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New Tools for the CGE Analysis of PTAs in the era of Non-Tariff Barriers and Global Value Chains: The Case of Mercosur and China

Lucas P. do C. Ferraz*
Marcel B. Ribeiro*

Contents

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Abstract · Resumo

This article explores new tools for the ex-ante analysis of PTAs using large scale CGE models. The traditional impact analysis based on tariff cuts and gross trade performance is then extended to incorporate new features of the ongoing globalization process, such as non-tariff barriers (NTBs) and the so-called trade in value-added. Several methodological as well as conceptual issues are then readdressed, including the proper use of estimated ad-valorem equivalents of NTBs as inputs in perfect competition CGE models as well as the very concept of a "preferential trade partner" in a world where nearly 65% of global exports correspond to trade in intermediates. The article concentrates its impact analysis on the Brazilian economy—providing an overview of its trade policy over the last decades—and the likely consequences of a hypothetical PTA involving Mercosur and China.

1. Introduction

International trade governance and the very nature of trade have changed significantly over the last decades. First, the difficulties faced by the multilateral trade system at the WTO prompted the escalation of preferential trade agreements (PTA's) at the bilateral, regional and even plurilateral levels. Just over the last two decades, more than four hundred PTAs were notified. Second, countries have been progressively trading in tasks (Grossman & Rossi-Hansberg, 2008) instead of trading in goods. Nowadays, more than two-thirds of global exports correspond to trade in intermediate goods and services, reflecting the increasing relevance of the fragmentation of production (Baldwin & Lopez-Gonzalez, 2013; Daudin, Rifflart & Schweisguth, 2011). Last, but not least, the so called "non-tariff barriers" have gained prominence in a world of much lower import tariffs. More recently, countries

*Escola de Economia de São Paulo, Fundação Getúlio Vargas (EESP/FGV). Rua Itapeva, 474, Bela Vista, São Paulo, SP, Brasil.
lucas.ferraz@fgv.br marcel.ribeiro@fgv.br

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notifications of technical barriers to trade (TBTs), as well as sanitary and phytosanitary measures (SPSs) started to proliferate, raising serious concerns among policymakers of potential protectionist behavior by countries, possibly threatening global efforts towards free trade. Regardless of the real objectives of the imposition of non-tariff barriers such as TBTs and SPSs, several empirical studies have pointed out their likely negative effects on trade flows (Leamer, 1990; Moenius, 2004; Disdier, Fontagné & Mimouni, 2008; Kee, Nicita & Olarreaga, 2009; Ferraz, Ribeiro & Monastério, 2017). These new features of globalization have obviously posed new challenges for the economic evaluation of preferential trade arrangements.

In this paper, we first contextualize the economy of Brazil into this new and challenging global environment. A comprehensive data set comprised of global input-output tables such as TIVA (Trade in Value Added), WIOD (World Input-Output Database) and GTAP (Global Trade Analysis Project) is used, conveying detailed information on how the economy of Brazil is currently positioned in terms of its integration into regional/global value chains. Particular emphasis is given to the manufacturing sector, once this is often considered to be a key sector for developing economies and it is usually the sector with the greatest potential for integration into relevant international supply chains. The second part of the paper is devoted to a specific case study where the possible implications of a "new age"[1] preferential trade agreement between Brazil and China[2] is evaluated. China is currently one of Brazil's most relevant "natural trade partners" (Venables, 2003; Ferraz, 2012). A set of dynamic CGE simulations is carried out where the results are evaluated according to the logic of integration to international supply chains as well as trade in value added, instead of the usual 'gross" trade analysis. In this sense, we explore an innovative approach to evaluate the economic impacts of PTAs in an increasingly interconnected global economy. In both parts of the paper, we draw extensively on the recent input-output framework developed by Johnson & Noguera (2012a, 2012b) and extended by Koopman, Wang & Wei (2014) to evaluate trade in value added.

The methodological approaches taken in this paper offer original contributions both to the empirical literature of PTAs as well as to the literature of Gravity models applied to the estimation of non-tariff barriers, such as TBT and SPS. Regarding PTAs, the existing literature is extensive and draws on the early theoretical works of Jacob Viner (1950), James Meade (1955) and Lipsey (1957) among others. Those authors were the first to formalize the concepts of trade creation and trade diversion in a preferential trade arrangement. A very important development of this literature derives from the empirical works with gravity models (Anderson, 1979), where the definition of a "natural trade partner" has its origins. This paper extends the concept of a "natural trade partner" to a world economy currently interconnected through international supply chains. The extended concept traces out "backward" and "forward" linkages of trade in intermediates among countries, shedding some light on those potential trade partners where the formation of PTAs is more prone to lead to integration according to the value chain logic. This paper also offers methodological alternatives to a relatively recent empirical literature on the role of PTAs to the formation of global/regional value chains (Blyde, Graziano & Martincus, 2015; Orefice & Rocha, 2011;

[1] In the so called "new age" trade agreements, trade talks on regulatory harmonization and mutual recognition are at the center stage (see Hertel, Walmsley & Itakura, 2001).

[2] China is nowadays Brazil's main trade partner, comprising more than 20% of Brazilian total imports and exports, followed by the USA and Argentina.

Hayakawa & Yamashita, 2011). Based on the results of varying econometric approaches, these authors find a positive correlation between the formation of PTAs and the integration of international production chains. However, problems associated with endogeneity and the fact that not all trade flows and foreign direct investments generated by PTAs are related to the formation of global/regional value chains do not allow this literature to come up with safe conclusions regarding causality. The dynamic CGE approach adopted in this work seems more suitable to handle the methodological drawbacks of this recent empirical literature since the simulation of a PTA can be taken as an exogenous shock. Moreover, interregional CGE models—such as the one used in this work[3]—are generally based on sufficiently detailed global input-output databases, where trade in value added as well as trade in intermediates can be traced out through the use of appropriate input-output techniques (Johnson & Noguera, 2012a).

Regarding Gravity models, we estimate the ad valorem equivalents of non-tariff barriers (TBT/SPS) to be used in a consistent way as inputs into perfect competition CGE models. Most of the empirical literature available on the effects of TBT/SPS measures on bilateral trade flows are based on gravity models. However, existing misspecification problems in several of these studies called the attention of a group of trade theorists, starting by the influential work of Anderson & van Wincoop (2003), where the issue of "remoteness" in gravity equations was first addressed. The work by Silva & Tenreyro (2006) pointed out to another possible misspecification problem in gravity regressions, suggesting that under heteroskedasticity, the parameters of log-linearized gravity models estimated by OLS may lead to biased estimates of the true elasticities. More recently, another influential work by Helpman, Melitz & Rubinstein (2008) raised the issue on the existence of firm heterogeneity and also on the correct treatment of zero bilateral trade flows in traditional gravity estimations, prompting a new generation of empirical studies addressing those new specification concerns. Some recent examples include the works of Disdier & Marette (2010), Crivelli & Groeschl (2016) and Ferraz et al. (2017).

In our case study, we adopt a rather sophisticated estimation approach, based on the new insights from Helpman et al. (2008). Their approach seems more suitable to our case study since it can discriminate between the effects of TBT/SPS measures on the extensive (industry's fixed costs) as well as the intensive (industry's variable costs) margins of trade, according to the new insights on the heterogeneity of exporting firms described in the seminal work by Melitz (2003).

Our final results highlight three important singularities. First, the economy of Brazil is far from the ongoing global paradigm of specialization in stages of production (fragmentation) and connection to global/regional value chains. On the contrary, the low levels of foreign content embedded in Brazilian manufacturing exports are suggestive that they are still mostly "made in Brazil", whereas global exports are progressively "made in the world". Second, TBTs and SPSs measures may constitute significant bilateral trade barriers among Brazil and China. Ignoring the existence of those barriers can significantly undermine sector-specific gains from trade if PTA negotiations are restricted to the reduction of traditional GATT (*General Agreement on Tariffs and Trade*) instruments such as import tariffs and quotas. Third, joining a PTA with China may pave the way to the integration of Brazil's manufacturing sector to relevant GVCs in more dynamic regions of the world.

[3]We use the GTAP (Global Trade Analysis Project) model.

The structure of this paper is organized as follows. Section 2 presents a set of stylized trade facts about the Brazilian economy, exploring some of the new information available in the "so called" TIVA and WIOD databases. Section 3 discusses the extended concept of "natural trade partners" according to the logic of global/regional value chains. Sections 4 describes the econometric model used to estimate the *ad valorem* equivalents of existing TBTs and SPSs measures on bilateral trade flows between Brazil and China. Section 5 presents the database for the econometric estimations. Section 6 shows the impacts of a PTA involving Mercosur and China, under alternative scenarios, tracing out bilateral trade in value added as well as bilateral trade in intermediates. Section 7 summarizes the main findings of this paper.

2. Contextualizing Brazilian economy in the era of global value chains

From the post second world war till the end of the eighties, the import substitution model formed the basis of industrialization policies in Latin American countries, including Brazil.

Brazil's import substitution model succeeded in building a diversified and complex domestic manufacturing sector, based on a relatively dense and interconnected domestic supply chain of intermediates and final goods. By the beginning of the eighties, value added in manufacturing activities in Brazil peaked 25% of country's GDP, a level close to the average of OECD countries at the time. The significant development of manufacturing activities in Brazil was followed by widespread productivity gains over the domestic economy. Along two decades, from 1960 to 1980, average annual growth in total factor productivity in Brazil reached 2.3%, a level by far the highest among Latin American countries, and also higher than in the USA, South Korea, China and the average of OECD countries during the same period (Veloso, Matos & Coelho, 2015).

The end of the seventies and beginning of the eighties were characterized by a period of market-oriented reforms in China and the start of its emergence as a global trader. Far from the adoption of the import substitution model, China and most of its Asian neighbors took advantage of their cheaper labor costs and decided to unilaterally open up to trade, attracting a whole set of less sophisticated manufacturing activities from richer offshoring nations such as the USA and Western European countries. This period also coincided with the decline of the share of manufacturing value added over GDP in most developed regions in the world as well as in some developing countries such as Brazil: in 1984, manufacturing valued added represented near 23% of GDP in OECD countries and Brazil. In 2010, this share had declined to less than 15% in both regions. Along the same period, the share of manufacturing value added over GDP in Asia raised from 22% to over 28% in 2010 (Bonelli & Bacha, 2013). Those facts may help to explain why the Asian continent is nowadays called "factory Asia".

The emergence of Asia as a significant pole of manufacturing activity[4] in the world gave rise to a new global pattern of trade specialization: developed regions became relatively more specialized in the production and supply of high-skilled services as well as some high-tech intermediate goods whereas developing regions became relatively more specialized in the

[4]More recently, eastern European countries such as Czech Republic, Slovak and Hungary also became poles of manufacturing activities linked to regional value chains in European countries. Mexico is also another example of a developing country with significant poles of manufacturing activities deeply integrated to regional value chains in NAFTA.

production and supply of low-skilled manufacturing tasks. Despite its higher concentration in the international trade of intermediates instead of final goods[5], this new global pattern of specialization seems to be in agreement with Hecksher–Ohlin predictions regarding trade patterns based on factor proportions theory (Los, Timmer & De Vries, 2015).

The new global pattern of specialization can be easily identified in the numbers shown in Table 1 for a set of regions over the period 1995–2008, working with the data sourced from WIOD. Using a similar methodology as the one adopted by Timmer, Los, Stehrer & De Vries (2013), it is possible to trace out the number of workers directly and indirectly involved in the production of final manufacturing goods in each region. Results in Table 1 highlight four important facts. First, manufacturing related jobs have been shrinking as a share of total labor force for all countries and regions presented, except China (columns 1 and 2). Second, over 50% of manufacturing related jobs is not directly involved in manufacturing activity. Instead, they are indirectly involved through agriculture and services activities. In Brazil, nearly 65% of manufacturing related jobs are actually employed out of the manufacturing sector (columns 3 and 5). Third, direct manufacturing jobs have been losing participation in developed regions' labor force. On the other hand, they have been gaining relative importance in developing ones (column 7). Fourth, the production of final manufactured goods has become more intensive in services for all regions in the world. However, this process has been clearly more intensive in developed regions compared to developing ones (columns 6, 7 and 8).

Regardless of being a developing economy, structural changes in Brazil are harder to interpret based solely on the information available in Table 1. On one hand, direct manufacturing employment has increased over the period 1995–2008 in Brazil, as in other developing regions such as Mexico, China and India. On the other hand, the growth of manufacturing related service jobs in Brazil has increased nearly two times faster, a pattern

Table 1. GVC workers directly and indirectly involved in the production of manufacturing goods (1995–2008).

	Manufactures GVC workers as (%) share of all workers in the economy		Manufacturers GVC workers in 2008 by sector			Change in Manufacturers GVC workers 1995–2008 (%)			
Country	1995 (1)	2008 (2)	Agriculture (% of the total) (3)	Manufacturing (% of the total) (4)	Services (% of the total) (5)	Agriculture (6)	Manufacturing (7)	Services (8)	Total (10)
West. Europe	24.40	20.40	5.60	49.90	44.50	−35.30	−12.90	21.40	−2.50
East. Europe	31.20	28.20	17.30	53.80	28.90	−34.30	−3.50	18.70	−6.10
USA	16.04	11.12	6.77	52.38	40.85	−22.43	−26.24	−14.17	−21.47
Japan	22.55	19.36	10.64	53.18	36.19	−37.96	−25.53	3.47	−19.04
Canada	20.76	16.02	5.64	41.00	53.36	−39.52	−10.69	15.00	−1.60
South Korea	29.69	22.83	12.18	49.20	38.62	−41.67	−21.74	33.77	−11.20
Taiwan	30.95	29.23	3.73	62.48	33.79	−64.31	9.12	22.25	4.89
Mexico	30.26	24.45	23.18	50.43	26.38	−12.42	29.70	53.76	21.19
China	31.73	33.35	46.96	33.89	19.15	8.95	30.58	31.90	19.65
India	27.92	27.27	45.85	33.19	20.96	3.80	35.10	36.10	18.85
Brazil	29.60	28.70	30.18	34.31	35.51	−7.79	34.81	72.19	26.90

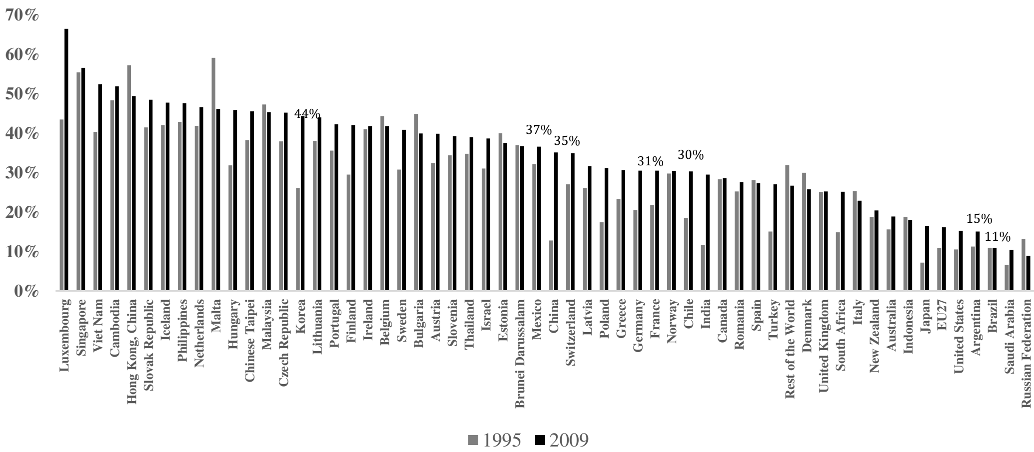
Source: Author's calculation based on World Input-Output Database.

[5]Based on the World Input-Output Database (WIOD), trade in intermediates represented more than two thirds of global exports in 2011.

of specialization that resembles the ones verified for the group of developed regions in the world. Indeed, a broader view of structural changes occurred in the Brazilian economy for the period of 1984–2014 reveals that the share of services value added raised from 45% of country's GDP to nearly 70%. Regarding the composition of its total exports, in 2011 manufactured and services exports corresponded to 41.4% and 16.2% of total exports in Brazil, respectively. However, when the composition of total value added exported is taken into consideration, those same shares change to 27.4% and 40.7%, suggesting that a lot of services intermediates are exported embedded in the exports of manufactured goods.

Therefore, the ongoing pattern of specialization in services activities for the economy of Brazil, rather than the result of deeper integration to global/regional value chains, as it seems to be the case for developed economies (Table 1), may be rather the consequence of its relative isolation. Excessive import protection for long periods, associated with the formalization of just a few and usually shallow PTAs over the last decades, might have contributed to the current low competitiveness of Brazil's manufacturing sector and its weak participation in relevant international supply chains. Figure 1 shows the evolution of the foreign content embedded in manufactured exports for a group of 58 countries, from 1995 to 2009. While most countries in the sample seemed to have significantly increased its participation in the ongoing process of fragmentation of production over the period, the share of foreign intermediates embedded in Brazil's manufactured exports has kept stagnated at the level of 11%. According to this criterion, the manufacturing sector in Brazil is one of the least integrated to value chains among its peers, showing a higher level of integration only in comparison to the manufacturing sectors in commodity exporters such as Saudi Arabia and Russia.

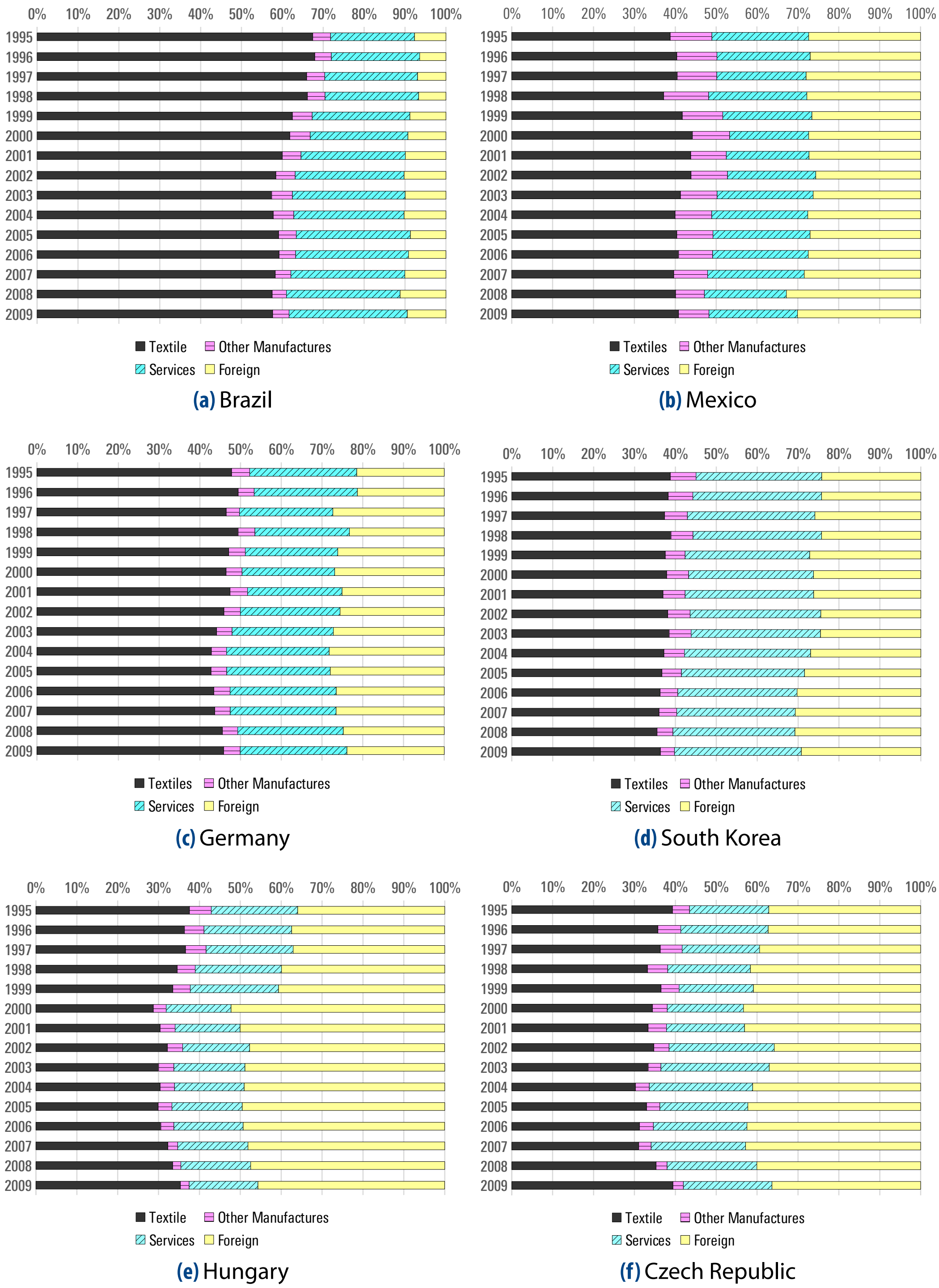
Figure 2 slices up the total value added created in the production of a final good in the textile sector for a sample of countries, including Brazil, over the period 1995–2009.[6] This analysis unravels two main facts. First, a significant share of total value added generated in the production of a final textile good remunerates factors of production in the domestic services sector. This is true for all countries in the sample. Second, there is a significant



Source: Author's calculation based on the "Trade in Value Added" database (TiVA – OECD).

Figure 1. Foreign content in manufacturing exports over the period 1995–2009.

[6]For details on the methodology used to estimate the shares in Figure 2, see Timmer et al. (2013).



Source: Author's calculation based on the "Trade in Value Added" database (TiVA – OECD).

Figure 2. Value chain income created in the production of a final good in the textile sector for a group of countries (2011).

foreign content embedded in the local production of a final textile good for all countries in the sample, except Brazil. For instance, in 2009 nearly 30% of total value added created in the production of a final textile good in Germany was devoted to the payment of factors of production located abroad. For the same year, this share was nearly 10% in Brazil.

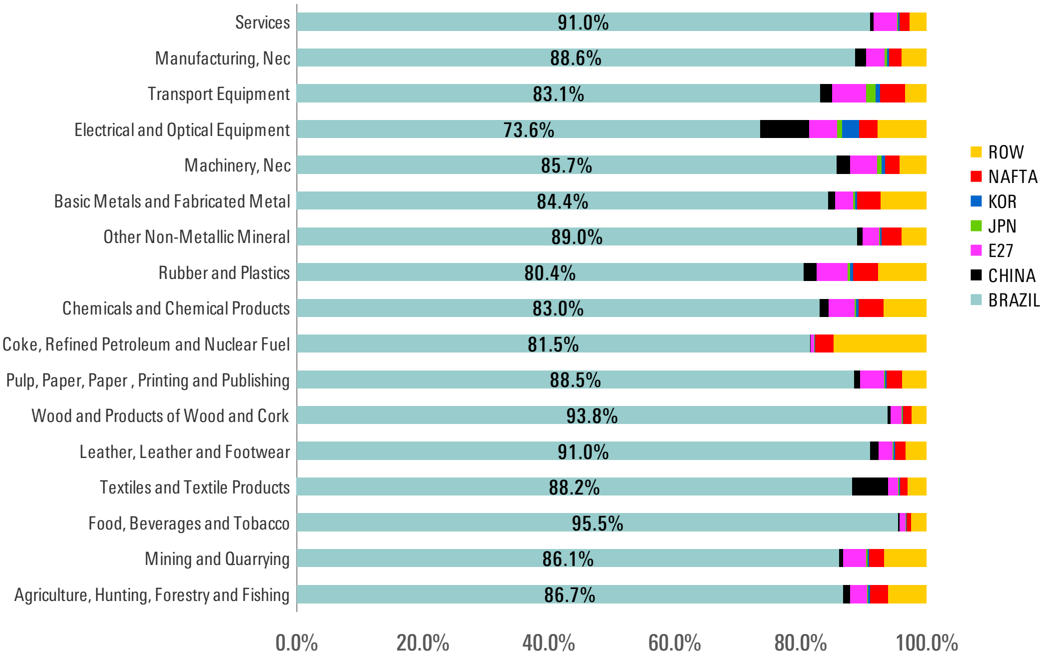
When the whole domestic economy is considered, calculated shares in Figure 3 confirm that nearly 87% (in average) of all inputs used in the production of a final manufactured good in Brazil (in 2011) were sourced locally. It is worthy to note the relevance of China as a significant source of imported intermediates.

The analysis of Figures 1 to 3 suggests that the manufacturing sector in Brazil is still little integrated to significant international supply chains. The flipside of this whole process seems to be the increasing relevance of lower value-added services activities in Brazil and the resulting fall in total factor productivity.

3. The "Natural Trade Partner" concept extended to Trade in Intermediates

Assuming that PTAs can create additional incentives for member countries to integrate their production structures and to build global/regional value chains, which partners should a country prioritize once it has decided to open up to trade?

One possible way to tackle this issue is to measure the participation of a country in international supply chains according to its "backward" and "forward" linkages (Koopman et al., 2014). On one hand, the higher the foreign content embedded in a country's domestic exports, the stronger are its backward linkages. By the same token, the higher the share of



Source: Author's calculation based on World Input-Output Database.

Figure 3. Share of domestic inputs in total inputs consumption by each sector in the economy of Brazil (2011).

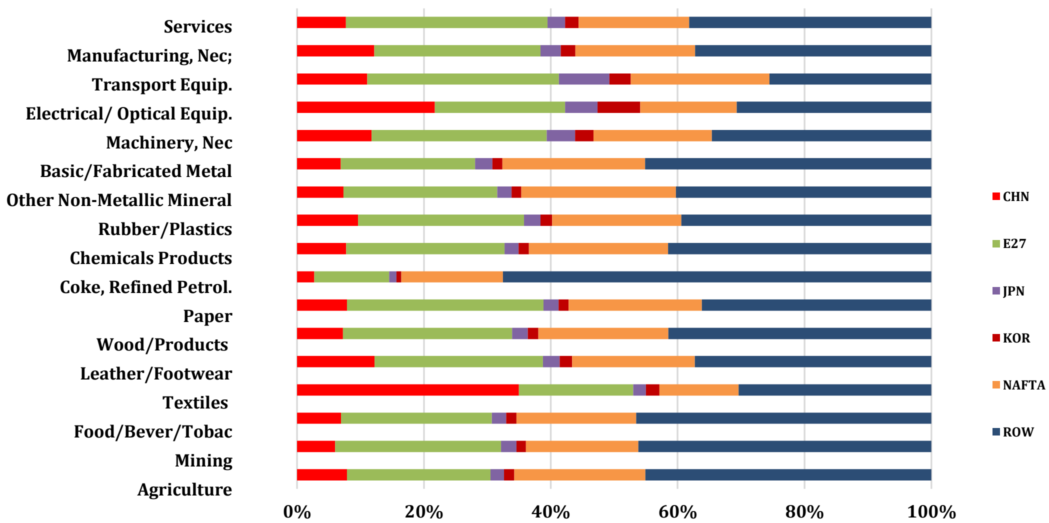
a country's domestic exports of intermediates embedded in third countries' exports, the stronger its forward linkages.

Therefore, the formalization of PTAs among countries with pre-existing strong backward and forward linkages should be more prone to the formation of global/regional value chains, as long as it may reinforce bilateral trade in intermediates, once trade barriers are reduced.[7]

The Chinese economy is responsible for more than 20% of Brazilian imports and exports and can then be considered a Brazil's natural trade partner, according to Vinner's traditional definition. When backward and forward linkages are considered, Figure 4 and 5 show that China is also a significant source of intermediates to Brazil's exports (backward linkages) as well as a significant consumer of Brazil's exports of intermediate goods that go embedded in Chinas's exports (forward linkages) to third countries.

Therefore, a PTA involving Brazil and China may have a high potential to be welfare improving (net trade creation) for the Brazilian economy and may also increase bilateral trade in intermediates according to the supply chain logic. Backward and forward linkages, therefore, can extend the traditional view of a natural trade partner beyond trade creation and trade diversion to include how prone is a hypothetical PTA to create additional price/cost incentives to the formation of global/regional supply chains.

Figure 4 and 5 also suggest that other regions of the world such as NAFTA and EU_27 could possibly be considered natural trade partners for Brazil, according to the value chain logic.[8] However, when an intertemporal perspective is taken into consideration, China seems to take the lead as a preferential trade partner. This idea is made clearer by the analysis of Figure 6, which shows the evolution of the share of imported intermediates over

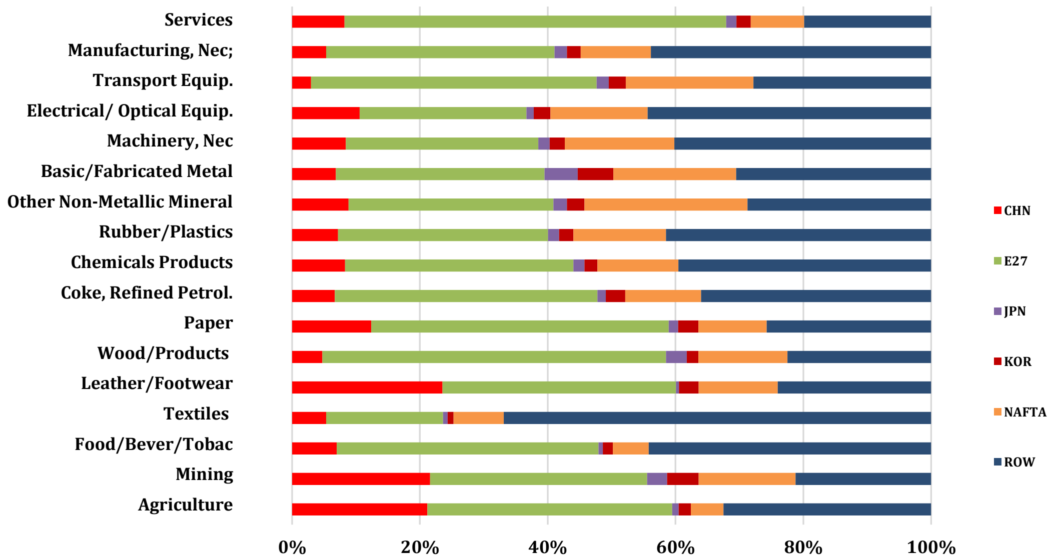


Source: Author's calculation based on World Input-Output Database.

Figure 4. Share of China's backward linkages on Brazil's sectoral exports of final goods (2011).

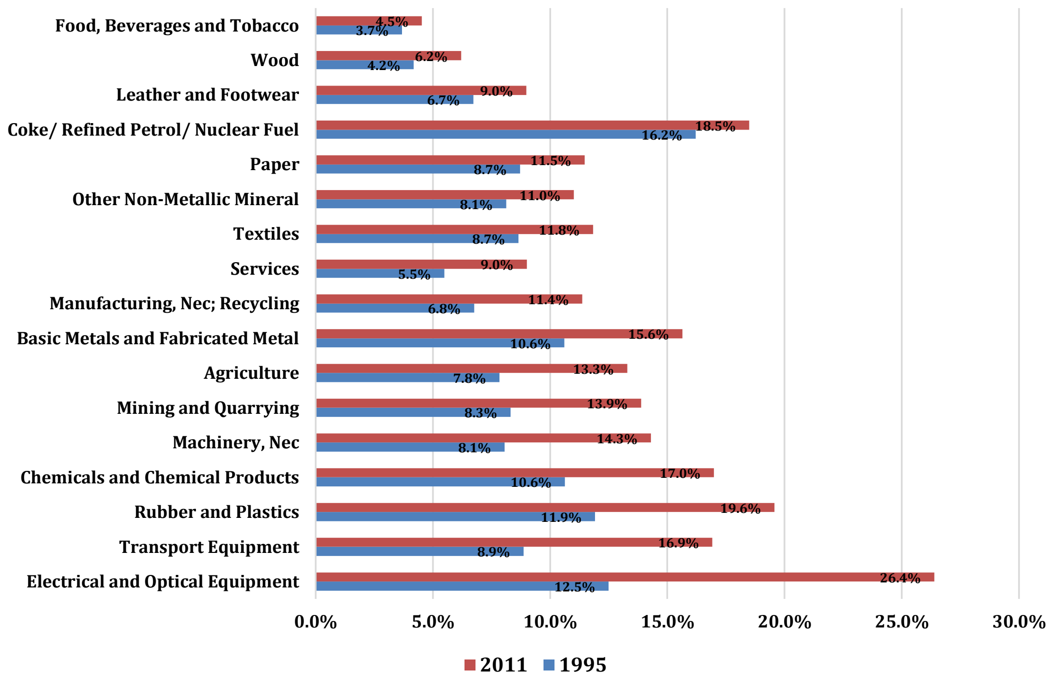
[7] However, since mutual preferential market access is not necessarily given to the most efficient suppliers once a broader bilateral trade perspective is taken, trade creation cannot be taken for granted.

[8] The EUA and EU_27 could both be considered Brazil's natural trade partners according to Vinner's logic.



Source: Author's calculation based on World Input-Output Database.

Figure 5. Share of China's forward linkages on Brazil's sectoral exports of intermediates (2011).

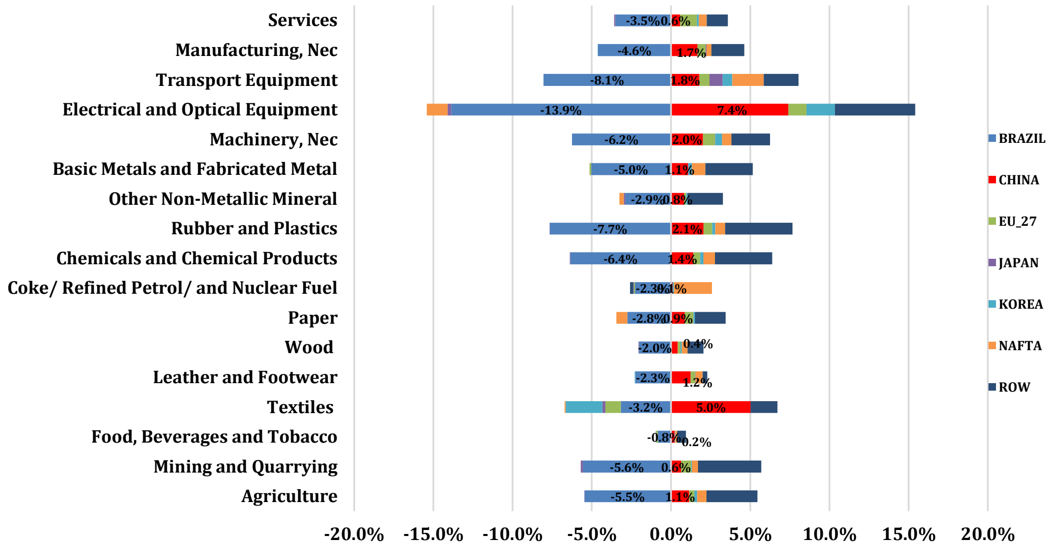


Source: Author's calculation based on World Input-Output Database.

Figure 6. Evolution of the share of imported intermediates over total consumption of intermediates by sector in Brazil, from 1995 to 2011.

total intermediates consumption by a set of production sectors in Brazil, for the period 1995 to 2011.

Accordingly, the share of imported intermediates over total intermediates consumption has risen for all sectors in the period, particularly in higher technological sectors such as Chemicals, Machinery, Transport equipment, Electrical/optical equipment and Rubber/Plastics. Figure 7 shows the relative dynamics of local consumption for each country-source of intermediates by sector in Brazil, suggesting that the increase in imported intermediates was made at the expense of local intermediates for all sectors. Furthermore, among the three regions, China was by far the economy that has benefited the most over the period, increasing its relative supply of intermediates to all sectors in Brazil, including high technological sectors such as Electrical/optical equipment, Transport equipment and machinery, as well as lower-skilled labor intensive sectors such as Textiles.



Source: Author's calculation based on World Input-Output Database.

Figure 7. Evolution as a source of intermediates by sector in Brazil (1995 to 2011).

4. Estimating the Ad valorem equivalents of TBT/SPS measures

This section explains in detail the gravity specification used to estimate the ad-valorem equivalents of TBT/SPS measures on bilateral trade flows between Brazil and China, to be used as inputs in our CGE simulations (section 6).

4.1 The Gravity Equation

The gravity specification used to estimate the impacts of TBT/SPS measures on bilateral trade flows is described by this equation:

$$y_{ijst} = \gamma_s \tau_{ist} + \alpha_s NTB_{ist} + \alpha_s^p NTB_{ist} + X_{ijst}\theta + \alpha_i + \psi_j + \upsilon_s + \eta_t + \varepsilon_{ijst}, \tag{1}$$

where i denote the importer country (China, and Mercosur countries: Brazil, Argentina, Uruguay, Paraguay);[9] j for the exporter country; s for sector; and t for the time period.

[9] Since Mercosur is a Custom Union, countries are supposed to negotiate trade agreements as a block. Therefore, though our focus is on bilateral trade relations between Brazil and China, we simulate a trade deal between Mercosur and China.

Therefore, y_{ijst} denotes log of the (CIF) value of country i's imports from country j, in sector s and time period t. Dummy variables α_i, ψ_j, v_s and η_t control for the fixed effects of importers, exporters, sectors and time, respectively. The vector X_{ijst} represents standard gravity control variables, such as: log of GDP (both for importer and exporter), bilateral distance, common language, border sharing and colonization. We also control for relation (p) and sector-relation (s, p) specific dummies.[10] The dummy variable NTB_{ist} controls for sector-specific TBT/SPS measures imposed by importer i in sector s, which is still active in year t. It is defined as a dummy variable which is equal to 1 if there exists at least one measure for that sector adopted by the importer and zero otherwise. We consider that once a measure is imposed by importer i in year t it also holds for the subsequent years. Moreover, τ_{ist} denote the tariff applied by the importer i in sector s at year t.

We are interested in estimating the effects of TBT/SPS measures within each sector for each possible bilateral combination of trade flows among Mercosur countries and China. The average effect of an TBT/SPS measure in sector s is given by the coefficients α_s and the additional effect in those sectors for a given bilateral trade relation is given by α_s^p. Therefore, elasticity of imports with regard to the adoption of a regulatory measure on each sector, for each relation analyzed, are given by $\exp\left(\alpha_s + \alpha_s^p\right) - 1$.[11]

4.2 Heckman selection model

The issue of sample selection bias in gravity models can be properly addressed through the Heckman's selection model (Heckman, 1979). In this work, we use Heckman's model in its two-stage version. The first stage specifies a Probit model which estimates the impact of a TBT/SPS measure on the probability of a firm to become an exporter. We follow the specification described by Helpman et al. (2008) where the extensive margin decision of an exporting firm is represented by the following Probit model:

$$\rho_{ijst} \equiv P\Big(T_{ijst} = 1 \mid X\Big) = \Phi\left(\varphi_s \tau_{ist} + \beta_s NTB_{ist} + \beta_s^p NTB_{ist} + Z_{ijst}\kappa + W_{ijst}\theta\right), \qquad (2)$$

where T_{ijst} is an indicator variable which is equal to one if there are positive imports of country i from country j in sector s at year t; Z_{ijst} is a vector that includes all covariates (including the fixed effect dummies) from the gravity equation; and W_{ijst} is the vector of the excluded variables that allow the identification of the selection effect. We considered *a priori* several specifications, including the number of documents, time and cost required to export and import.

According to the work by Helpman et al. (2008) if the probability to become an exporter is somehow correlated to the decision on how much to export, the estimated impact of TBT/SPS measures on trade flows—using standard gravity OLS approaches—are likely to be downward biased. Regarding firm heterogeneity, the authors point out that standard gravity equations "confound the effects of trade barriers on firm-level trade with their effects on the proportion of exporting firms". Accordingly, if firm heterogeneity is not somehow included as an explanatory variable in the standard gravity equation, its absence may induce an upward bias on the estimated effects of NTBs on trade flows.

[10] Those dummies are included in the vector X_{ijst} for notational convenience.

[11] This adjustment is necessary because imports are in logs and the TBT/SPS is a dummy variable.

Based on the extensive margin estimation we can compute

$$\hat{h}_{ijst} = \Phi^{-1}\left(\hat{\rho}_{ijst}\right) \qquad \text{and} \qquad \hat{\lambda}_{ijst} \equiv \lambda\left(\hat{h}_{ijst}\right) = \frac{\phi\left(\hat{h}_{ijst}\right)}{\Phi\left(\hat{h}_{ijst}\right)},$$

which are respectively a *proxy* for firm heterogeneity and the inverse Mills ratio (non-selection hazard). Therefore, in the second stage the inverse Mills ratio is an additional explanatory variable in the standard gravity equation such as

$$y_{ijst} = \gamma_s^* \tau_{ijst} + \alpha_s^* NTB_{ist} + \alpha_s^{p*} NTB_{ist} + \beta_\lambda \hat{\lambda}_{ijst} + X_{ijst}\beta^* + \alpha_i^* + \psi_j^* + v_s^* + \eta_t^* + \varepsilon_{ijst}^*. \tag{3}$$

Equation (3) estimates the impact of a TBT/SPS measure on bilateral trade flows, conditional on the fact that firms are exporters. We also consider the specification that includes firm heterogeneity as a covariate. Based on Helpman et al. (2008), it is possible to show that the fraction of exporting firms in each exporting sector and bilateral trade flow can be estimated by $\hat{h}_{ijst}$.[12]

From equation (3) we can compute the tariff equivalents of TBT/SPS measures for each GTAP sector. It can be calculated as the ratio of the sectoral elasticity of bilateral imports w.r.t. the dummy (NTB variable) over the elasticity of the same bilateral imports w.r.t. import tariffs. In the OLS model this is simply the ratio

$$TE_{sp} = \frac{\exp\left(\alpha_s + \alpha_s^p\right) - 1}{\gamma_s},$$

for each sector s and bilateral relation p.[13] However, for the Heckman selection model, the tariff equivalent is calculated as the ratio of the marginal effect of the NTB over the marginal effect of the import tariff, conditional that goods are already imported (or exported). Formally, it is provided by:

$$\begin{aligned} TE_{sp} &= \frac{ME\left(NTB_{ist}\right)}{ME\left(\tau_{ijst}\right)} \\ &= \frac{\mathbb{E}\left[\, y_{ijst} \mid NTB_{ist} = 1, T_{ijst} = 1 \,\right] - \mathbb{E}\left[\, y_{ijst} \mid NTB_{ist} = 0, T_{ijst} = 1 \,\right]}{\partial\, \mathbb{E}\left[\, y_{ijst} \mid T_{ijst} = 1 \,\right] / \partial \tau_{ijst}}, \end{aligned} \tag{4}$$

where $ME(\cdot)$ denotes the marginal effect computed using rather standard derivations. As illustrated, the tariff equivalent is calculated only for the group of firms that are already importers, which is consistent with the perfect competition CGE model we use in the second stage (that only accommodates the intensive margin of trade). In this regard, the

[12] The exact correction in order to control for firm heterogeneity is to estimate a non-linear regression including the variable $\log\left(\beta_h \exp\left(\hat{h}_{ijst} + \hat{\lambda}_{ijst}\right) - 1\right)$. However, following Helpman et al. (2008) we add $\hat{h}_{ijst}$ in a standard linear regression. In their work, the authors show that both specifications led to the same results, although the non-linear specification is the one that is theoretically consistent with the Melitz model.

[13] See Yotov, Piermartini, Monteiro & Larch (2016) for excellent guidance on how to calculate tariff equivalents of non-tariff barriers (NTB) using Gravity models.

general equilibrium effects of NTBs such as TBT/SPS measures can be estimated through the calculation of their ad valorem equivalents and then through their implementation in CGE models (Gasiorek, Smith & Venables, 1992; Harrison, Rutherford & Tarr, 1994; Andriamananjara et al., 2004; Andriamananjara, Ferrantino & Tsigas, 2003; Francois, Van Meijl & Van Tongeren, 2005). However, as signaled in Baldwin (2000), the notifications of TBTs and SPSs by importing countries are likely to generate extra fixed as well as variable costs for exporting firms. Therefore, when working in conjunction with those notifications, CGE models should somehow accommodate an imperfect competition market structure able to represent export-specific fixed costs due to the existence of NTBs.[14]

This article uses the GTAP model on its dynamic version under a perfect competition market structure (Ianchovichina & Walmsley, 2012). Therefore, in order to assure consistence with perfect competition, calculated ad valorem equivalents of TBTs and SPSs must represent estimations of pure extra variable costs and shall not be influenced by any kind of fixed costs. The Heckman selection model seems to be suitable for this task as long as fixed costs are not expected to exert any sort of influence on its second stage gravity equation. This must be true since fixed costs must only influence entrepreneur's decision to become an exporter (Heckman's first stage equation representing the effects of NTBs on the extensive margin of trade) but not his decision on how much to export, given that he is already an exporter (Heckman's second stage equation representing the effects of NTBs on the intensive margin of trade).

5. Database and Empirical Results

Bilateral flows of imports (in current dollars) as well as import tariffs were obtained from the World Integrated Trade Solutions (WITS) of the World Bank. The data are annual from 2006 to 2013, according to GTAP sector aggregation. Tariff data used in this work are sectoral simple averages. The advantage of using simple averages—rather than the weighted averages by trade flows—is to circumvent possible endogeneity in the estimation procedure. GDP data were obtained from the World Bank. The work uses GDP data in current dollars since the HS code data were only available in current dollars as well. Additional control variables, such as bilateral distance, common language and border sharing as well as colonization were obtained from the CEPII. The number of documents necessary to import was used as the excluded variable (instrument) in the first stage of the Heckman selection model. This variable was sourced from the site "Trading across borders" of the Doing Business (World Bank).

Most of the TBT and SPS measures imposed by Mercosur countries and China were sourced from the site of the World Trade Organization (WTO). However, a significant amount of notifications reported to the WTO does not necessarily report the product codes affected by such notifications. Therefore, the database used in this work had to be complemented by additional information available from other sources such as the Brazilian National Institute of Metrology, Quality and Technology (Inmetro) and the Centre for WTO Studies (CWS). While Inmetro provided us product codes for additional TBT notifications, the CWS provided the codes for the additional SPS notifications. Product codes were available at the four-digit classification of the Harmonized System (HS04).

[14]The first attempts to represent those fixed costs in CGE models can be found in Zhai (2008) and more recently in Akgul, Villoria & Hertel (2014).

Last, we used a correspondence between the GTAP sectoral classification and its breakdowns at the HS04 level, assigning the GTAP sectoral classification to bilateral trade flows in the Heckman selection model.

The sample we use has 83,635 observations on positive bilateral trade flows with Mercosur countries (Brazil, Argentina, Paraguay and Uruguay) and China as the sole importers over the period 2006–2013. When zero trade flows are added to the sample, the number of observations rises to 323,015. Over the years, nearly 74% of the observations corresponded to zero trade flows, suggesting a high potential for sample selection bias when only positive trade flows are considered in standard gravity estimations.

The third column in Table 2 reports standard (pooled) OLS estimates of a gravity model. The estimated coefficients have the expected signs and are mostly significant at the 1% level, exception made for the estimates on the impact of the exporting country's GDP, which is not statistically different from zero. The second column reports the estimations of a Probit model with basically the same set of explanatory variables as the model in column three and corresponds to the first stage of the Heckman selection model. The Probit model estimates the impacts of traditional gravity variables on the probability to become an exporter. The significance of the estimated coefficients suggests a likely correlation between the decisions on how much to export (import) and the probability to become and exporter. This is the second piece of evidence on the existence of sample selection bias in traditional OLS gravity estimates. For identification reasons related to the second stage estimations of the Heckman selection model, we considered several measures related to costs of importing and exporting, such as time, cost and number of documents required for both. In our estimations, the number of documents required to import was the only variable that was statistically significant in the Probit model but not in the second stage OLS model. Therefore, it was used as the excluded variable, i.e., introduced in the first stage but not in the second stage of the Heckman selection model.[15]

According to Melitz (2003), the sectoral extensive margin of trade is determined by the heterogeneity on the productivities of domestic firms. In other words, the more productive firms will become exporters and the less productive ones will only sell domestically. A zero-profit condition determines endogenously the productivity threshold. Accordingly, sectors facing higher fixed costs to export are likely to sell lower volumes abroad, since only a few most productive firms might be able to retain positive profits from the exporting activity. As long as "the number of documents to import" in the destination country constitutes an additional fixed cost of exporting firms in source countries, it should exert a negative and statistically significant effect on the probability of a firm to become an exporter, as it is shown in the second column of Table 2. As a fixed cost, however, it should have no influence on the marginal decision on how much to export, given that a firm is already exporting, as it seems to be the case according to estimations reported in the third column.[16]

The Mills ratio estimated in the first stage (second column) is then used as an additional explanatory variable in the second stage (fourth column) of the Heckman selection model. Estimations reported in column four reveal two important facts. First, the high significance of the Mills ratio corroborates the existence of sample selection bias and the importance

[15] We only present the final specification of the excluded variable to save space.

[16] This is probably a more suitable instrument than the "regulatory costs to start operating a business" as used in the seminal work of Helpman et al. (2008), since "the number of documents to import" seems to be less general and more trade specific.

Table 2. Two-stage Heckman selection model (2006–2013).

	Dependent variable: y_{ijst}			
	Probit	OLS	Heckman Selection	Firm Heterogeneity
GDP importer	0.398***	0.461**	0.972***	0.539***
	(0.0594)	(0.178)	(0.170)	(0.196)
GDP exporter	−0.0503	0.0604	−0.0838	0.0425
	(0.0339)	(0.0993)	(0.1030)	(0.1000)
Distance	−0.400***	−0.704***	−1.125***	−0.811***
	(0.0296)	(0.0963)	(0.0963)	(0.106)
Colonial Ties	0.361***	0.312	0.981***	0.410*
	(0.115)	(0.210)	(0.250)	(0.235)
Language	0.354***	0.628***	1.045***	0.725***
	(0.0491)	(0.124)	(0.119)	(0.123)
Land border	0.247***	0.443***	0.646***	0.501***
	(0.0708)	(0.136)	(0.150)	(0.155)
Import Documents	−0.402***	0.411*		
	(0.0877)	(0.219)		
Inverse Mills ratio			3.579***	
			(0.294)	
Firm heterogeneity				−0.272
				(0.225)
Observations	323,015	83,635	83,635	83,635
Adjusted R^2	0.580	0.501	0.535	0.501

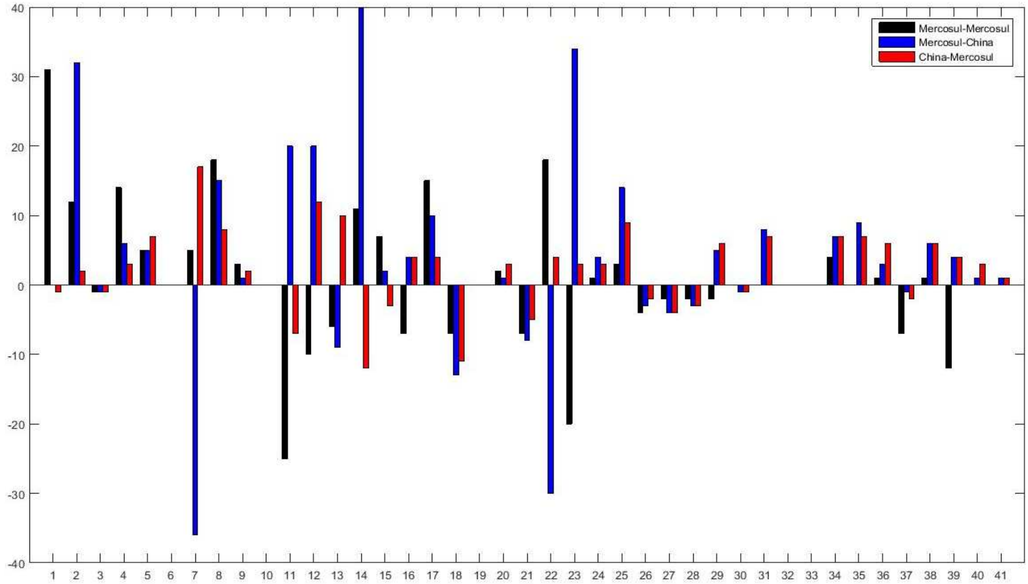
Notes: The simulations in each column also control for the interactions between an existing measure (dummy variable) and each of the 42 GTAP sectors (sectoral dummy variables). All regressions include sectoral, importer, exporter and time dummies. Sector clustered standard errors in parenthesis (corrected for two-step procedure for Heckman and Firm heterogeneity models). *Significant at 10%; **Significant at 5%; ***Significant at 1%.

of taking zero trade flows into account when working with gravity models. Second, not controlling for the existence of sample selection bias in traditional gravity estimations may lead to downward biased estimates.

In the last column of Table 2 the *proxy* variable for firm heterogeneity is then added to the second stage gravity equation. Results suggest that its impact is not statistically different from zero. The insignificance of firm heterogeneity may be explained, at least in part, due to a low number of exporting firms in Brazil, where only a few multinationals firms with higher than average productivity levels are responsible for most of the exports in the country.[17]

Results reported in Figure 8 shows the sectoral impacts of existing measures (TBT/SPS) on bilateral trade flows among Mercosur countries, on Mercosur countries' bilateral imports

[17] In their estimations, Helpman et al. (2008) worked with bilateral trade data at the national level. They obtained that the effect of firm heterogeneity is usually stronger than the effect of sample selection bias in gravity equations. We guess that their results can be sensitive to the level of data aggregation.



Source: Author's calculation based on the Probit model (First stage for Heckman model). See text for details.

Figure 8. Sectoral impacts of NTBs on the probability to become an exporter (%).

from China and on China's imports from Mercosur countries, respectively, for each one of the 42 GTAP sectors.

All the estimations were derived from the first stage Probit model and therefore measure the likely impacts of existing notifications on the probability of a firm to become an exporter at each GTAP merchandise sector level, in each source country (i.e. Mercosur countries and China).

According to Figure 8, the imposition of an NTB by an importing country may have contrasting sectoral effects on the exporting country. For instance, when a typical country from Mercosur imports from China, pre-existing TBT/SPS in GTAP sector 7 decreases the sectorial probability of a Chinese firm to become an exporter to Mercosur by over 30%. In contrast, the imposition of non-tariff barriers in GTAP sector 23 increases the sectorial probability of a Chinese firm to become an exporter to countries in Mercosur by more than 30%. These two apparently conflicting results may be reconciled when a more careful look is given to the expected firm-level effects of a TBT/SPS. Accordingly, the imposition of a given measure by an importing country may exert simultaneous and conflicting effects on the exporting firm's demand, marginal costs and fixed costs. This is the reason behind the apparent ambiguity when the net effects of measures on firm's behavior are evaluated. For instance, when the fixed cost effect of a measure is dominant, it will affect negatively the extensive margin of trade, meaning that the probability of a firm to become an exporter will decrease. On the other hand, when the demand effect of a given measure is dominant[18], it will increase the probability of a firm to become an exporter. It is worth noting that when it comes to the intensive margin of trade (second stage equation), variations in fixed effects

[18]For instance, a firm may decide to become an exporter if the positive demand shock resulting from adopting the new standard notified in the importing country pays for the higher total costs it will be obliged to bear.

due to the imposition of a given measure play no role in the decision of a firm on how much to export.

Results in Table 3 show the estimated tariff equivalents of existing TBT/SPS for each GTAP sectorial trade flow among countries in Mercosur and China. These tariff equivalents are calculated from the marginal effects of sectoral measures and tariffs on bilateral imports estimated from the second stage equation of the Heckman selection model. For the non-reported tariff equivalents in the Table, it means that its calculated impacts on bilateral trade flows were either positive or not statistically different from zero.

In general, results in Table 3 suggest that the protectionist effects of existing TBT/SPS are more relevant for bilateral imports among Mercosur countries and for Mercosur's imports from China (column 3) than for China's bilateral imports from Mercosur countries (column 4). While the negative effects of existing TBT/SPS on Mercosur's imports from China seem to be evenly spread among sectors, the same effects from the perspective of Chinese imports from Mercosur seem to be concentrated in the Agribusiness sector. Due to its very nature, this is a sector with a higher incidence of SPS than TBT.

Moreover, due to the asymmetric distribution of tariff equivalents among sectors in Table 3, any uniform reduction of pre-existing NTBs for bilateral trade flows among Mercosur countries and China, resulting from a hypothetical PTA, would be probably more beneficial for China's exports to Mercosur than the other way around.

6. Case Study

This section presents the main economic impacts of a hypothetical free trade agreement between Mercosur and China on the economy of Brazil. The analysis in this section goes beyond the traditional CGE impact analysis based on gross trade flows and proposes a more precise representation of the likely impacts of PTAs in a globally fragmented economy, where trade in intermediates represent more than 66% of global trade in goods and services. This value-added approach connects the traditional CGE analysis of PTAs with an auxiliary input-output model that is able to convert gross results into valued-added figures. Our methodology is also related to the empirical works of both Johnson & Noguera (2012b) and Koopman et al. (2014), and allows comparisons of value added exported as well as the share of reprocessing of imported intermediates over total imports at pre and post simulation equilibriums.

6.1 CGE model and database

Our general equilibrium exercise uses the extended GTAP 9 database for dynamic recursive models.[19] This database combines detailed information on bilateral trade flows, transportation and trade protection, representing trade relations among 140 regions and 57 sectors/region, together with national input-output tables for each region as well as information on interregional income flows. The database is then harmonized and completed with additional information from the World Bank and IMF, resulting in a rather realistic description of the world economy for 2011 (the last version of the GTAP database). The database was then updated till 2016 using real data for GDP, labor force and population for each region, sourced from both World Bank and CEPII (*Centre d'Etudes Prospectives*

[19] This is basically the GTAP 9 database for the static version of the GTAP model, with additional data on interregional income flows.

Table 3. Ad valorem equivalents (%) of NTBs by GTAP sector and bilateral relation.

Sectors	Mercosur-Mercosur	Mercosur-China	China-Mercosur
Extractive			
Fishing	0.71	–	–
Coal	–	–	–
Oil	1.45	1.2	0.29
Gas	1.46	–	–
Agribusiness			
Bovine meat products	20.87	17.71	17.71
Vegetables, Oils and fats	10.18	–	–
Dairy products	17.9	18.9	19.18
Processed rice	–	19.57	18.23
Sugar	20.56	–	9.36
Food prod. nec.	9.58	8.87	4.68
Beverage/Tobacco	–	4.96	5.39
Manufacturing			
Textiles	–	8.29	–
Wearing apparel	–	9.95	1.69
Leather products	–	8.92	–
Wood products	3.63	7.8	–
Paper products	6.28	–	–
Petroleum/coal prod.	–	7.25	–
Mineral products nec	3.39	–	–
Metals nec	–	8.35	–
Metal products	1.93	–	–
Motor vehicles/parts	–	11.41	2.27
Transport equipment	–	9.46	–
Electronic equipment	–	–	0.86
Manufactures nec.	4.96	–	–

Source: Author's calculation based on the OLS model (Second stage of Heckman's model). See text for details.

et d'Informations Internationales). The baseline trajectory for impact analysis was then projected from 2016 till 2030, using the same set of (forecasted) variables.

The GDyn model (Ianchovichina & Walmsley, 2012) was used in order to evaluate the long run effects of a PTA between Mercosur and China on the economy of Brazil. GDyn is a large-scale recursively dynamic AGE model representing the global economy. The model identifies 57 sectors in each of 140 regions of the world. Its system of equations is fully based on microeconomic foundations providing a detailed specification of household and perfect competitive firm behavior within individual regions and trade linkages between regions, according to the standard Armington hypothesis (Armington, 1969) in large scale CGE models. The model extends the static version of GTAP model (Hertel, 1996) to include international capital mobility, capital accumulation, and an adaptive expectations theory for investment.

According to Ianchovichina & Walmsley (2012), the GDyn model provides a better treatment of the long run within the GTAP framework. In contrast with the standard version of GTAP, in the GDyn model capital can move not only between industries within a region but also between regions. The ability to accommodate international capital mobility allows the analysis of policy shocks that affect economic incentives to invest overseas, such as the ones related to the outsourcing of production. In this sense, the GDyn model seems particularly suitable for the purpose of evaluating the likely effects of PTAs on the formation of GVCs as long as foreign capital ownership can be taken into account and GVC income flows can be better traced out.

The GDyn model also classifies as a Johansen type model (Dixon & Jorgenson, 2013)[20] in the sense that it estimates the general equilibrium effects of external shocks using comparative statics analysis, period by period. In this regard, the model solves a system of linearized equations, comparing two different equilibrium states, after each periodic (usually one year) process of adjustment (if any). Results for a given endogenous variable (like GDP, volume exported/imported, etc.) is reported according to percentage differences between their estimated values in two distinct trajectories (baseline and policy) over the period 2017–2030. On one hand, the "baseline" trajectory reports the world economy as if the policy shocks under evaluation had not taken place, using forecasts for countries' GDP, labor force and population as model inputs. On the other hand, the "policy" trajectory reports the world economy when the same policy shocks are allowed to take effect, according to a fully endogenized model dynamics.

Model closure considers perfect inter-sectorial mobility of production factors such as labor and capital and imperfect mobility for land and natural resources. Returns of investments are equalized among regions and firms' technology is exogenous. Non-tariff barriers are modelled as "iceberg" transport costs, following Hertel et al. (2001)

6.2 Simulation results

6.2.1 The big picture: standard macro results

Table 4 shows the simulated impacts of a comprehensive FTA involving Mercosur countries and China in two distinct scenarios. First, we consider a PTA between Brazil and China and then another PTA where Mercosur countries negotiate as a block. In both scenarios we assume full elimination of bilateral import tariffs as well as a 50% reduction in bilateral TBT/SPS barriers (according to section 5). By 2030, additional GDP growth in Brazil is expected to reach 0.56% per year, reflecting additional investments of 2.50% per year and greater participation in global trade. When Brazil is the sole country to negotiate, the rest of

Table 4. Macroeconomic Effects of a FTA between Mercosur and China (in %, 2030).

	FTA: Only Brazil and China				FTA: Mercosur and China			
	GDP	Exports	Imports	Investment	GDP	Exports	Imports	Investment
Brazil	0.56	5.4	6.86	2.5	0.56	5.47	7.01	2.5
Argentina	−0.07	−0.24	−0.18	−0.04	1.04	4.19	6.63	3.46
Venezuela	0.02	0	0.2	0.13	0.49	3.72	5.76	1.24
Paraguay	−0.16	−0.13	−0.3	−0.45	0.53	3.64	3.29	1.89
Uruguay	−0.13	−0.16	−0.3	−0.27	3.23	7.11	11.17	8.68
China	0.09	0.24	0.47	0.21	0.15	0.39	0.76	0.36

Source: Author's calculation based on GDyn model.

[20]Johansen solutions are currently standard in the CGE literature (see Pearson, Parmenter, Powell, Wilcoxen & Dixon, 1992 and Dixon & Parmenter, 1996).

Mercosur are expected to be worse off with the agreement (column 2). This is an expected result, as these countries lose market-share in Brazil due to cheaper competing imports from China. Given the much larger size of China's economy, long term trade gains in this economy are expected to be less impressive in comparison to the ones obtained by Brazil.

When Mercosur countries negotiate as a block (columns 6 to 9), the long-term results for Brazil remain basically unchanged, reflecting its larger size and the fact that bilateral tariffs among Mercosur countries are currently quite close to zero. In this scenario, the rest of Mercosur is clearly better off. In the case of Argentina, the second largest economy in Mercosur, additional GDP gains per year are expected to reach 1.04% by 2030. China is expected to be slightly better off in this second scenario, with additional GDP gains of nearly 0.15% per year in the long term.

6.2.2 Export and import flows: standard and value-added approaches

Table 4 reported general macro results in standard CGE analysis. Since nowadays nearly 70% of global exports correspond to trade in parts and components, it seems important to report and compare long-term growth in gross trade flows as well as in value added exported.

Table 5 reports the long-term impacts on Brazil's bilateral exports of a comprehensive PTA involving Mercosur and China. By 2030, the economy of Brazil is expected to increase it's per year gross exports to its main trade partners (China, USA and EU), with the exception of Argentina, where the Brazilian economy is expected to be exporting less to (−8.15%, per year), as a consequence of the agreement. However, when the growth in value added generated by exports is taken into consideration, figures are generally lower, suggesting that standard CGE analysis focused on gross trade figures may overestimate trade income gains generate by the agreement. In particular, while Brazil's gross exports to Uruguay is expected to be 11% higher by 2030, domestic value added per year generated by these exports is expected to decrease by −3.69%. In the case of Argentina, the loss in domestic value added is greater than the loss in gross exports.

The positive difference between the increase in gross exports and value added exported reported in Table 5 is a clear sign that the foreign content embedded in Brazil's exports has increased as a consequence of the agreement, reflecting a higher prevalence of trade in intermediates among Brazil and some of its main trade partners, such as USA, EU, China

Table 5. Impacts on Brazilian exports and imports by partner (in %, 2030).

	Exports			Inports		
Destination	Gross	Value-added	Difference	Gross	Value-added	Difference
USA	3.46	3.14	0.32	−13.46	−12.08	−1.38
EU	2.62	2.51	0.11	−11.46	−9.73	−1.73
Argentina	−8.15	−10.17	2.02	−0.8	−1.85	1.05
China	7.69	7.51	0.18	69.02	57.61	11.41
Row	2.95	2.78	0.17	−7.26	−0.83	−6.43
Venezuela	55.23	52.54	2.69	4.57	3.15	1.42
Paraguay	−6.9	−8.59	1.69	2.17	1.19	0.98
Uruguay	11.02	−3.69	14.71	−3.25	−3.55	0.3
Total	4.56	4.07	0.49	5.34	4.85	0.49

Source: Author's calculation based on GDyn model.

and Argentina, despite the prediction of lower export volumes to its main trade partner in Mercosur. The higher foreign content embedded in Brazil's export is expected to improve the competitiveness of its goods abroad, increasing its penetration in larger and more competitive markets in the USA, EU and the rest of the world.

When it comes to bilateral imports, the difference between gross import flows and value added imported by the Brazilian economy is positive for all countries involved in the FTA. This is also suggestive of a greater prevalence of trade in intermediates among countries in Mercosur and China, probably reflecting a higher foreign content embedded in goods and services imported by the Brazilian economy from its PTA partners. Results in Table 5 are also suggestive that the significant increase in Brazilian imports from China is made at the expense of imports from the USA and EU. To the extent that imports from China may replace more efficient suppliers in those regions, this may result in trade diversion, partially reducing potential welfare gains in Brazil.

6.2.3 Bilateral trade flows at the sector level: standard and value-added approaches

Results in Table 6 report the likely impacts of the Mercosur–China FTA on bilateral trade between Brazil and China at several GTAP sector levels. As suggested by the numbers reported in the Tables, differences between gross trade and trade in value added are even more impressive when comparisons are made at a more disaggregated sectoral level.

In particular, "mercantilist" type analyses focused on gross trade imbalances may prove to be misguided when it comes to the sectoral evaluation of net income generated by exports. Again, the differences reported in Table 6 may reflect a higher prominence of

Table 6. Impact on Brazil's bilateral trade with China (in %, 2030).

	Exports			Inports		
Sectors	Gross	Value-added	Difference	Gross	Value-added	Difference
Agriculture						
Paddy rice	8.9	21.1	−12.1	32.1	67.4	−35.3
Wheat	4.7	32.1	−27.4	−5.5	72.3	−77.8
Cereal grains nec	3.4	31.6	−28.2	11.6	64.3	−52.7
Vegetables, fruit, nuts	61.7	29.9	31.8	55.5	63.1	−7.7
Oil seeds	4.5	4.9	−0.43	52.3	50.9	1.4
Sugar cane, sugar beet	–	14.3	−14.3	−1.7	56	−57.6
Plant-based fibers	15.2	11.4	3.8	5.3	83.2	−77.9
Crops nec	45	37.5	7.5	67.8	49.8	18
Bovine cattle, sheep, goats, horses	17.7	33.2	−15.5	14.6	74.8	−60.2
Animal products nec	53	41.2	11.7	19.5	76.3	−56.8
Wool, silk-worm cocoons	49.4	1,531.5	−1,482.1	4.4	80.7	−76.2
Extractive						
Forestry	20.5	11	9.5	35.2	54.7	−19.4
Fishing	−0.3	27.2	−27.5	14.9	55.5	−40.6
Coal	36.9	8.4	28.5	−0.6	42.8	−43.4
Oil	−0.3	2.5	−2.8	6.5	34.8	−28.3
Gas	–	5.5	−5.5	–	46.1	−46.1
Minerals nec	0.5	1.2	−0.6	5	60.2	−55.2

Source: Author's calculation based on GDyn model.

trade in intermediates involving Brazil and China as well as third countries, with likely consequences to the way goods and services are produced in both regions.

For instance, results for Brazilian agricultural sectors in Table 6 suggest that annual growth in sectoral value added generated by exports are expected to be systematically higher when compared to gross export growth by 2030. Therefore, gross trade figures reported for those sectors may now quite well underestimate the expected sectoral net income growth due to the agreement. This is mainly the consequence of three effects that reflects the very nature of trade in agricultural goods. First, the foreign content embedded in natural resource intensive goods such as agriculture is usually low. Second, agricultural intermediates may also be indirectly exported to China embedded in other sectors' exports of final goods in Brazil. Third, Brazil's exports of agricultural intermediates to other countries may be later reprocessed and redirected to China, following the logic of GVC. The last two kinds of indirect exports do not show up as gross exports to China in standard national input-output tables. The same is obviously true from the point of view of Brazilian imports and may help to explain why Brazil's imported value added in agricultural goods is systematically higher than gross imports.

When it comes to bilateral trade in both agribusiness and manufacturing, results in suggest a different trade logic in comparison to the one described above. First, the production and exporting of manufactures are, in general, not constrained by the existence of domestic natural resources. This helps to explain the ongoing predominance of international supply chains in manufacturing sectors and the higher foreign content embedded in the exports of manufactured goods in comparison to other goods such as agricultures (backward linkages). Second, manufactured intermediates are usually inputs for the production of final goods in other manufacturing sectors, which weakens the creation of value added through indirect (domestic) exports. Last, indirect exports through third countries are clearly a possibility for the exports of manufactured goods (forward linkages). Therefore, in more complex sectors such as agribusiness and manufacturing, Brazilian gross exports would be expected to grow faster than the domestic value added they create. This is precisely the result reported in Table 7, a clear sign that Brazil's manufactured exports to China are expected to carry a higher foreign content of intermediates in the long term as a consequence of the agreement.

Regarding Brazil's imports of manufactured goods from China, gross imports are expected to grow faster than value added imported by 2030, suggesting that China's manufactured exports to Brazil are also expected to employ a higher foreign content of intermediates in the long term.

Results are therefore suggestive that long-term changes in relative prices are expected to be associated with structural changes when it comes to bilateral trade between Brazil and China. This issue will deserve a more comprehensive and detailed analysis in the following section.

6.2.4 Connecting to Global Value Chains: Are there signs of integration?

Results in Table 8 show the macro sectorial "vax ratio"[21] for exporting sectors in Brazil. It turns out that the qualitative behavior is basically the same as the one described for sectoral bilateral trade between Brazil and China. While Brazil is expected to add a greater share of foreign inputs within its total exports of manufactured (including agribusiness) and service

[21] This follows the definition found in Johnson & Noguera (2012b) and means value added exported over gross exports.

Table 7. Impact on Brazil's bilateral trade with China (in %, 2030).

Sectors	Exports			Inports		
	Gross	Value-added	Difference	Gross	Value-added	Difference
Agribusiness						
Bovine meat products	358.3	35.6	322.7	107.6	103.4	4.2
Meat products nec	52	42.3	9.6	223.9	103.2	120.7
Vegetable oils and fats	3.3	5.2	−1.9	69.3	52.9	16.4
Dairy products	331.8	20.2	311.5	276.5	91.7	184.8
Processed rice	50.6	12.6	38	170.2	61.1	109.1
Sugar	25.1	11.4	13.8	88.4	53.8	34.6
Food products nec	68.3	32.9	35.4	51.7	57.9	−6.2
Beverages and tobacco products	96.6	11.9	84.6	36.4	57.4	−21.1
Manufacturing						
Textiles	121.9	8.1	113.7	99.3	82.5	16.7
Wearing apparel	238.7	30.7	208	125.2	98.9	26.3
Leather products	76.5	70.1	6.4	178.7	137.9	40.7
Wood products	9	8.4	0.6	142.7	62.9	79.8
Paper products, publishing	7.8	7.9	−0.1	81.1	57	24.2
Petroleum, coal products	34.3	6.7	27.6	11.1	34.9	−23.8
Chemical, rubber, plastics	68.6	13.3	55.2	45.7	48	−2.3
Mineral products nec	106.4	11.3	95.1	60.2	52.6	7.6
Ferrous metals	25.4	13.7	11.7	52.8	63.8	−11
Metals nec	53.7	15.8	38	115.4	65.2	50.1
Metal products	122.2	7.2	115.1	107	68.5	38.5
Motor vehicles and parts	81.4	33	48.4	171	95	76
Transport equipment nec	50.5	23.3	27.2	226.2	162.3	63.9
Electronic equipment	37.9	5.6	32.4	49.2	42.2	7
Machinery and equip. nec	102.9	21.3	81.5	87.4	72.2	15.2
Manufactures nec	252.1	13.9	238.2	75.9	65.2	10.6
Services	81	11.8	69.2	−2.3	49.9	−52.3

Source: Author's calculation based on GDyn model.

Table 8. Sectoral Vax Ratio.

Sector	Baseline	Policy	Impact (%)
Agriculture	0.999	1.01	1.12
Extractive	0.794	0.803	1.12
Manufacture	0.489	0.482	−1.56
Services	3.165	3.086	−2.49

Source: Author's calculation based on GDyn model.

goods by 2030, implying less domestic value added will be created at the margin, domestic indirect exports will distort the vax ratio for agricultures and extractive goods, meaning higher domestic value added will be created at the margin. Since Table 8 reports Brazil's total exports (when sectors are added up), indirect exports through third countries do not play a role as a possible mechanism in the determination of the "vax ratio" for the macro sectors represented.

In order to trace out some clearer long-term signs of integration according to the value chain logic, tables 9 to 11 decompose bilateral trade among the largest economies in the agreement, taking into consideration its absorption in the primary destination country, its reflection back to the primary exporting country and its redirection to third country destinations such as the USA and EU. For instance, when Brazil exports to China, Table 9 shows that absorption is expected to increase by 0.52% by 2030, meaning a greater share of Brazil's export will attend final demand in China. At the same time, redirection of Brazil's exports to Argentina (embedded in Chinese exports) is expected to increase by 57% (in relative terms) and reflection to Brazil will increase by 58% (implicit "go and back" logic of Brazil's exports of intermediates to China). Since redirection of Brazil's export to relevant trade partners such as the USA and EU is expected to decrease as a share of total exports to China, trade in intermediates among Brazil, China and Argentina is expected to be reinforced as a result of the agreement. By the same token, when China exports to Brazil, Table 9 shows that absorption of Chinese exports is expected to decrease by −0.30% (meaning more reprocessing of China's intermediates in Brazil), while reflection to China grows by 3.40% and redirection of China's export to Argentina (embedded in Brazil's exports) decreases by −17%. On the other hand, redirection of China's export to significant Brazilian trade partners (embedded in Brazil's export) such as the USA and EU is expected to increase. Therefore, international supply chains involving China, Brazil, the USA and EU are expected to be created/reinforced by the agreement.

When it comes to bilateral trade between Brazil and Argentina, there are clear signs that the agreement is expected to lead to more integration into relevant global value chains for the two most industrialized economies in Mercosur. For instance, when Brazil exports to Argentina, absorption is expected to decrease by −2.21% in the long term, meaning a greater share of Brazilian intermediates being reprocessed in Argentina and redirected to third countries. However, redirection is expected to increase for China (17.86%), EU (6.51%) and the USA (8.09%) at the expense of reflection to Brazil (−1.33%). The same pattern is observed when Argentina exports to Brazil: a greater share of reprocessing in Brazil and redirection to third countries at the expense of reflection to Argentina. Since trade in manufactured goods represents nearly 90% of bilateral trade between Brazil and Argentina, results reported in Table 10 are suggestive that a PTA between Mercosur and China may favor the integration of existing regional value chains in Mercosur to the ones in third regions such as China, the USA and EU.

Table 11 reports the long-term expected behavior for bilateral trade relations between China and Argentina. As in the case of China and Brazil (Table 9), (potential) existing

Table 9. Trade decomposition: Absorption, reflection and redirection (in %).

	Brazil exports to China			China exports to Brazil		
Final destination	Baseline	Policy	Impact	Baseline	Policy	Impact
USA	6.84	6.7	−2.05	1.55	1.66	7.1
Brazil	0.46	0.73	58.7	89.89	89.62	−0.3
EU	7.41	7.25	−2.16	1.74	1.77	1.72
Argentina	0.14	0.22	57.14	0.88	0.73	−17.05
China	65.88	66.22	0.52	1.47	1.52	3.4

Source: Author's calculation based on GDyn model.

Table 10. Trade decomposition: Absorption, reflection and redirection (in %).

	Brazil exports to Argentina			Argentina exports to Brazil		
Final destination	Baseline	Policy	Impact	Baseline	Policy	Impact
USA	1.73	1.87	8.09	2.17	2.26	4.15
Brazil	6	5.92	−1.33	84.99	84.07	−1.08
EU	2.61	2.78	6.51	2.5	2.59	3.6
Argentina	77.41	75.7	−2.21	1.81	1.7	−6.08
China	1.96	2.31	17.86	1.55	1.75	12.9

Source: Author's calculation based on GDyn model.

Table 11. Trade decomposition: Absorption, reflection and redirection (in %).

	China exports to Argentina			Argentina exports to China		
Final destination	Baseline	Policy	Impact	Baseline	Policy	Impact
USA	1.35	1.43	5.93	5.28	5.36	1.52
Brazil	3.93	3.71	−5.6	0.37	0.6	62.16
EU	2.16	2.25	4.17	5.91	6.05	2.37
Argentina	82.42	81.67	−0.91	0.11	0.17	54.55
China	2.03	2.38	17.24	72.62	71.81	−1.12

Source: Author's calculation based on GDyn model.

value chains between China and Argentina are expected to be (created) reinforced with the agreement, given the growth in reflection not only when China exports to Argentina, but also when Argentina exports to China.

Moreover, when China exports to Argentina, a higher share of China's intermediates is expected to be redirected to other regions (embedded in Argentina's exports) at the expense of Brazil. On the other hand, when Argentina exports to China, the agreement is expected to lead to a higher share of reprocessing in China (lower absorption) and higher redirection to other countries/regions such as Brazil, the USA and EU.

6.2.5 Connecting to GVC: moving up or down the ladder?

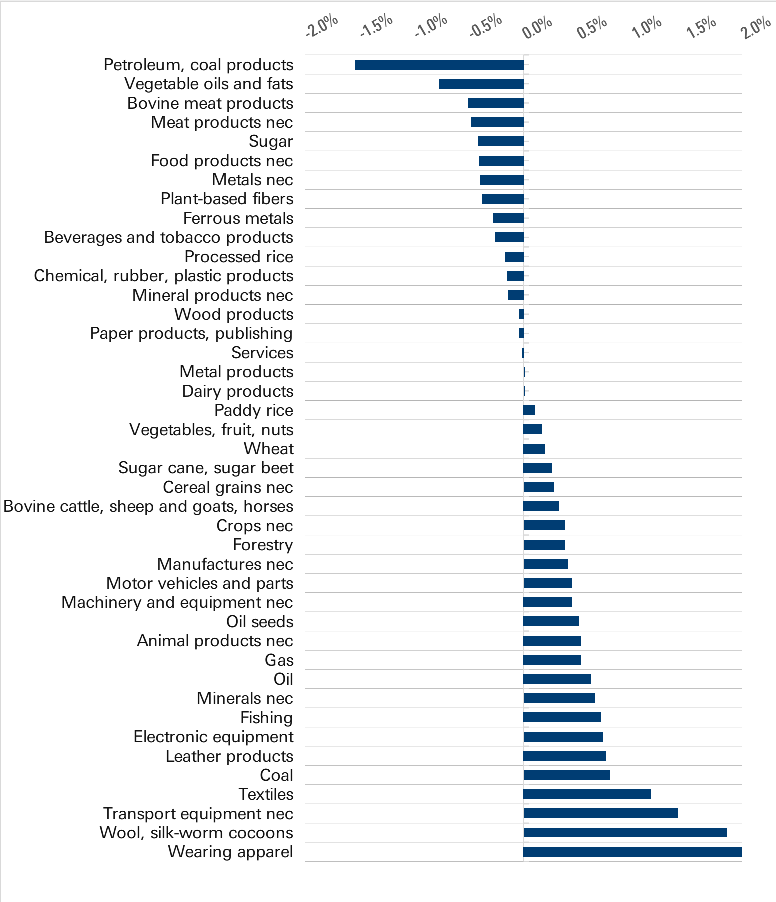
So far, the analysis in section 6 suggests that a comprehensive PTA between Mercosur and China is expected to lead to structural changes in the way the largest economies in the block trade with each other. In this regard, results in Table 10 show that bilateral trade between Brazil and Argentina is expected to become less concentrated in the south-cone region, expanding to other countries such as China, and up to a lower extent to the USA and EU, following the value chain logic.

The higher prominence of trade in intermediates will likely induce specialization in sector specific tasks for the economies involved in the agreement, according to their local comparative advantages at each stage of production of any given final good. Therefore, it seems relevant to investigate how production sectors in Brazil are expected to adjust in the long term as a consequence of the agreement. In this regard, the change in value added generated by unit value of total output produced may work as a useful proxy variable in order to figure out whether a sector is expected to specialize in more or less sophisticated tasks, once it starts participating in international supply chains (see Baldwin & Lopez-Gonzalez, 2013).

Figure 9 shows the expected change in the ratio of value added generated over total value of output produced for a set of GTAP sectors in the economy of Brazil, by 2030, as a result of the agreement. Positive changes are expected to be associated with specialization in higher value-added tasks inside any given sector, whereas negative variations suggest specialization in less sophisticated tasks. Exception made for Chemicals, rubber and plastics, all the other capital intensive sectors such as Motor vehicles and parts, Electronic equipment, Transport equipment and Machinery are expected to become more specialized in higher valued-added tasks.

7. Final Remarks

The last few decades have witnessed significant changes in the way countries do trade. The global fragmentation of production induced by the reduction in international freight costs and advances in communication technology has contributed to accelerating the pace of industrialization in several developing countries in Asia and Eastern Europe, with significant impacts on labor markets. As a general global pattern, workers in developed countries have been progressively specializing in high value-added service tasks, while



Source: Author's calculation based on the results from GDyn model.

Figure 9. Change in value added generated per unit value of total output (in %, 2030).

simple manufacturing activities have been increasingly offshored to lower cost developing nations.

The economy of Brazil, especially its manufacturing sector, seems to be still stuck in the old paradigm of vertical production where most of the supply chains involved in the manufacturing of final goods are predominantly domestic. Therefore, while foreign goods are nowadays made in the world, Brazilian goods are still 'made in Brazil". This relative isolation to trade in tasks may help to explain the loss of competitiveness of Brazil's manufacturing industry over the last decades.

Using a rather innovative approach in order to evaluate the impacts of PTAs in a highly fragmented world, this article suggests that the formalization of preferential trade agreements with natural trade partners (according to backward and forward linkages) may pave the way for the Brazilian industry to integrate into global value chains. In the case of a PTA between Mercosur and China, simulation results showed a tendency of decentralization when it comes to the bilateral trade between Brazil and Argentina, the two most industrialized economies in Mercosur. In particular, bilateral trade between Brazil and China is expected to intensify in the long term and a greater share of reprocessing of intermediates as well as redirection to other nations is also expected to occur in both countries. In this regard, Brazilian exports of intermediates to the USA, EU and Argentina are expected to increase, now embedded in China's exports of final goods to those destinations. Moreover, domestic value chains in Brazil are expected to become more specialized in higher value-added tasks in the long term, a usually relevant policy question in the trade debate involving developing economies.

When it comes to non-tariff barriers to trade, this article proposes a more reliable way to estimate the tariff equivalents of TBT/SPS measures, highlighting the importance to take into consideration its effects on both the extensive as well as intensive margins of trade. In particular, since only the intensive margin equation is considered in the estimation of tariff equivalents, they are fully compatible with a perfect competition market structure as the one assumed in the GDyn model.

References

Akgul, Z., Villoria, N. B. & Hertel, T. W. (2014). *Introducing firm heterogeneity into the GTAP model with an illustration in the context of the Trans-pacific Partnership Agreement.* URL: https://www.gtap.agecon.purdue.edu/resources/res_display.asp?RecordID=4445

Anderson, J. E. (1979). A theoretical foundation for the gravity equation. *The American Economic Review*, *69*(1), 106–116. URL: https://www.jstor.org/stable/1802501

Anderson, J. E., & van Wincoop, E. (2003). Gravity with gravitas: A solution to the border puzzle. *The American Economic Review*, *93*(1), 170–192. doi: 10.1257/000282803321455214

Andriamananjara, S., Dean, J. M., Feinberg, R., Ferrantino, M. J., Ludema, R. & Tsigas, M. (2004, abril). *The effects of non-tariff measures on prices, trade, and welfare: CGE implementation of policy-based price comparisons* (Office of Economics Working Paper Nº 2004-04-A). Washington, DC: U.S. International Trade Commission (USITC). URL: https://www.usitc.gov/publications/332/ec200404a.pdf

Andriamananjara, S., Ferrantino, M. & Tsigas, M. (2003, dezembro). *Alternative approaches in estimating the economic effects of non-tariff measures: Results from newly quantified measures* (Office of Economics Working Paper Nº 2003-12-C). Washington, DC: U.S. International Trade Commission (USITC). URL: https://www.usitc.gov/publications/332/ec200312c.pdf

Armington, P. S. (1969). A theory of demand for products distinguished by place of production. *IMF Staff Papers*, *16*(1), 159–178. doi: 10.2307/3866403

Baldwin, R. (2000). Regulatory protectionism, developing nations, and a two-tier world trade system. *Brookings Trade Forum*, *2000*, 237–293. URL: https://www.jstor.org/stable/25063151

Baldwin, R., & Lopez-Gonzalez, J. (2013, April). *Supply-chain trade: A portrait of global patterns and several testable hypotheses* (Working Paper N^{o} 18957). National Bureau of Economic Research (NBER). doi: 10.3386/w18957

Blyde, J., Graziano, A. & Martincus, C. V. (2015). Economic integration agreements and production fragmentation: Evidence on the extensive margin. *Applied Economics Letters*, *22*(10), 835–842. doi: 10.1080/13504851.2014.980569

Bonelli, R., & Bacha, E. (2013). Crescimento brasileiro revisitado. *In:* F. Veloso, P. C. Ferreira, F. Giambiagi & S. Pessôa (Org.), *Desenvolvimento econômico: Uma perspectiva brasileira.* Rio de Janeiro: Campus.

Crivelli, P., & Groeschl, J. (2016). The impact of sanitary and phytosanitary measures on market entry and trade flows. *The World Economy*, *39*(3), 444–473. doi: 10.1111/twec.12283

Daudin, G., Rifflart, C. & Schweisguth, D. (2011). Who produces for whom in the world economy? *Canadian Journal of Economics*, *44*(4), 1403–37.

Disdier, A.-C., Fontagné, L. & Mimouni, M. (2008). The impact of regulations on agricultural trade: Evidence from the SPS and TBT agreements. *American Journal of Agricultural Economics*, *90*(2), 336–350. doi: 10.1111/j.1467-8276.2007.01127.x

Disdier, A.-C., & Marette, S. (2010). The combination of gravity and welfare approaches for evaluating non-tariff measures. *American Journal of Agricultural Economics*, *92*(3), 713–726.

Dixon, P. B., & Jorgenson, D. W. (Org.). (2013). *Handbook of computable general equilibrium modeling* (Vol. 1A). North-Holland.

Dixon, P. B., & Parmenter, B. R. (1996). Computable general equilibrium modelling for policy analysis and forecasting. *In:* H. M. Amman, D. A. Kendrick & J. Rust (Org.), *Handbook of computational economics* (Vols. 1, Chapter 1, pp. 3–85). Elsevier. doi: 10.1016/S1574-0021(96)01003-9

Ferraz, L. P. d. C. (2012, November). *Os BRICS sob a ótica da teoria dos acordos regionais de comércio* (Texto para Discussão N^{o} 1789). Brasília, DF: Instituto de Pesquisa Econômica Aplicada (IPEA). URL: http://www.ipea.gov.br/portal/index.php?option=com_content&view=article&id=16429

Ferraz, L. P. d. C., Ribeiro, M. B. & Monastério, P. (2017). On the effects of non-tariff measures on Brazilian exports. *Revista Brasileira de Economia*, *71*(3), 301–320. URL: http://bibliotecadigital.fgv.br/ojs/index.php/rbe/article/view/59487

Francois, J., Van Meijl, H. & Van Tongeren, F. (2005). Trade liberalization in the Doha Development Round. *Economic Policy*, *20*(42), 349–391. doi: 10.1111/j.1468-0327.2005.00141.x

Gasiorek, M., Smith, A. & Venables, A. J. (1992). '1992': Trade and welfare – A general equilibrium model. *In:* L. A. Winters (Org.), *Trade flows and trade policy after '1992'.* Cambridge University Press.

Grossman, G. M., & Rossi-Hansberg, E. (2008). Trading tasks: A simple theory of offshoring. *The American Economic Review*, *98*(5), 1978–1997. doi: 10.1257/aer.98.5.1978

Harrison, G., Rutherford, T. & Tarr, D. (1994, abril). *Product standards, imperfect competition and completion of the market in the European Union* (Policy Research Working Paper Nº WPS 1293). Washington, DC: World Bank. URL: http://documents.worldbank.org/curated/en/871461468744326568/Product-standards-imperfect-competition-and-completion-of-the-market-in-the-European-Union

Hayakawa, K., & Yamashita, N. (2011, February). *The role of preferential trade agreements (PTAs) in facilitating global production networks* (Discussion Paper Nº 280). Institute of Developing Economies (IDE), JETRO. URL: http://www.ide.go.jp/English/Publish/Download/Dp/280.html

Heckman, J. J. (1979). Sample selection bias as a specification error. *Econometrica*, *47*(1), 153–161. URL: https://www.jstor.org/stable/1912352

Helpman, E., Melitz, M. & Rubinstein, Y. (2008). Estimating trade flows: Trading partners and trading volumes. *The Quarterly Journal of Economics*, *123*(2), 441–487. doi: 10.1162/qjec.2008.123.2.441

Hertel, T. W. (Org.). (1996). *Global trade analysis: Modeling and applications*. Cambridge University Press. doi: 10.1017/CBO9781139174688

Hertel, T. W., Walmsley, T. L. & Itakura, K. (2001). Dynamic effects of the "New-Age" Free Trade Agreement between Japan and Singapore. *Journal of Economic Integration*, *16*(4), 446–484. URL: https://www.jstor.org/stable/23000768

Ianchovichina, E., & Walmsley, T. L. (Org.). (2012). *Dynamic modeling and applications for global economic analysis*. Cambridge University Press.

Johnson, R. C., & Noguera, G. (2012a). Accounting for intermediates: Production sharing and trade in value added. *Journal of International Economics*, *86*(2), 224–236. doi: 10.1016/j.jinteco.2011.10.003

Johnson, R. C., & Noguera, G. (2012b, June). *Fragmentation and trade in value added over four decades* (Working Paper Nº 18186). National Bureau of Economic Research (NBER). doi: 10.3386/w18186

Kee, H. L., Nicita, A. & Olarreaga, M. (2009). Estimating trade restrictiveness indices. *The Economic Journal*, *119*(534), 172–199. doi: 10.1111/j.1468-0297.2008.02209.x

Koopman, R., Wang, Z. & Wei, S.-J. (2014). Tracing value-added and double counting in gross exports. *The American Economic Review*, *104*(2), 459–94. doi: 10.1257/aer.104.2.459

Leamer, E. E. (1990). Latin America as a target of trade barriers erected by the major developed countries in 1983. *Journal of Development Economics*, *32*(2), 337–368.

Lipsey, R. G. (1957). The theory of customs unions: Trade diversion and welfare. *Economica*, *24*(93), 40–46. doi: 10.2307/2551626

Los, B., Timmer, M. P. & De Vries, G. J. (2015). How global are global value chains? A new approach to measure international fragmentation. *Journal of Regional Science*, *55*(1). doi: 10.1111/jors.12121

Meade, J. E. (1955). *The theory of customs unions*. Amsterdam: North-Holland.

Melitz, M. J. (2003). The impact of trade on intra-industry reallocations and aggregate industry productivity. *Econometrica*, *71*(6), 1695–1725. doi: 10.1111/1468-0262.00467

Moenius, J. (2004, February). *Information versus product adaptation: The role of standards in trade* [Working Paper]. doi: 10.2139/ssrn.608022

Orefice, G., & Rocha, N. (2011, July). *Deep integration and production networks: An empirical analysis* (Staff Working Paper Nº ERSD-2011-11). Geneva, Switzerland: World Trade Organization – WTO.

Pearson, K. R., Parmenter, B. R., Powell, A. A., Wilcoxen, P. J. & Dixon, P. B. (1992). *Notes and problems in applied general equilibrium economics* [Advanced Textbooks in Economics, vol. 32]. Amsterdam: North-Holland.

Silva, J. M. C. S., & Tenreyro, S. (2006). The log of gravity. *The Review of Economics and Statistics*, *88*(4), 641–658. doi: 10.1162/rest.88.4.641

Timmer, M. P., Los, B., Stehrer, R. & De Vries, G. J. (2013). Fragmentation, incomes and jobs: An analysis of European competitiveness. *Economic Policy*, *28*(76), 613–661. doi: 10.1111/1468-0327.12018

Veloso, F., Matos, S. & Coelho, B. (2015, setembro). *Produtividade do trabalho no brasil: uma análise setorial* (Texto de Discussão N^{o} 85). Rio de Janeiro/São Paulo: FGV-IBRE.

Venables, A. J. (2003). Winners and losers from regional integration agreements. *The Economic Journal*, *113*(490), 747–761. doi: 10.1111/1468-0297.t01-1-00155

Viner, J. (1950). *The customs union issue*. New York: Carnegie Endowment for International Peace.

Yotov, Y. V., Piermartini, R., Monteiro, J.-A. & Larch, M. (2016). *An advanced guide to trade policy analysis: The Structural Gravity Model.* World Trade Organization. URL: https://vi.unctad.org/tpa/web/vol2/vol2home.html

Zhai, F. (2008). Armington meets Melitz: Introducing firm heterogeneity in a global CGE model of trade. *Journal of Economic Integration*, *23*(3, Special Issue), 575–604. URL: https://www.jstor.org/stable/23001233