in the EU, and the lower elasticity of substitution.

As there is already a process of negotiation since 1995 between MERCOSUR and the EU for the formation of a free trade area between them, and in view of the resumption of the negotiations in 2013, it is intended to examine whether the formation of a trade agreement between the EU and Brazil would generate welfare gains to Brazil, as well as the profile of trade that would be stimulated by this process of integration. The results of this simulation are presented in the next subsection.

4.4. Results and discussion

4.4.1. Domestic production and international trade

In Brazil, there are major variations in domestic production. The primary products are those who benefit most from the liberalization process, with an expansion of production of 2.22% (Table 6). The production of low technological intensity products also increases (0.57%). This reflects the greater liberalization that occurred in these sectors in the EU, with a significant reduction of import tariffs and the consequent increase of demand in the European bloc for Brazilian products. In all other industry sectors, on the contrary, especially that of high technological intensity, there was a drop in Brazilian production (-3.71%), due to the largest reduction of import tariffs in these sectors in Brazil.

The European block, on the other hand, showed an opposite pattern in relation to the Brazilian one, with a drop of production of primary products (-0.5%) and an increase in most industrial products. The average-high and high-technological sectors presented the highest growth, reaching 0.18% and 0.17%, respectively, followed average-low technological sectors. Meanwhile, Mercosur experienced the highest decrease in production in sectors of high

¹² All the elasticities used in the simulation are the default values provided by the GTAP model.

Table 6
Variation of domestic production (%).

Sectors	Brazil	UE.28	BRICS	NAFTA	Mercosur	ROW
Primary	2.22	−0.46	−0.03	0.00	0.18	−0.04
Low	0.57	−0.09	0.03	0.02	0.01	0.02
Average – low	−2.38	0.14	0.01	0.03	0.10	0.02
Average – high	−2.21	0.18	0.01	0.00	−0.96	0.02
High	−3.71	0.17	0.04	0.00	0.17	0.03
Services	0.08	0.00	0.00	0.00	−0.02	0.00

Source: Author's calculation.

Table 7
Variation in the volume of imports from EU (%).

Sectors	Brasil	UE.28	BRICS	NAFTA	Mercosur	ROW	Total
Primary	76.01	−1.78	−2.34	−2.54	−2.30	−2.34	−0.90
Low	59.14	−0.44	0.02	0.03	0.83	−0.05	−0.13
Average – low	0.09	0.07	0.13	0.19	0.70	0.13	0.33
Average – high	10.58	−0.04	0.47	0.52	1.05	0.41	0.30
High	−2.82	−0.14	0.57	0.65	1.70	0.50	0.36
Services	−4.23	−0.07	0.37	0.39	1.25	0.33	−0.10

Source: Author's calculation.

technological content, with the production of the block countries losing ground in the Brazilian market for the benefit of the European block.

The behavior of production is largely explained by the evolution of international trade as a result of the creation of the trade agreement. As might be expected, Brazil and EU are the most affected regions, with the largest variations in those sectors with the greatest reduction of import tariffs. Table 7 shows the variation in EU imports. Imports of primary products of the block from Brazil grew significantly, reaching 76%, at the expense of imports from other trading partners of the block, which declined. Preferences granted to Brazil and their comparative advantages seem to have been essential to this result. There was also, an increase in purchases of Brazil's low-technological sector (59.1%), although there was a decline of other industry sectors of high technology. The block imports of other trading partners had no significant changes, even reaching a slight increase in imports on those products with higher technological content, occupying the space lost by Brazil.

Brazilian imports showed a more significant variation in relation to the European block (Table 8). The EU was more favored by preferential opening of the Brazilian market for its exports, leading to a rise of Brazilian imports in all sectors. The major highlights were primary products and high-technological goods, with variations of 125.9% and 80.3%, respectively. While in primary products Brazilian imports grew from all partners, in the industrial sectors, especially those of higher technological intensity, there was a clear shift of imports from countries outside the block to the EU. As might be expected, the Mercosur countries lost access to the Brazilian market, especially in average-high and high-technological sectors, with a decline of 12.1% and 16.8%, respectively.

Table 8
Variation in volume of imports from Brazil (%).

Sectors	Brasil	UE.28	BRICS	NAFTA	Mercosur	ROW	Total
Primary	–	125.89	3.78	3.55	3.85	3.76	11.35
Low	–	103.44	−9.87	−9.87	−9.20	−9.93	8.96
Average – low	–	59.95	−6.28	−6.25	−5.73	−6.29	−4.59
Average – high	–	65.22	−12.65	−12.61	−12.12	−12.69	−0.52
High	–	80.32	−16.87	−16.80	−15.95	−16.92	−3.82
Services	–	2.09	2.54	2.56	3.43	2.50	−4.03

Source: Author's calculation.

Table 9
Effects on welfare (in millions of USD).

Regions	Allocative effects	Terms of trade	I–S effect	Total effect	% of GDP
Brazil	534	2428	–104	2859	0.209
UE.28	2091	1178	81	3350	0.020
BRICS	–883	–913	148	–1648	–0.026
NAFTA	–147	–576	–371	–1095	–0.007
Mercosur	–61	–308	55	–315	–0.060
ROW	–344	–1823	192	–1975	–0.014
Total	1189	–13	0	1176	0.002

Source: Author's calculation.

The simulation results point to a well-defined pattern of trade between Brazil and the EU. While the creation of the trade agreement indicates an increase of the proportion of primary products in Brazil's exports, due to a significant growth of exports of primary products to the European block, there is a tendency of increase in Brazilian imports from EU toward industrial products with higher technological content. The only sector that shows an increase of the total volume of exports in Brazil is the primary product (11.4%), while the highest reduction occurred on products with high technological intensity, with a decline of 3.8%.

4.4.2. Effect on welfare

In general equilibrium models based on perfect competition, with fixed factor endowment and technology, the way to increase the welfare occurs by reducing distortions with changes in allocative efficiency resulting from the interaction between changes in tariffs and volumes.¹³ However, changes in welfare are not restricted to allocative changes, but also include changes in terms of trade¹⁴ and the relative price of saving and investment (Azevedo and Feijó, 2010).¹⁵

The Brazil-EU agreement is beneficial from the standpoint of welfare only to the two regions involved in the integration process (Table 9). In Brazil, there is an aggregate welfare gain in the order of USD 2859 million, equivalent to 0.21% of the country's GDP, mainly boosted by the improvement in the terms of trade (USD 2428 million). As expected, Brazil and the EU show gains associated with a greater variation in export prices in relation to import prices between the regions analyzed. The gain in welfare of the EU is higher than the Brazilian, reaching USD 3350 million, caused mainly by better allocation of their resources. Nevertheless, the total effect of the agreement represented only 0.02% of the European block's GDP. In all other regions examined there is a loss of welfare due to deteriorating terms of trade. In contrast, the global welfare gain reaches to USD 1176 million, showing a net benefit to the world as a whole, due to the creation of the agreement, which is concentrated in Brazil and the EU.

It is important to present the origin of allocative gains or losses and variations in the terms of trade under the sectoral point of view. Allocative effects are closely related to the magnitude in which a country reduces its import tariffs. Cheaper imported products cause gains especially in expanded consumption (Azevedo and Feijó, 2010). The analysis of the decomposition of allocative efficiency shows that all sectors showed gains in efficiency in the EU, especially for primary products, as shown in Table 10. In this sector, earnings reached USD 520 million, as a result of a significant

¹³ The regional household's equivalent variation (EV) reflects the difference between the expenditure required to obtain the new level of utility at initial prices (YEV) and that level of utility available at the initial equilibrium (Y), that is to say $EV = YEV - Y$.

¹⁴ The terms of trade are defined as the ratio of prices received by tradable products and the prices paid for them.

¹⁵ Hertel (1997) points out that the model also includes a global bank that intermediates between global savings and regional investments, selling saving goods to each regional household to satisfy their demand for savings and buying shares in a portfolio of regional investment. Savings is an argument in regional household utility function and constrained optimization leads to a demand for homogeneous saving goods, which as any other good depends on income of the household and its relative price. Once the global bank assembled all regional savings, there are two approaches by which the global bank can allocate regional investments. The first, so-called 'fixed regional composition' (which is used in this paper), assumes that regional composition of global capital stocks is left unaltered in the simulation. Therefore, regional and global investments move together and the rates of return in each region will differ. The second mechanism (rate of return component) is an alternative investment approach, in which the rates of return are the same in all regions. Investment depends on expected rate of return in the next period, which declines as capital stock increases. Investments are allocated in order that changes in the expected rate of return are equalized across regions. The impact on the welfare derived from the component investment-saving (IS) depends on the price of saving and investment, and the fact that the region is a net supplier or receiver of savings. The regions that are net supplier savings benefit from an increase in the price of savings related to the price of investment, while net receivers lose.

Table 10
Decomposition of allocative efficiency (millions of USD).

Sectors	Brazil	UE_28	BRICS	NAFTA	Mercosur	ROW	Total
Primary	47	520	−705	−38	1	−179	−354
Low	184	181	−35	−24	−8	−60	237
Average – low	20	478	−19	−6	2	5	480
Average – high	223	295	−46	−29	−32	−28	383
High	86	265	−74	−28	−9	−33	206
Services	120	74	−39	−21	−14	−68	51
Total	534	2091	−883	−147	−61	−344	1189

Source: Author's calculation.

increase in imports, particularly from Brazil, which released the resources of the block to be employed in sectors where it is most efficient. In Brazil, as in the European block, all sectors also showed allocative gains, due to the high reduction in import tariffs in most Brazilian sectors. The major allocative gains were concentrated in average-high technological sectors (USD 223 million) and low technology products (USD 184 million). The greatest loss in efficiency is located in the primary products of the BRICS countries, which have lost access to EU and Brazilian markets. Nevertheless, the simulation yielded an overall increase of allocative efficiency of USD 1189 million.

The variation in the terms of trade shows that gains in Brazil occurred in all sectors, but especially for primary products, which reached USD 1337 million (Table 11). Improving terms of trade is the result, almost exclusively, the increase in export prices of the country, caused by a high demand from the EU. In the case of the European block, the terms of trade improvement is concentrated in services and high technology sectors. It is clear, therefore, that the integration between Brazil and the EU would accentuate the recent tendency of improvement in Brazilian terms of trade, due to international rising of prices of primary products caused by the increase of demand.

Finally, Fig. 1 summarizes the effects of the EU–Brazil agreement on the welfare of the examined regions. It is possible to see that Brazil is the great beneficiary, with a gain equivalent of 0.21% of its GDP. Much of this result is due, as previously discussed, to the improvement of terms of trade of the country. The EU also gains, but less than Brazil, 0.02% of its GDP. All other regions show losses, especially the BRICS countries, which lose space in both markets, obtaining a reduction in their terms of trade, as well as a lower allocative efficiency.

It is possible to conclude that a trade agreement between Brazil and the EU has mutual benefits for both in terms of volume of production, trade, and welfare. Countries tend to increase production in those products that have the greatest comparative advantage, as well as reduce the production of those with lower advantage. This is the case both in the production of primary products, which increases in Brazil and drops in the EU, as the production of higher technological intensity, which drops in Brazil and increases in the European block. The resulting specialization pattern of the integration process would favor the production of Brazilian primary products, at the expense of more technological intensive sectors. In the EU, on its turn, the opposite would occur.

The traditional Vinerian tools to analyze PTAs – trade creation and trade diversion – are still useful to measure the basic impacts of integration. Viner concluded that trade creation is welfare improving while trade diversion is welfare worsening, despite subsequent authors have made some qualifications to the direct link between trade

Table 11
Variation in terms of trade (millions of USD).

Sectors	Brazil	UE_28	BRICS	NAFTA	Mercosur	ROW	Total
Primary	1337	−281	−309	8	−77	−752	−74
Low	318	66	−182	−36	−45	−132	−11
Average – low	264	−3	−57	−62	−63	−51	28
Average – high	124	285	−45	−113	−58	−192	1
High	108	465	−168	−140	−26	−236	4
Services	279	646	−152	−233	−41	−459	40
Total	2430	1178	−913	−576	−308	−1823	−12

Source: Author's calculation.

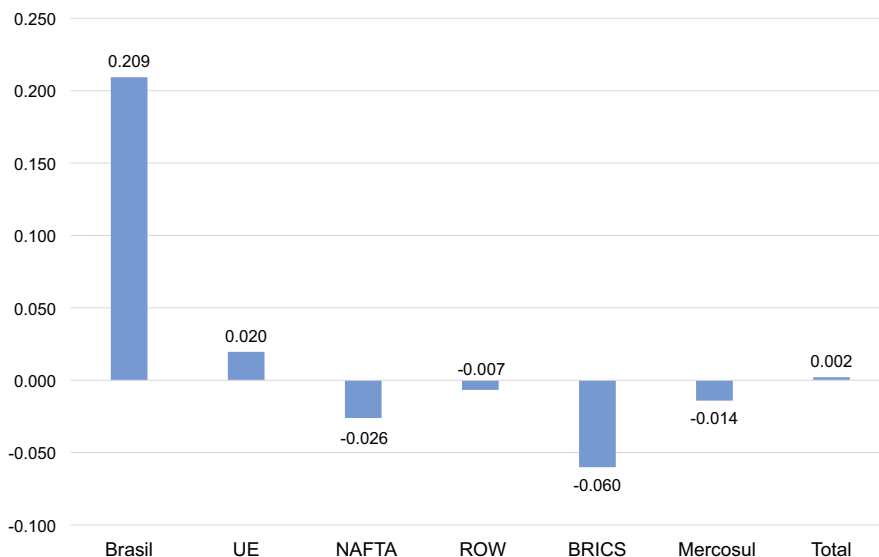


Fig. 1. Summary of the effects of simulation on the welfare aggregate (% of GDP).

Source: Author's calculation.

Table 12

Effects on welfare due to changes in elasticities of substitution (millions of USD).

Region	Default	Mean	Standard deviation	93.75 confidence interval	
Brazil	2859	2862	359	1426	4298
UE.28	3350	3355	328	2044	4667
BRICS	-1648	-1655	209	-2490	-820
NAFTA	-1095	-1101	85	-1441	-761
Mercosur	-315	-318	23	-409	-228
ROW	-1975	-1980	128	-2493	-1468

Source: Author's calculation.

creation-diversion and its welfare consequences (Lipsey, 1957; Meade, 1955; Panagariya, 1996).¹⁶ The simulation shows that the standard story that bilateral trade agreements improve welfare of the signatories in detriment of non-member countries by diverting existing trade away from previous trading partners is also observed in this case.

The results obtained are consistent with those found by studies of Bichir et al. (2001), Curzel (2007), Gurgel et al. (2002), who simulated agreements between the EU and Mercosur. These authors pointed out that the block of South America would be the biggest beneficiary of the integration in terms of welfare gains, GDP and trade, once the complete elimination of protectionism on products in that the partner has comparative advantages.

However, as pointed out by Domingues et al. (2008), the results obtained in these simulations are sensible to the value of elasticities of substitution (ESUBD, ESUBT and ESUBVA). As stressed by the authors, a reduction in these values lowers the welfare benefits of tariff reductions. In order to test the sensitivity to elasticity values, they are reduced and increased by 50%, ranging between 50 and 150 percent around the default values. The systematic sensitivity analysis estimates means and standard deviations results for the endogenous variables related to these ranges. They were employed to calculate a 93.75 confidence interval using Chebyshev's inequality for welfare values for each region, as showed in Table 12.¹⁷

¹⁶ Trade diversion can be welfare improving if the consumer welfare gains, due to the fall in prices after the removal of tariffs, outweigh the higher real costs of imports. Conversely, trade creation could reduce welfare if the benefits of trade creation for a member of the bloc are outweighed by losses of tariff revenue from the pre-RIA volume of imports from the partner country.

¹⁷ The 93.75 confidence interval is obtained by subtracting and adding 4 standard deviations the mean.

It is possible to note that standard deviations values results are not high compared with their means in all cases, ranging from 0.26 to 0.50. As a result, one can be 93.75 percent confident that welfare in both Brazil and the EU increases while all other regions experience a welfare reduction. As [Domingues et al. \(2008\)](#) point out, this provides relevant information that is not revealed by point estimates. For Brazil, the confidence interval shows that welfare gains could range between USD 1426 and USD 4298 million.

It is worth noting that the present paper, unlike the studies discussed here, used a differentiated sectoral aggregation, following the OECD classification, in order to visualize the effect of the agreement on the sectors according to their technological intensity. In addition, the paper examines the integration between Brazil, and not the Mercosur, and the European block. This simulation is of potential interest because of Brazil has been reclassified by the EU as “middle income country” leading to loss of GSP preferential tariff treatment granted to developing countries. Thus, the formation of a preferential trade agreement would reverse the loss of this benefit with the European block. In 2013, Brazil resumed talks on a possible EU-Mercosur agreement, but also opened the possibility of individual negotiations among its members.

5. Conclusions

Computable general equilibrium models have been largely employed to anticipate future scenarios and give support in the decision making of those responsible for conducting economic policies. This study assesses the impact of the integration process, involving Brazil and the EU on production, trade flows and welfare of the regions analyzed, with emphasis on the members of the block and Brazil. It was started from the premise that there is a negotiation on an agreement between Mercosur and the EU that would give members of Mercosur greater autonomy to negotiate with the block and the recent Brazil’s loss of GSP preferential tariff treatment granted to developing countries.

From the point of view of production and consumption, the results show that, in Brazil, there is an expansion of domestic production in primary sectors, on which the country has clear comparative advantages, while there was a significant increase in exports of these products from Brazil to the EU. Meanwhile, in the European block, there was an increase in domestic production of those more technological intensive sectors, where there was also an increase in exports to Brazil. In this sense, the creation of the block would emphasize Brazil’s recent tendency toward increasing primary good intensity of its exports. However, this result should be taken with precaution. [Nakahodo and Jank \(2006\)](#) stress that many commodities present some indirect technological content, as technological intensity inputs, like genetic adapted seeds, are employed to produce them.

The analysis of welfare based on allocative efficiency shows that Brazil is the region that benefits most from the integration, with significant gains in those sectors where tariff reduction was more intense in the European block, precisely primary products. Also, much of the gains come from improved export prices of these products, generating an improvement in terms of trade of the country. In the EU, conversely, the welfare gain is mainly related to allocative efficiency, also driven by the primary sectors, that the block imports release productive resources to move to other sectors, where the block is more efficient. Although the other regions examined show a loss of welfare, the global net effect of the creation of the block is positive. However, when the welfare gain is calculated as a percentage on the GDP, it is evident that Brazil is the greatest beneficiary, reaching 0.56% of GDP.

The magnitude of the effect was not large, what is quite common in computable general equilibrium models based on the hypothesis of perfect competition. The literature on these models, such as [Allen et al. \(1996\)](#) and [Hoekman et al. \(1998\)](#) shows that the welfare gains are usually higher in models with imperfect competition, when compared to models that only allow perfect competition. Anyhow, these models allow one to identify tendencies and, thus, influence public policies. In this sense, on one side, the agreement seems to be relevant for Brazil, given the changes expected in relation to the loss of the treatment of preferential tariff of GSP in the EU market for Brazil. But, on the other hand, the results indicate that it would deepen a pattern of productive specialization that has been crystallized in the Brazilian economy in recent years, with greater dependence on exports of primary products.

Given that the results obtained in this simulation are sensible to the value of elasticities of substitution, a systematic sensitivity analysis was performed, with elasticities of substitution ranging between 50 and 150 percent around the default values. It shows that one can be 93.75 percent confident that welfare in both Brazil and the EU increases and all other regions experience a welfare reduction, confirming the trade signatories as the only beneficiaries of the agreement.

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