Import Competition from China, Product Switching and Performance of Manufacturing Firms in Brazil

Juliana Dias Alves

Dezembro de 2020

Abstract

This paper studies the Brazilian manufacturing sector in line with the literature on heterogeneous firm, focusing on product scope. Using detailed Brazilian manufacturing firm-product-year level data over the period 2005-2009, I compared the growth in share of imports from China and analyzed its effects in scope of Brazilian manufacturing firms. A significant effect of 'creative destruction' was detected only for the lower-half of the size distribution of firms, while the big ones expand their product mix. In addition, using the Broad Economic Categories classification (Final, Intermediate and Capital goods), showed similar results: the smallest ones were the most negatively impacted, both for final and intermediate goods; and the large ones were positively impacted by Chinese imports of intermediate goods. The results are consistent for IV estimation and some robustness check. Finally, an additional result concludes that large firms focus on the core products, expanding its share on productive scope.

JEL classifications: F1, F14, F61

Keywords: Chinese Competition, Multiproduct, Scope, Heterogeneous firms, Brazilian manufacturing.

1. Introduction

After join World Trade Organization (WTO) in 2001 China became one of the biggest global exporting and has significantly increased international trade flows, reshaping the competitive environment across countries, particularly in terms of manufactured goods. The growth of China's manufacturing exports induced economists to investigate the effects of import competition from low-wage countries on firm and industry levels on developed countries (Bernard et al., 2006; Liu, 2010; Autor et al., 2013; Mion and Zhu, 2013; Bloom et al., 2016). Little attention was paid to developing countries (Iacovone et al., 2013; Goldberg et al., 2010).

Iacovone et al. (2013) argued that policy-makers in low income countries, like Mexico, worried that China could leave no room for them in the markets for labor-intensive manufactures. But, as time passed, China became richer and its comparative advantage is shifting away from the simplest goods towards a middle range product, and the most direct competition is against on middle-income countries. In Latin America, the concern was about the future for manufacturing industry mostly because of the process called "desindustrialization". As argued by Jenkins (2014), the growing of Chinese demand for primary commodities and the increased competition from China in manufactured goods, let the South American divided. Some sectors were major beneficiaries by Chinese demand for raw materials and agricultural products, but other sectors, like the manufacturing sector, complained about losing market share.

As the international trade data shows, while Brazilian share in manufactured imports has declined in recent years in the United States and its major Latin American markets, the Chinese participation has increased significantly. Although the largest losses were observed in low technology products, significant losses were also detected in medium-high technological products (Jenkins, 2014).

Brazil faces the competition from China mostly after 2001, like most of the countries of the world[1]. In 1990 Brazilian imports represented almost 7% of GDP and after 2000´s it was around 12%. Similarly to other countries, there was a change in the relative importance of the origin of imports, with the three main countries, United States, Argentina and Germany, having reduced their share in total Brazilian imports while China expanded its influence. Chinese´s imports jumped from $ 1.3 billion in 2001 to almost $ 16 billion in 2009. Figure 1 shows a monotonically upward trend in the share of China in Brazilian manufacturing imports, between 1996 and 2009: it jumped from an average of 2.5% (1996-2001) to 14% (2002-2009), 11.5 percentage points over a short period of time.

[1] In many studies, the entry of Chine in WTO in 2001, is considerate a quasi-natural shock. This is a very realistic assumption.

It should also be noted that the share of a group of countries abundant in unskilled labor ("Low Wage")[2] had increased more slowly and modestly.

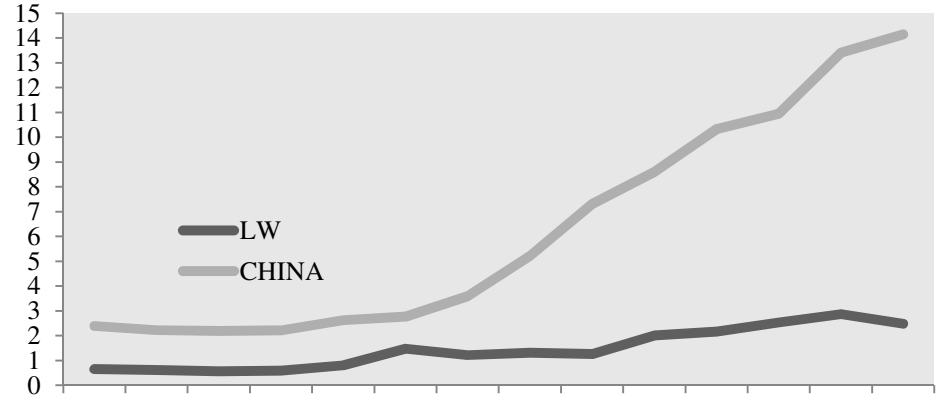

FIGURE 1 - Share of Chinese imports and "Low Wage" imports in total of Brazilian manufacturing imports, 1996-2009

The changes in composition and in the origin of Brazilian imports in a short period of time have implications for firm dynamics. It is reasonable to consider that competition between Brazil and United States is different from the competition that occurs between Brazil and China. As observed by Barua (2016), the current evidence shows that within a particular product category, these originating in high-wage countries have a superior quality comparing to those originating in low-wage countries (Schott 2004; Hummels and Klenow 2005). Others studies have shown that import competition leads to product quality upgrading (Amiti and Khandelwal 2013; Fernandes and Paunov 2013).

Table 1 highlights how big were the changes in Brazilian and Latin American imports from China, the US and the rest of world in four different years: 1996, 2001, 2005 and 2009. Both areas show an outstanding growth of the flow of imports from China, respectively 1,339% and 2.017% in real terms, between 1996 and 2009. The imports from the United States lost importance in both regions in a very significant way: from 1996 to 2009, the increase was significantly lower, 67% in Brazil and 95% in Latin America.

[2]The countries "Low Wage" are the same as those defined by Bernard, Jensen e Schott (2006), Álvarez e Claro (2009) e Mion e Zhu (2013): Afghanistan, Albania, Angola, Armenia, Azerbaijan, Bangladesh, Benin, Bhutan, Burkina Faso, Burundi, Cambodia, Central African Republic, Chad, Comoros, Congo, Equatorial Guinea, Eritrea, Ethiopia, Gambia, Georgia, Ghana, Guinea, Guinea Bissau , Guyana, Haiti, India, Kenya, Laos, Lesotho, Madagascar, Malaysia, Maldives, Mali, Mauritania, Moldova, Mozambique, Nepal, Nigeria, Pakistan, Rwanda, Samoa, São Tomé, Sierra Leone, Somalia, Ski Lanka, São Vicente , Sudan, Togo, Uganda, Vietnam, Yemen.

Table 1: Brazilian´s imports and Latin American´s imports from China, United States and World (%), 1996-2009

Year	Brazilian´s imports			Lantin America´s imports		
	China	US	World	China	US	World
1996	1.2	12.1	48.2	3.1	90.5	191.5
2001	1.4	14.0	52.4	9.6	135.0	275.7
2005	5.3	11.9	62.1	29.3	151.0	379.0
2009	15.9	18.8	111.3	63.7	166.0	478.6
Growth (1996-2001)	7.2	7.1	2.1	134.9	54.6	37.9
Growth (2001-2005)	253.3	(18.6)	13.4	189.6	6.9	31.7
Growth (2005-2009)	39.4	(26.9)	(17.2)	0.8	(49.0)	(41.5)
Growth (1996-2009)	427.4	(36.2)	(4.1)	585.2	(15.7)	6.3

Source: BACI, 1996-2009. Nominal trade values by year and Growth using IPA

The Table 1 also shows the increment on imports from China since 2005. However, 2009 can be seen as the year of the consolidation, with the value jumping from 5.3 billion dollars in 2005 to 15.9 billion in 2009. A similar effect can be observed in Latin America, where the imports in 2005 were US$ 29.3 billion and in 2009 US$ 63.7 billion.

These observations were made in an aggregate level. Nowadays, micro data basis are available and facilitating investigations on others levels like at plant level and/or product level. In a first movement, the investigations were at plant level (Bernard, Reading and Schott (2009) and others) and after many results showing the dominance of multiproduct firms in production and trade, a range of theoretical models focusing on the behavior of these firms have been developed (Eckel and Neary, 2010; Bernard et al., 2011; Mayer et al., 2014), where the product level adjustment is a very important procedure.

An important empirical result for Mexico show that Chinese import exposure induced product churning within-firms (Iacovone et al., 2013). In fact, when facing import competition from China, the imports of marginal products will shrink and probably quit, whereas core products benefit from the import of intermediate goods, a reallocation toward core products within firm. Goldberg et al. (2010) argue that access to these new imported inputs enables firms to expand their domestic product scope generating dynamic gains from trade. In fact, after investigating the relationship between declines in trade costs, the imports of intermediate inputs and domestic firm product scope for India, they found that lower input tariffs account for new products introduced by domestic firms and this expansion in the product scope of the firms was driven by increasing international trade access to new input varieties rather than just imported cheaper inputs. Recently, another result for India, Chakraborty and Henry (2019) show the causal effects of Chinese import competition on India on the

firms who drop their peripheral products and concentrate on the core ones. They also found that the effect is stronger for firms producing intermediate inputs.

Analyze the imports by broad economic categories at the firm level was an empirical strategy initially applied by Goldberg et al. (2009). More recently, Shu and Steinwender (2018) argue that the access to imported intermediates goods allows the local domestic firm to purchase such goods from foreign suppliers, which may decrease the input costs, increase the quality of inputs, and/or improve the efficiency of the production process. As a result, firms may produce new and/or higher quality output, and/or may innovate more due to increased profit margins or more opportunities to learn about new product design, new production processes, new materials or technologies, and even new organizational methods. At the same time, access to imported intermediates goods may decrease innovation by reducing the need for process-improving technologies.

Before the strong presence of the Chinese in international trade, the effects of Brazilian trade policy liberalization in the early-1990s that opening-up the economy was observed as an increase in productivity in the manufacturing sectors, spurred by easier access to better quality imported inputs. The research on this topic has barely prospered because the analysis was made at sector level and without import data by firm (Schor (2004, 2006) and Lisboa at al. (2010)). In fact, the joint investigation of impact in plant level and product level is recent. Alves and Ferreira (2013) investigate at firm level the effects of Chinese imports in the Brazilian manufacturing firms from 1996 to 2007. The results show that the probability of firms exit is negatively impacted by Chinese imports mostly in smaller plants and are significant to explain the variation in productivity (TFP), where the intermediate goods had a positive and significantly impact. Oliveira (2016) confirmed this evidence: firm selection is the most relevant channel of adjustment to shocks and the import competition from China is positively related to plant exit probability, with the effects concentrated among small plants[3].

The aim of the present study is to investigate, at product level, the effects of the imports from China on manufacturing plants in Brazil and verify if the results are in line with those already related by the growing international empirical literature. It is important to investigate: 1) if the import competition shock from China affects the process of "creative destruction" in Brazilian manufacturing industry, and 2) if the plant level adjustment mechanism is consistent with the theoretical prediction of multiple product models. Or, in other words, what do happen to product mix of Brazilian manufacturing if change the origin of trade?

[3] At the product level, we still do not have results for Brazil so far.

The remainder of this paper is organized as follows. Section 2 describes the three datasets used with the description of variables, and the measure of import competition from China. Section 3 summarize Brazilian previous context and results, with a characterization of manufacturing firms, changes in firms scope during 2005-2009, by manufacturing sector, and the differentiated impacts of Chinese imports, both by sector and by use category. Section 4, a brief review of theoretical literature is presented and some empirical results related to this study already available. Also in Section 4 some stylized facts about Brazilian industrial firms are presented as well as the general dynamics of the productive scope in the period from 2005 to 2009. Section 5 presents the empirical results and robustness checks. Finally some conclusions are reported in section 6.

2. Data

This work was only possible because of the connection, at firm level, of a detailed product-level information database and data concerning sales, receipts, shipments, employees and value added, provided by two different surveys conducted by the Brazilian Institute of Geography and Statistics (IBGE). The first, called Annual Survey of Industry-Product (PIA-Product), investigates products and services produced by Brazilian industry, covering the plants of every manufacturing firm with 30 or more employees and/or that had gross revenue above a certain threshold in the preceding year of the survey. Each firm informs the amount produced, Output Value, and revenue from sales of each product and service. The reference is a predefined nomenclature, which encompass around 3,500 different items, named List of Industrial Products[4] (*PRODLIST-Industry*), following the Common Classification of MERCOSUR (NCM). The data are presented by classes of the National Standard Industrial Classification of All Economic Activities (CNAE 2.0)[5]. PIA-Product started in 1998, but micro data only became available in 2005. For this paper, the data were available from 2005 to 2009.

The second database is the Annual Survey of Industry – Enterprise (PIA-Enterprise). It provides information about the number of employees, wages and salaries, revenue and expenses, production cost and gross value added. The survey unit corresponds to enterprises with 10 or more employees and/or those whose gross revenue surpassed a certain threshold in the previous year of the survey[6].

Therefore while PIA-Product provides a panel of firms with the Output Value of each product and service, classified according to the Prodlist, PIA-Enterprise characterizes several dimensions of each

[4] PRODLIST-Industry is a classification used by the Brazilian Institute of Geography and Statistics (IBGE).
[5] Based on the International Standard Industrial Classification of All Economic Activities – ISIC 4 (https://unstats.un.org/unsd/classifications/Econ/Download/In%20Text/ISIC_Rev_4_publication_English.pdf
[6] The period ranging from 1996 to 2007 was originally classified according to the previous industrial classification, CNAE 1.0. From 2007 to 2009, classification was according to CNAE 2.0. Since the estimates use data from before and after 2007, the correspondence between both classifications was investigated and every pre-2007 product information was recoded according to CNAE 2.0

firm at four digits classes of CNAE. The connection of both surveys allows analysis at firm and product level. Output Value of each item was deflated by a specific price index. These deflators were obtained from the Supply and Use Tables (TRU), which is part of the System of National Accounts (SNC), after establishing a correspondence between activities in SNC and CNAE 2.0[7]. All the variables used are descripting on Table A.1 (Appendix).

The link between this two databases and the international trade comes from a third database: *Base pour l'Analyse du Commerce International* - BACI[8]. It provides information on international trade disaggregated by products, value and quantities transacted between countries and their trading partners, according to the 6-digit Harmonized System classification - SH. The data provided is compatible with product level discrimination at eight-digit of the Mercosur Common Nomenclature - NCM (version 2007) that, in turn, is connected to CNAE. In other words, a connection was made to an international trade database, with import and export data by product and by country of origin with the possibility of sectorial aggregation, with an individual database of Brazilian industrial firms, classified by CNAE, version 2.0, four digits.

It is important to highlight that the connection between the two bases via CNAE code also brought the possibility of aggregating imported products by use categories, according to Broad Economic Categories - BEC. As import and export data are also components of the National Accounts System, the IBGE's classification was followed to consider products destined for final consumption or intermediate consumption or/and used as capital goods.

After describe the data used, let´s define the industry measure of import competition from origin trade as the share of country´s origin imports relative to total imports from Brazil. As pointed by Oliveira (2016), this measure was first introduced by Bernard et al. (2006), but adopted by many others like Broda and Romalis (2009); Bloom et al. (2016); Iacovone et al. (2013). The intuition for using this measure comes from the Heckscher-Ohlin model, which in the context of Brazil and China trading, would be expected that the continuous increase in trade between the two countries will reallocate resources away from Brazilian industries facing intense Chinese competition (manufacturing) towards industries where Chinese demand is playing an important role (agriculture and mining industries).

Using the database BACI, the variable $IMP\_OR_{j,t}$ is defined as:

$$IMP\_OR_{it} = \left(\frac{M_{jt}^{Or}}{M_{jt}}\right), \qquad (1)$$

[7] To detail information see Alves and Ferreira (2018).
[8] Original data from COMTRADE, *United Nations Statistical Divison*, from 1996 to 2009.

where M_{jt}^{OR} is total imported from industry j, from country *OR* in time *t.* M_{jt} represents the total imported by industry j in time *t*[9]. So $IMP\_OR_{j,t}$ measure , for each industry j (or CNAE three digits), the share of total imported from origin OR in total imported by manufacturing industry in Brazil.

The second equation (2) measures the share of import from China (CH) by use category and can been rewrite as follow:

$$IMP\_CH_{jt} = \left(\frac{M_{jt}^{CH}{}_{Final} + M_{jt}^{CH}\_Intermediate}{M_{jt}}\right) \qquad (2)$$

where $M_{jt}^{CH}\_Final + M_{jt}^{CH}\_Intermediate = M_{jt}^{CH}$

In this equation, similar to equation used in Alves (2013), total imported from China is disaggregated by use category: final consume goods (final), intermediate goods (input) and capital goods (capital). Rewriting the equation (2) to show the use category of imported good, flow the equations (3) and (4):

$$IMP\_CH_{jt}^{Final} = \left(\frac{M_{jt}^{CH}\_Final}{M_{jt}^{CHIna}}\right) * \left(\frac{M_{jt}^{CHIna}}{M_{jt}}\right) \qquad (3)$$

$$IMP\_CH_{it}^{Intermediate} = \left(\frac{M_{jt}^{CH}{}_{Intermediate}}{M_{jt}^{CHIna}}\right) * \left(\frac{M_{jt}^{CHIna}}{M_{jt}}\right) \qquad (4)$$

where $IMP\_CH_{jt}^{Final} + IMP\_CH_{jt}^{Intermediate} = IMP\_CH_{jt}$.

Therefore, what will be used in the estimates are micro data from Brazilian industrial firms, obtained from the PIA Enterprise and PIA Product surveys, together with the importing data, aggregated by industries (CNAE´s three digits) and categorized by use: final or intermediate goods. One final observation is that the equation (1) will not be defined only for China but also for another´s countries, used as Instrumental Variables. After that, next section presents Brazilian´s previous results and the evolution of trade with China.

[9]Similar to Mion and Zhu (2013) the share of imports are used instead of the coefficient used in BJS (2006) (whose denominator also includes the Value of Production minus Exports), due to the negative coefficients found, basically due to the high value of exports considering three-digits CNAE.

3. Heterogeneity: Brazilian previous results, Chinese Share of Brazilian Imports and Product Variety

After the process of trade opening and monetary stabilization in the mid-1990s, the Brazilian manufacturing faced two important changes: the growth in productivity and the change in its structural composition. These changes were heterogeneous and some industrial sectors increase importance while others loose relative shares (Ferreira and Rossi, 2003). Using micro data of industrial firms positive results from the tariff reduction were found on the growth of Brazilian industrial productivity. (Hay, 2001; Muendler, 2004; Schor, 2004: Schor, 2006). Schor (2004) points out that the impact of increased competition on productivity was not greater than the impact of the possibility of using imported inputs. Similar conclusion came from Lisboa at al. (2010) about TPF´s growth in the Brazilian industry. In fact, the empirical results for the Brazilian economy indicate an increase in the competitive pressure of imports and the adoption of "new" inputs and equipment as the main causes of productivity gains in the post-opening period in the early nineties.

The expansion of China in the international trade was a global phenomenon, not restricted to Brazil, mostly in the 2000. Chinese exports supplied the world with low-priced manufactured goods and industrial equipment (Bloom, Draca and Van Reenen, 2007)[10]. Table 2 shows the evolution of the share of imports from China in total Brazilian imports for three sub periods: 1996-2000, 2001-2005 and 2005-2009[11], by industrial sectors (two digits CNAE).

The first thing to highlight is the heterogeneity of Chinese imports by industry. In some sectors share of imports from China increase from 4.8% in 1996-2000 to 34% in 2005-2009, as in *Manufacture of Textile products* (13) (variable $IMP\_CH_{it,}$ columns (3) - (5)). Unsurprisingly, a significant increase in the share of imports can be seen in some of the labor intensive industries like *Apparel and Accessories* (14), *Preparation of leathers and manufacture of leather goods, travel goods and footwear* (15), a consistent result considering the Chinese comparative advantage. On the other hand, an increase in the share of imports in capital-intensive industries can also been observed: in *Manufacture of computer equipment, electronic and optical products* (26), Chinese imports change from 3.2% at the first period to 27.5% in the last period.

[10] On the other hand, the increase in Chinese imports of basic inputs was responsible for an extraordinary increment in the prices of agricultural, energy and mineral commodities.

11 The first period was from 1996-2001, clearly before China's accession to the WTO. The second period, 2001-2004, was a transition period following China's WTO accession but still some continued restrictions on Chinese exports. From 2004 Chinese exports to Latin America grew rapidly with several Latin American countries, including Argentina, Chile, Peru and Venezuela, granted China "market economy status" (Jenkins, 2014). The last period, 2005 -2009, covers the years of the global financial crisis (2008/2009) but also an increment of Chinese competition in peripheral markets. It is important to note that Brazilian Real was significantly overvalued at this period.

Table 2: Share of Chinese Imports, total and use category, by Industrial sectors - 1996-2000, 2001-2004 e 2005-2009

Sector	Description	MCHtotal			MCH_Final			MCH_Intermediate		
		1996-2000	2001-2004	2005-2009	1996-2000	2001-2004	2005-2009	1996-2000	2001-2004	2005-2009
10	Manufacture of food products	0.63	1.06	2.87	0.01	0.38	1.42	0.24	0.69	1.45
11	Beverage Manufacturing	0.09	0.04	1.63	0.00	0.01	0.05	0.03	0.03	1.58
12	Manufacture of tobacco products	1.09	0.13	0.16	0.01	0.13	0.20	0.58	-	-
13	Manufacture of textile products	4.80	16.64	34.03	0.03	1.09	2.64	3.72	15.56	31.39
14	Manufacture of apparel and accessories	26.47	37.70	49.71	0.26	37.61	49.62	0.08	0.09	0.08
15	Preparation of leathers and manufacture of leather goods, travel goods and footwear	19.14	25.72	52.14	0.19	24.80	49.95	1.28	0.92	2.19
16	Manufacture of wood products	3.18	4.41	10.85	0.03	2.67	5.55	1.17	1.74	5.30
17	Manufacture of cellulose, paper and paper products	0.21	0.28	2.50	0.00	0.12	0.26	0.10	0.16	2.24
18	Printing and playback of recordings	0.84	3.41	6.95	0.00	1.31	5.72	0.62	2.10	1.23
19	Manufacture of coke, petroleum products and biofuels	2.02	7.65	3.71	0.01	-	-	2.02	7.65	3.71
20	Manufacture of chemical products	1.54	2.61	6.04	0.01	0.06	0.12	1.46	2.55	5.92
21	Manufacture of pharmaceutical chemicals and pharmaceuticals	2.15	3.05	4.87	0.01	0.13	0.31	2.01	2.92	4.56
22	Manufacture of rubber and plastic products	2.12	2.52	9.99	0.01	0.42	0.87	1.58	2.10	9.11
23	Manufacture of non-metallic mineral products	2.51	6.06	18.65	0.02	1.44	4.08	1.31	4.61	14.57
24	Metallurgy	1.03	2.08	7.41	0.01	-	-	1.03	2.08	7.41
25	Manufacture of metal products, except machinery and equipment	2.71	4.27	14.33	0.02	0.91	2.62	1.91	3.36	11.71
26	Manufacture of computer equipment, electronic and optical products	3.19	9.74	27.50	0.02	1.84	5.09	2.23	7.90	22.41
27	Manufacture of electrical machines, equipment and materials	4.42	8.17	24.40	0.03	2.67	7.57	2.41	5.50	16.83
28	Manufacture of machinery and equipment	1.07	1.85	7.85	0.01	0.22	0.55	0.97	1.63	7.30
29	Manufacture of motor vehicles, trailers and bodies	0.05	0.43	2.11	0.00	0.00	0.02	0.04	0.42	2.09
30	Manufacture of other transport equipment, except motor vehicles	1.68	1.32	4.10	0.01	0.04	0.47	1.53	1.28	3.64
31	Furniture manufacturing	3.36	9.03	32.16	0.02	1.92	4.63	2.18	7.11	27.52
32	Other manufacturing	15.34	19.49	31.65	0.15	17.26	25.71	1.11	2.24	5.94
Total/mean		4.33	7.29	15.46	0.04	4.13	7.28	1.29	3.16	8.18

Source: BACI, 1996-2009. Author´s elaboration.

The period 2001 to 2004 (variable IMP_CH_{it}, column (4)) shows a big jump in Chinese share of total imports compared to the previous period (1996-2000, column (3)), mostly because the entrance in WTO in 2001. The next sub period, 2005-2009 (column (5)), seems to consolidate the impact of Chinese imports in Brazilian manufacturing. In 17 of the 23 sectors, the growth in the share of Chinese imports was greater in the period 2005-2009 than in the previous period, 2001-2004.

The columns (4) - (6) and (7) - (9) show the results for $IMP\_CH_{it}^{Final}$ and $IMP\_CH_{it}^{Intermediate}$, respectively, final goods and intermediate goods[12]. Here, imports of final goods are concentrated in the labor-intensive sectors, *Manufacture of apparel and accessories* (14) and *Preparation of leathers and manufacture of leather goods, travel goods and footwear* (15), with a huge variation from less than 0.3% in the period 1996- 2000 to almost 50% in 2005-2009. The import of intermediate goods (inputs and capital goods) increased considerably in the capital intensive sectors, (25) to (27), in addition to the *Textile* sector (13). In this last one, the main effect was clearly related to the import of inputs.

Table 2 also shows a differentiation both by sector and by use category of total imported by Brazil with origin in China. After the remarkable movement of China in international trade with its accession to the WTO after 2001, it is important to study the effects of Chinese imports competition on the Brazilian manufacturing firms. Unfortunately, only one analytical article was found - Chakraborty and Henry (2019) – focused on the effects of import competition from one BRIC[13] country to another. Their results point out that Chinese imports only affects firms through competition in the domestic

[12] Similarly to others authors, I categorize the manufacturing sector into two major sub-sectors: (1) Final goods, which contain consumer of durable and non-durable goods; and (2) Intermediate goods, which contain capital, intermediate and basic goods.
[13] BRIC is an acronym referring to the countries of Brazil, Russia, India, and China.

market and provides strong evidence of product reallocation within firms forcing them on direction to their core competencies.

In the case of India it was observed that the average number of products produced by an average Indian manufacturing firm rises from around 1 during the 1990s to almost 3 in 2007 and the rate of growth in the increase in the number of products slowed down in the post-2001 period. According to the theory, it was expected to found that Chinese comparative advantage should increase significantly after 2001 for industries where it was already high in the previous period. But, instead of that Chakraborty and Henry (2019) found out that after 2001 more industries had increase their shares of Chinese imports.

Unfortunately, for this research, the data was not available for the period before 2001. But, as noted in Table 2, the period after 2004 seems to consolidate the influence of Chinese imports in the Brazilian manufacturing. Even so analyzing the variety of products in an average Brazilian multiple-product firm surviving over 2005-2009, for most of the industrial categories (13 out of 22), there was an increase in the number of products, comparing the first and the last year (Table 3). For an average Brazilian manufacturing industry, the variety of products was constant, 2.7, in 2005 and in 2009.

Using these facts as a background, this research investigates whether the increase in the import share from China is significantly correlated with variations in the product mix of the manufacturing firms in Brazil. Tables 2 and 3 show a high degree of heterogeneity across Brazilian manufacturing. In the next section a brief resume of models with heterogeneous firms is presented, as well as some stylized facts of Brazilian industrial firms.

Table 3: Number of product by representative firm, CNAE`s two digits classification, surviving Brazilian`s manufacturing firms and multiple products, 2005-2009

cnae2	2005	2006	2007	2008	2009
10	3.63	3.54	3.76	3.73	3.71
11	2.83	2.53	2.59	2.67	2.50
12	1.91	1.97	1.91	1.91	1.90
13	2.23	2.42	2.24	2.30	2.23
14	2.77	2.80	2.88	2.86	2.82
15	1.80	1.80	1.80	1.81	1.76
16	2.02	2.34	2.09	2.08	1.92
17	2.25	2.21	2.36	2.38	2.31
18	2.31	2.21	2.53	2.51	2.46
19	3.52	3.21	3.46	3.56	3.53
20	4.49	5.04	4.98	4.98	4.94
21	5.03	5.09	5.52	5.20	4.75
22	2.05	2.28	2.17	2.16	2.22
23	2.13	2.13	2.21	2.16	2.08
24	2.58	2.47	2.33	2.39	2.50
25	2.05	2.25	2.12	2.18	2.17
26	3.24	3.37	3.12	3.11	3.36
27	2.88	2.72	2.76	2.89	2.99
28	3.36	3.20	3.54	3.53	3.47
29	2.52	2.25	2.52	2.53	2.67
30	2.24	1.96	2.18	2.12	2.04
31	2.98	2.89	2.99	2.96	2.95
32	2.04	2.08	2.16	2.23	2.12
33	**2.60**	**2.25**	**1.94**	**2.08**	**1.91**
TOTAL	**2.73**	**2.71**	**2.76**	**2.76**	**2.72**

Source: PIA Product, 2005-2009

4. Related literature and some stylized facts in Brazil

To the heterogeneous firm environment, Bernard et al. (2010), Bernard et al. (2011) and Eckel and Neary (2010) added the multiproduct plants and consumers with stronger preference over some varieties, which allow demand shocks to influence results. Thereby, most productive firms would produce more varieties since they can afford paying for fixed costs associated to the production of each extra item, which helps to explain the stylized fact that most productive plants tend to produce more varieties.

The idea of Eckel and Neary (2010) about "core competence", certain products that firm would be manufactured more efficiently, brought the consequence of the international competition may then result in higher aggregate TFP by forcing firms to produce varieties closer to their competence core, but can also result in fewer items produced by a country. Bernard at al. (2011) also shows that multiproduct firms would tend to obtain higher revenue from items closer to their excellence core,

since productivity and quality would decline as new varieties are manufactured. Arkolakis and Muendler (2010) found that in the presence of entry cost per each new variety supplied, larger and more efficient plants would produce more output and varieties, resulting in positive correlation between extensive and intensive margins within a firm (Alves and Ferreira, 2018).

Verhoogen (2020) considered three categories of drivers of industrial upgrading in developing countries: (i) on the output side, consumer preferences and the degree of competition in export and domestic markets; (ii) on the input side, conditions in credit, labor, and intermediate-input markets; (iii) and firm capabilities, including mechanisms that affect the entrepreneurial ability or knowledge possessed by firms. This is an interesting categorization and this study try to focus on the input side, more specifically on intermediate-input markets.

Empirical results available until now show that firms buy higher-quality inputs on international markets than on domestic ones. Therefore, it would be expected that a reduction of tariffs tend to lead developing countries to upgrade the quality of their inputs. But tariff reductions not only improve access to high-quality imported inputs, they also expand the variety of inputs available, which may in turn enable firms to produce new outputs. Goldberg et al. (2010) provide evidence that the increased availability of imported inputs led firms to expand their set of output varieties. Bas and Pavnov (2019) directly observe both inputs and outputs of Ecuadorean firms and confirm the findings.

Others results are available at empirical international literature. Bellone et al (2019) examines how Japanese firms change their product portfolios in response to increase of imports with origin in China. The results point out that the import competition pressures do affect the product churning for multi-product plants and the negative effects of import competition are mitigated by increased in export opportunities. Hur and Yoon (2018) examine resource reallocation within firms by investigating how firms change their product portfolios in response to a fall in trade costs using Korean firm-product data. They show that firms experiencing large tariff reductions are more likely to not only decrease the number of products but also focus their production in specific products. In fact, firms allocate resources from less efficient products to more efficient ones.

After this brief empirical review, some stylized facts about the multiproduct plants in Brazil are presented, based on Alves and Ferreira (2018). In 2009, 37% of Brazilian manufacturing firms produced more than one variety. This result was very close to 41% found in the US[14]. We also know that MP firms were responsible for 81% of the output, a proportion similar to those reported for India and Japan. As theoretical predictions of Bernard at al. (2010, 2011) and Eckel and Neary (2010), MP

[14] The result refers to year 2009. However values for the other years are all very similar.

firms should be larger, more productive and produce more output. These characteristics make them more likely to be exporters. One of the key predictions of the multiproduct model is that higher productivity firms produce a larger range of products than the lower productivity firms. In Bernard et al. (2010) higher productivity firms extract higher revenues per product, distributing the fixed costs in a wider range of products.

Table 4 provides a comparison between multi-product (MP) and single-product (SP) plants in Brazil for 2005 and 2009. Compared to SP firms, MP generated, on average, 8% more output[15], employed 10% more workers that were 4% more productive. Regarding their presence in the international market, MP was 20% more likely of being an exporter than SP and also is, on average, 5% more productive (TFP).

Table 4 – Relationship of MP with output, number of employees, exporting status, labor productivity, and TFP. Brazil, 2005-2009.

Characteristics	MP
Ln(*output*)	0.08***
Ln(*n.employees*)	0.10***
Exporter (1 if yes)	0.20***
Ln(*output/employee*)	0.04***
Ln(TFP)	0.05 ***

Source: PIA-Product (IBGE), 2005 and 2009. Authors' computation.
NOTE: Reported values correspond to estimated coefficient μ of equation: $Z_{ji} = \mu D_{ji}^{h} + F_i + \varepsilon_j$. Characteristics in the 2st column correspond to variables *Z*. F_i are sector fixed effects. Significance: *** 1%, ** 5% and * 10%. Number of observations: 159,717.

Another key prediction of multi-product firm model is that firms output is skewed towards its core competence. Table 5 presents the average share of revenue originated by each good after controlling the number of varieties produced[16]. The columns show the number of varieties manufactured by a firm (1, 2, and so on). Any firm producing 10 or more goods was pooled in the last column (≥ 10). A specific row informs the average contribution of a product to the total revenue of a "representative" firm producing the number of items indicated in the specific column. For instance, among firms producing only 2 items, the contribution of a single good for the total revenue was, on average, 75%, while the remaining 25% would come from the second good. Firms producing 9 items concentrate, on average, 45% of their revenue on only one item and another 20% on a second variety. The remaining 35% is divided among the other 7 products, also in a disproportionate manner. These results are very similar to the patterns reported by Bernard et al. (2010), Goldberg et al. (2010), Navarro (2012) and Soderbom and Weng (2013), when analyzing US, India, Chile and China, respectively.

[15] The variable´s definitions used on Table A.1 are on Appendix.
[16] The variable used was output value, taken from PIA-Product.

Table 5 – Average share (%) in output originated by each good given the number of varieties produced. Period: 2005 and 2009.

Importance rank in output production	Number of varieties produced by each firm									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**≥ 10**
1st	1.00	0.75	0.64	0.58	0.54	0.50	0.49	0.46	0.45	0.45
2nd		0.25	0.25	0.24	0.23	0.22	0.21	0.21	0.20	0.20
3rd			0.11	0.12	0.12	0.12	0.12	0.12	0.12	0.12
4th				0.06	0.07	0.08	0.08	0.08	0.08	0.08
5th					0.04	0.05	0.05	0.05	0.06	0.05
6th						0.03	0.03	0.04	0.04	0.04
7th							0.02	0.02	0.03	0.03
8th								0.01	0.02	0.02
9th									0.01	0.01
10th										0.01

Source: PIA-Product (IBGE), 2005 and 2009. Authors´ computation.

The overall finding for Brazil is that, on average, few items contribute with a very large fraction of the total output of each manufacturing firm. This is in line with the developments of BRS (2010) and Eckel and Neary (2010) for whom each firm has better performance in products closer to their excellence core, resulting in a distribution of revenue skewed in a way that the most important varieties are responsible for a greater share of the revenue[17].

As mentioned before, in 2009, 81% of output was generated by MP firms. Alves and Ferreira (2018) decomposing of output of each product by the type of firm producing it, estimating from 2005 to 2009, the proportion of output due to: (i) an intensive margin (net growth in the output of items already produced); (ii) an extensive margin divided between a product margin (net addition of items by continuing firms) and a plant margin (net entry of new firms) by manufacturing firms. The results were in line with those reported for most countries: intensive margin contributing far more to output growth, followed by product margin and, lastly plant margin.

The importance of the product extensive margin, second in the list above, can be better assessed if its contribution to growth is considered in relative terms: while the net growth of the intensive margin represented 76.2% of the aggregate increase from 2005 to 2009, the product margin contributed with 14.9% for the output growth from 2005 to 2009, which is a considerable amount since it is not talking about adjusting the volume of an already produced item (Alves and Ferreira, 2018).

A final last result should be mentioned here. Maintaining the focus only on surviving firms, because they are responsible for the product extensive margin, and following Bernard at al. (2010) classification, there are four mutually exclusive possibilities that should be considerate about the

[17] Nocke and Yeaple (2006) provide a different perspective: there are not differences within a firm associated to the production of any specific good, and managerial skills would determine the amount of varieties produced by each firm. As a result, one should observe an even distribution of revenue from different varieties.

productive mix: (i) "no change", when a firm does not add nor retire any variety; (ii) "drop", when at least one product is taken out of the production mix; (iii) "add", when at least one new item is incorporated to the production mix; and (iv) "both", for adding and dropping at least one product.

Panel A of Table 6 shows the percentage of firms enrolled in each activity. The second column shows that only 13.2% of MP firms have not changed the productive mix. The remaining 86.8% was distributed as follows: 17.1% added at least one product, 16.5% dropped at least one product, and 53.1% added and dropped at least one variety.

Table 6: Share of the firms, among surviving firms, according to action towards scope and characteristics: MP, exporting status, and size. Period: 2005-2009.

Action regarding scope	MP	Exporters (X)	Non exporters (NX)	10% larger*
Panel A: Share of firms				
None	13.2	32.5	39.7	28.7
Add	17.1	11.8	7.9	14.4
Drop	16.5	11.4	7.6	12.9
Both	53.1	44.4	44.8	44.1
Panel B: Share of output				
None	14.9	24.4	37.8	18.8
Add	16.7	14.5	11.2	13.6
Drop	14.5	12.0	12.4	11.1
Both	53.9	49.1	38.7	56.4

Notes. *With respect to output value. Columns add to 100%.

Regarding participation in external market, non-exporters were more likely to leave their mix unchanged: 39.7% compared to 32.5% among exporters. In the opposite direction, the fraction of those that have only added or only dropped product(s) was higher among exporters: respectively, 11.8% and 11.4% against 7.9% and 7.6% for NX. Firms belonging to the top decile were less likely to keep steady their production mix (28.7%) when compared to all firms together (37.3%). Larger companies were more likely to add new products, 14.4% (more than 9.2% of total firms), and retire old ones, 12.9% (more than 8.9% of total firms)[18].

Panel B informs the contribution of each action group for the aggregate output among surviving firms from 2005 to 2009. Those 13.2% of MP firms that did not change scope were responsible for only 14.9% of the output. The remaining 86.8% that modified the mix were responsible for 85.1% of the output which was distributed as follows: 16.7% generated by firms that only added products, 14.5% by droppers, and 53.9% by firms doing both.

[18] To more details see table 8 in Alves and Ferreira (2018).

It is clear that an average firm that promotes changes in the production mix contributes far more to aggregate output than one that does not. Export status and firm size presented big differences in panels A and B: while 28.7% of the firms in the top decile did not pursue any change in scope, contributed to only 18.8% of the output while 44.1% of these larger firms that added and dropped items from their productive mix, contributed to 56.4% of the output. Similar inversion happened among exporters: 32.5% kept their mix and granted only to 24.4% of the output. The remaining 67.5% that altered the mix contributed with 75.6% of the output among exporters. This two characteristics of firms, size and export orientation, will be used in the next section to accurate the estimation and to find better controls to refine results.

Summing up, the incorporation of multi-product firms into the international trade models of firm heterogeneity highlights a new channel of within-firm adjustment in response to trade competition in addition to the across firm selection (entry-exit) effect that arises in the single- product heterogeneous firm models. The main prediction from those models is that firms change their product mix or drop the least performing products in the face of trade competition. From Alves and Ferreira (2018) several stylized facts about Brazilian´s manufacturing firms were presented. The results draw attention to the fact of the product extensive margin had higher contribution to output growth than the conventional extensive margin, from entry and exit of firms. And the result that larger firms have higher probability of either adding or dropping products from their production mix will be helpful to investigate the heterogeneous behavior of firms, also the fact that exporting firms are more likely to change their productive scope.

The next section investigates whether intensified import competition from China is an important contributing factor behind the changing of Brazilian manufacturing scope, in addition to the characteristics of the firms already mentioned above.

5. Estimation

5.1 Previous Issues

First, though the above framework addresses important issues for the identification of the impact of Chinese import competition, there are potential sources of endogeneity that may bias the coefficients resulting from estimation. The coefficient of importation could be endogenous because industry shocks affecting the outcome variables could be correlated with demand for imports. César and Falcone (2019) to account for this endogeneity concern used as instrument the simple average of China's industry import share across high-income countries and also tested the robustness of the results to alternative groups of countries. Barua (2016) used the lag changes in China's share of

imports a large low-wage country (Indonesia) as an instrument for changes in China´s share of India´s imports. Oliveira (2018) used as an instrument for the share of imports from China the corresponding exposure to Chinese trade by middle-income countries[19] other than Brazil.

The instrumental variables strategy of using other countries' exposure to trade was first introduced by David et al. (2013), and is widely adopted in studies regarding the growth of China in international trade, such as Iacovone et al. (2013), Costa et al. (2016), and those related above. Following this strategy for Brazilian manufacturing is important because there might be factors originating in Brazil that affect plant outcomes and are simultaneously related with imports from China. As pointed by Oliveira (2018), there might be supply shocks in Brazil, due to technological innovations or government policies, or changes in the pattern of demand, due to aggregate income or a change in preferences that are correlated with exposure to Chinese trade. If this is the case, then the error term will be correlated with the shares of Chinese imports and applying an instrumental variable (IV) estimation approach is recommended. To deal with this issue in this study, the Latin American imports from China (other than Brazil) will be used as an instrument and some alternative instruments will be used to test the robustness of the results.

Second, it is important to considerate the fact that importing one kind of category of goods (intermediate inputs and/or capital goods) could be cheaper for Brazilian firms than producing domestically. Similar to others countries, the access to this source of cheaper, higher quality and greater variety of inputs is a significant determinant of the expanding product mix and higher productivity levels that characterized the Brazilian firms[20]. Goldberg et al (2010) show that Indian manufacturing firms, especially the large ones, imported cheap, high-quality intermediate goods after trade reforms in the 1990s. And recently, Chakraborty and Henry (2019) found that China's internal trade reforms and the accession to the WTO in 2001 may resulted in a trade creation effect: small manufacturing firms now imports a large fraction of its intermediate inputs from China to produce new products. So, even though this research do not use imports by firms, to account for the possibility of classifying the imports by use category of goods is a valid strategic to investigate the access of Brazilian firms to different kind of goods and consequentially observe their impacts on the outcomes.

Third, there is substantial heterogeneity in product scope adjustment; the big firms tend to distribution expand product scope, whereas the smaller firms tend to reduce it. To deal with the heterogeneity, and following other studies, a size distribution in terms of total Output Value divides firms into four

[19] These are the middle-income countries used for aggregation: Albania, Cuba, Lybia, Samoa, Algeria, Dominica, Macedonia, Serbia American Samoa, Dominican Rep., Malaysia, South Africa, Argentina, Equatorial Guinea, Maldives, St. Lucia, Azerbaijan, Ecuador, Marshall Islands, St. Vincent, Belarus, Fiji, Mauritius, Suriname, Belize, Gabon, Mexico, Thailand, Bosnia-Herzegovina, Grenada, Montenegro, Tonga, Botswana, Guyana, Namibia, Turkey, Bulgaria, Iran, Panama, Turkmenistan, China, Iraq, Paraguay, Tuvalu, Colombia, Jamaica, Peru, Venezuela, Costa Rica, Kazakhstan, Romania, Croatia, Lebanon, Russia.

[20] It is a fact that the entrance of China in WTO made the prices became cheaper.

groups. Incorporate this heterogeneity on analysis is determinant for all the outcomes and the crucial issue of differential response by manufacturing firms is consistent with previous empirical findings, as previously discussed in section 3.

5.2 Baseline estimates and heterogeneity

The theories of multi-product firms suggest that in the face of changing trade costs firms can increase their productivity through rationalization of product scope. This subsection investigates the impact of import competition from China on the selection of products within-plant of Brazilian manufacturing firms from 2005 to 2009. Let´s begin by examining the impact on the number of products produced by a plant, using the following linear regression with fixed effects specified as:

$$\ln(NP)_{ijt} = \beta_1 * (firmscontrols)_{it} + \beta_2 * (IMP\_OR)_{jt} + \eta_t + \mu_j + \theta_{jt} + \xi_{ijt} \qquad (5)$$

where the dependent variable is the logarithm of number of product variety[21] produced by a Brazilian manufacturing firm *i* belonging to sector *j* at time *t*; the f*irmscontrols*$_{it}$ is a vector of variables that includes some characteristics of each firm *i* in *t*[22]; IMP_OR$_{jt}$, defined in section 3, is the share of imports in total imported from a specific country or group of countries; μ_j are industry fixed effect by each three digits CNAE; η_t are proxies for year fixed effect to control for any specific shock by year that could affect all firms at the same way; and θ_{jt} refers to an interaction between industry fixed effect and a time trend or interactions of industry and year fixed effects, aiming to capture others influences like shocks at the industry level, such as change in labor policy or monetary/credit policy, which varies over time and may also impact the decisions of productive scope of a firm.

The vector *firmscontrols* is a group of variables selected based on the results obtained from previous research (Alves, 2015). Observing the period from 1996 to 2007, after the growth of China participation in international trade, Brazilian manufacturing firms responded, in short, as follows: (i) smaller and less productive firms were more affected by competition of Chinese imports and also had higher probability of exit the market; (ii) considering the Total Factor Productivity (TFP), while at the aggregate level the Chinese imports were not significant to explain its variation, when imports were considered by use category (final and intermediate), the inputs originating in China were important to explain the positive variation of TFP in Brazilian firms. Those results were used as a background to define the variables used as *firms controls*: the logarithm of TFP; the *dummy* for export, that is equal

[21] I add 1 to variable number of product, since the dependent variable is a logarithm.
[22] I estimate the equations of this section also considering firm controls for t-1. The results are almost the same. I choose period t because is possible to have more observations, since I only have five years at the database.

one if firms exports and zero otherwise; and the logarithm of number of employees, a proxy of firm size[23].

The coefficients from estimating equation (5) are in Table 8. Columns (1) – (3) show the results for natural logarithm of the number of products produced by a Brazilian manufacturing firm in a single year regressed on IMP_CH, the vector of variables used as *firm controls*, industry fixed effects, year fixed effects (column (1)) and interactions of either industry fixed effects with year trends or industry with year fixed effects (columns (2) and (3)). Across all the estimations, the statistical significance of Chinese competition doesn't change and it is not significant to affect the product mix of the Brazilian firms at the aggregate level. Similar results were found to India (Chakraborty and Henry, 2019).

To deal with the heterogeneity in the effects of trade shocks on multi-product firms (Dhingra, 2013; Qiu and Zhou, 2013; Lopresti, 2016), the set of firms was divided into four different groups based on Output Value (VP), where the logarithm of VP is higher for firms belonging to the fourth quartile[24]. Recent studies point out that firms at the right tail of the productivity distribution have a significant role in the performance of the aggregate economy and from section 4, it´s possible to see that for Brazilian firms this reality is no different. Try to understand whether these firms behave differently from others is very important. The quartiles are indicated by a dummy variable, defined by Q_i (i=1, 2, 3, 4). In each case, the variable measuring the different size category takes a value of 1 for the firms belonging to the respective category and zero otherwise.

Table 8 shows the results considering the heterogeneity in the distribution of VP of Brazilian manufacturing firms in Columns (4) – (6). The interactions of dummies in each quartile with IMP_CH showed a significant coefficient for firms belonging to the first, the second and the fourth quartiles, but with opposite signs. Firms belonging to the first and the second quartiles drop products from their product mix when import competition from China increases in the domestic market. Instead, firms in the fourth quartile, the movement was on the opposite direction: positive effects of Chinese import competition on the scope of big Brazilian firms were detected.

After the results of Table 8, there is robust evidence that Chinese competition changes the productive scope of Brazilian firms. While for Indian firms the negative effect of Chinese import competition on the product scope occurred regardless of their sizes (Chakraborty and Henry (2019), for Brazilian firms the negative effect was restricted to smaller quartiles. Small firms clearly exhibit significant evidence of creative destruction as a result of import competition from China: the coefficients indicate that an increase of 10 percentage points in Chinese share of imports by Brazil reduces the product

[23] The variables are described in Table A.1 on Appendix.
[24] I used the logarithm to maintain the scale similar to other variables of equation.

scope of manufacturing firms by an average of 8.8%. The effect of "creative destruction" is greater for firms belonging to the first quartile, the smaller ones. On the other hand, the large firms expanded their product-mix by 11.3%, on average. And as pointed out by Qiu and Zhu (2013), for Brazil the evidence seems to show that for the most productive firms they add products as a result of import competition from China.

Table 8: Effect of Chinese Import Competition on Product Variety of Brazilian Firms and firms heterogeneity (Output Value), 2005-2009

Dependent variable: ln (NP)						
	(1)	(2)	(3)	(4)	(5)	(6)
IMP_CH_{jt}	-0.0106	-0.0030	-0.0055			
	(-0.56)	(-0.15)	(-0.29)			
IMP_CH_{jt}*Q1				-0.1237***	-0.1163***	-0.1191***
				(-4.86)	(-4.49)	(-4.65)
IMP_CH_{jt}*Q2				-0.0821***	-0.0743***	-0.0767***
				(-3.56)	(-3.16)	(-3.29)
IMP_CH_{jt}*Q3				0.0043	0.0126	0.0108
				(0.19)	(0.53)	(0.46)
IMP_CH_{jt}*Q4				0.0886***	0.0994***	0.0970***
				(3.24)	(3.58)	(3.50)
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes
Number OBS	34,349	34,349	34,349	34,349	34,349	34,349
IndustryFE	Yes	Yes	Yes	Yes	Yes	Yes
YearFE	Yes	Yes	Yes	Yes	Yes	Yes
*IndustryFE*time trend*	No	Yes	No	No	Yes	No
*IndustryFE*YearFE*	No	No	Yes	No	No	Yes

Notes: The dependent variable in columns (1) - (6) is the natural logarithm of number of products manufactured by a firm in each year plus 1. IMP_CH is the Chinese Import Share of total imports by Brazil at industrial level (three digits CNAE); IMP_CH*Q_i is an interaction of IMP_CH and the quartiles of Output Value (VP). Firm Controls include LnTFP, logarithm of Total Factor Productive, lnPO, logarithm of Number of employees, and X a dummy for exportation, equal 1 if firm exports. Numbers in the parenthesis are robust standard errors. Intercepts are not reported. *,**,*** denotes 10%, 5% and 1% level of significance.

As part of the robustness checks of the results Table 8A, in the Appendix, shows the coefficients of *firmcontrols* in a previous period, *t-1*. The results remain qualitatively the same.

As mentioned in previous subsection, there are potential sources of endogeneity that may bias the coefficients resulting from OLS estimation. As argue by Oliveira (2016), using exposure to China in countries similar to Brazil as instruments is to reflect the general trend in trade levels due to increase in Chinese supply. At the same time, these instruments require that the share of Chinese imports from a defined group of countries (for Oliveira, Middle-income countries) not be related to Brazilian firms. Table 9 presents the results for equation (5) using Latin American imports from China as an instrument, trying to avoid the fact that unobservable shocks would make the effect of Chinese competition on product variety of Brazilian firms endogenous. The choice of this "region" as an instrument is based on data presented on Table 1, where imports from Latin America showed a behavior very similar to Brazilian imports from China and appear to be exogenous from the perspective of Brazilian firms[25].

[25] The results for middle-income countries are also available are in Table 9A, at Appendix.

Table 9: Effect of Chinese Import Competition on Product Variety of Brazilian Firms, Instrumental Variable (IV) by Share of Latin American imports from China, and firms heterogeneity (Production Value), 2005-2009

Dependent variable: ln(NP)						
	(1)	(2)	(3)	(4)	(5)	(6)
IMP_CH_t	-0.0423	-0.0351	-0.0351			
	(-1.67)	(-1.32)	(-1.34)			
IMP_CH_{jt}*Q1				-0.2030***	-0.1931**	-0.1935***
				(-6.01)	(-5.60)	(-5.64)
IMP_CH_{it}*Q2				-0.1498***	-0.1398***	-0.1397***
				(-5.07)	(-4.59)	(-4.62)
IMP_CH_{jt}*Q3				-0.0161	-0.0057	-0.0052
				(-0.58)	(-0.20)	(-0.47)
IMP_CH_{it}*Q4				0.1041***	0.1165***	0.1167***
				(3.37)	(3.63)	(3.66)
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes
Number OBS	34,349	34,349	34,349	34,349	34,349	34,349
IndustryFE	Yes	Yes	Yes	Yes	Yes	Yes
YearFE	Yes	Yes	Yes	Yes	Yes	Yes
*IndustryFE*time trend*	No	Yes	No	No	Yes	No
*IndustryFE*YearFE*	No	No	Yes	No	No	Yes

Notes: The dependent variable in columns (1) - (6) is the natural logarithm of number of products manufactured by a firm in each year plus 1. Just MP firms. IMP_CH is the Chinese Import Share of total imports by Brazil at industrial level (three digit CNAE); IMP_CH*Q is an interaction of IMP_CH and the quartiles of Production Value (VP). Firm Controls include LnTFP, logarithm of TFP, lnPO, logarithm of Number of employees, and X a dummy for exportation, equal 1 if firm exports. Instrumental variable is Latin American imports share from China. Numbers in the parenthesis are robust standard errors. Intercepts are not reported. *,**,*** denotes 10%, 5% and 1% level of significance.

The results from IV estimation confirm the initial findings in Table 8. Small firms reduce their product scope as a result of Chinese import competition and the large firms, belonging to the fourth quartile, increase the number of products. Once again, no significant effect of Chinese imports on the product scope of Brazilian firms at the aggregate level was observed. However, when dividing firms by size distribution, the evidence is robust and significant of product drop or 'creative destruction' by small firms or for firms belonging to the 1th and 2th quartiles. The effect of Chinese competition is greater for firms belonging to the first quartile. A positive effect was found on large firms and this result was not found in previous investigations for other countries, such as India, for example.

After the results mentioned above, the investigation aims to find the reason(s) behind the benchmark outcome: product drop in case of small Brazilian firms because of Chinese import competition and product add in case of the large ones. The strategy to be used is to divide Chinese imports by use category: final or intermediate goods[26]. Using the definitions in equation (3) and (4), and rewriting the equation (5), equation (6) follows:

[26] Clearly it will be better if data of imports were available by firms. But this is not a reality for the Industrial Research of IBGE

$$\ln(NP)_{ijt} = \beta_1*(firmscontrols)_{it} + \beta_2*(IMP\_CH_{jt}^{Final}) + \beta 3 * (IMP\_CH_{jt}^{Intermediate}) + \eta_t + \mu_j + \theta_{jt} + \xi_{ijt} \quad (6)$$

The results for estimation of equation (6) are in Table 10[27].

Table 10: Effect of Chinese Import Competition on Product Variety of Brazilian Firms, use category and heterogeneous firms (by VP), 2005-2009

Dependent variable: ln(NP)						
	1	2	3	4	5	6
$IMP\_CH_{jt}^{Final}$	-0.0080	-0.0092	-0.0083			
	(-0.22)	(-0.26)	(-0.23)			
$IMP\_CH_{it}^{Intermediate}$	-0.0115	0.0005	-0.0045			
	(-0.55)	(-0.02)	(-0.21)			
$IMP\_CH_{jt}^{Final}$ *Q1				-0.0611	-0.0643	-0.0641
				(-1.35)	(-1.43)	(-1.42)
$IMP\_CH_{jt}^{Final}$ *Q2				-0.0459	-0.0480	-0.0475
				(-1.01)	(-1.06)	(-1.05)
$IMP\_CH_{it}^{Final}$ *Q3				0.0193	0.0181	0.0192
				(0.46)	(0.43)	(0.46)
$IMP\_CH_{it}^{Final}$ *Q4				0.0254	0.0254	0.0271
				(0.64)	(0.64)	(0.68)
$IMP\_CH_{jt}^{Intermediate}$ *Q1				-0.1860***	-0.1735***	-0.1776***
				(-4.88)	(-4.45)	(-4.61)
$IMP\_CH_{it}^{Intermediate}$ *Q2				-0.0978***	-0.0866***	-0.0899***
				(-3.81)	(-3.32)	(-3.49)
$IMP\_CH_{jt}^{Intermediate}$ *Q3				-0.0037	-0.0074	0.0047
				(-0.13)	(0.25)	(0.16)
$IMP\_CH_{it}^{Intermediate}$ *Q4				0.1391**	0.1545***	0.1499***
				(3.70)	(4.03)	(3.94)
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes
Number OBS	34,349	34,349	34,349	34,349	34,349	34,349
IndustryFE	Yes	Yes	Yes	Yes	Yes	Yes
YearFE	Yes	Yes	Yes	Yes	Yes	Yes
*IndustryFE*time trend*	No	Yes	No	No	Yes	No
*IndustryFE*YearFE*	No	No	Yes	No	No	Yes

Notes: The dependent variable in columns (1) - (6) is the natural logarithm of number of products manufactured by a firm in each year plus 1. Just MP firms. IMP_CH is the Chinese Import Share of total imports by Brazil at industrial level (Three digit CNAE) divide into two use category, final goods ($IMP\_CH_{jt}^{Final}$) and intermediate goods ($IMP\_CH_{jt}^{Intermediate}$); IMP_CH*Q is an interaction of IMP_CH´s (final and intermediate) and the quartiles of Output Value (VP). Firm Controls include LnTPF, logarithm of TPF, lnPO, logarithm of Number of employees, and X a dummy for exportation, equal 1 if firm exports. Numbers in the parenthesis are robust standard errors. Intercepts are not reported. *,**,*** denotes 10%, 5% and 1% level of significance.

The results continue to show that there are no effects of Chinese import competition on the scope of Brazilian manufacturing firms, at the aggregate level: neither the coefficient of $IMP\_CH_{jt}^{Final}$ nor the coefficient of $IMP\_CH_{jt}^{Intermediate}$ was significant (column (1) - (3)). However, in columns (4) - (6), it is possible to observe evidence that competition from Chinese imports has negatively affected the productive scope of small firms (first and second quartiles), through imports of intermediate goods from China. No effect was observed for imports of final goods. The effect in large firms, belonging to the fourth quartile, is positive and significant but only for imports of intermediate goods. In other words, the entry of Chinese capital goods and inputs had a positive impact on the productive scope of large Brazilian firms, allowing them to add new products to their production mix. This result is

[27] Table 10A on appendix shows the results for *firmcontrols* in *(t-1)*.

reasonable given the impact of China on international trade, a fall in trade costs and price reductions[28]. Again, to deal with endogenous issues, IV results are shown in Table 11.

Table 11: Effect of Chinese Import Competition on Product Variety of Brazilian Firms, IV estimation (Latin American), 2005-2009

Dependent variable: ln(NP)						
	1	2	3	4	5	6
$IMP\_CH_{jt}^{Final}$	-0.0949*	-0.0891*	-0.0794			
	(-1.85)	(-1.65)	(-1.51)			
$IMP\_CH_{jt}^{Intermediate}$	-0.0154	0.0030	-0.0097			
	(-0.49)	(0.08)	(-0.18)			
$IMP\_CH_{jt}^{Final}$ *Q1				-0.1754***	-0.1555***	-0.1453***
				(-3.07)	(-2.59)	(-2.48)
$IMP\_CH_{jt}^{Final}$ *Q2				-0.1569***	-0.1354**	-0.1244**
				(-2.86)	(-2.36)	(-2.23)
$IMP\_CH_{jt}^{Final}$ *Q3				-0.0824	-0.0578	-0.0446
				(-1.49)	(-1.00)	(-0.79)
$IMP\_CH_{jt}^{Final}$ *Q4				-0.1089*	-0.0841	-0.0694
				(-1.81)	(-1.36)	(-1.13)
$IMP\_CH_{jt}^{Intermediate}$ *Q1				-0.3247***	-0.3089***	-0.3319***
				(-5.91)	(-5.13)	(-4.78)
$IMP\_CH_{jt}^{Intermediate}$ *Q2				-0.1926***	-0.1743***	-0.2012***
				(-4.78)	(-3.85)	(-3.38)
$IMP\_CH_{jt}^{Intermediate}$ *Q3				0.0003	0.0266	0.0000
				(0.01)	(0.65)	(0.00)
$IMP\_CH_{jt}^{Intermediate}$ *Q4				0.2801***	0.3233***	0.2986***
				(6.70)	(6.64)	(5.06)
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes
Number OBS	34,349	34,349	34,349	34,349	34,349	34,349
IndustryFE	Yes	Yes	Yes	Yes	Yes	Yes
YearFE	Yes	Yes	Yes	Yes	Yes	Yes
*IndustryFE*time trend*	No	Yes	No	No	Yes	No
*IndustryFE*YearFE*	No	No	Yes	No	No	Yes

Notes: The dependent variable in columns (1) - (6) is the natural logarithm of number of products manufactured by a firm in each year plus 1. Just MP firms. IMP_CH is the Chinese Import Share of total imports by Brazil at industrial level (Three digit CNAE) divide into two use category, final goods ($IMP\_CH_{jt}^{Final}$) and intermediate goods ($IMP\_CH_{jt}^{Intermediate}$); IMP_CH*Q is an interaction of IMP_CH´s (final and intermediate) and the quartiles of Production Value (VP). Firm Controls include LnTPF, logarithm of TPF, lnPO, logarithm of Number of employees, and X a dummy for exportation, equal 1 if firm exports. Instrumental variable is Latin American imports share from China. Numbers in the parenthesis are robust standard errors. Intercepts are not reported. *,**,*** denotes 10%, 5% and 1% level of significance.

The results from IV estimation confirm the findings in Table 10 and add some new features. First of all, for aggregate level, the coefficients from Chinese import competition of final goods are negative and significant for the first time for final goods in two specifications (column (1) and (2)). Second, the IV results present two findings: (i) small firms (firms belonging to the 1st and 2nd Quartiles) drop their product as a result of the increase of Chinese import competition both for final and intermediate goods, with greater effect by intermediaries goods; (ii) firms belonging to the fourth quartile were positively impacted by Chinese imports, basically by intermediate goods. In short the effects of the Chinese share of imports were observed on product scope of the Brazilian firms in the aggregate level and by quartiles. The results emphasize the importance of the heterogeneity of impacts.

[28] Table 10A shows the results for independent variables in *t-1*.

The results presented in this section were based on quartile regressions (both OLS and IV) and clearly show consistent evidence that it is the firms from the lower-half of the size distribution that drop their peripheral products in response to Chinese competition, total imports or final/intermediate. This partial result is similar to Chakraborty and Henry (2019) for Indian firms. On the other hand, it was expected that Chinese competition could help firms in access a cheaper and diverse set of intermediate inputs, but the results were verified only for large firms, which increase the productive scope through greater access to imported Chinese intermediates goods. This result for Brazil was different from results from India and Mexico, where Chinese import competition affects only small firms. In Brazil, it was found positive effects of the Chinese import competition on the product variety of large firms, in particular, for the intermediate goods.

5.3 Core Competency and "creative destruction"

This subsection investigates the reason(s) behind the previous outcomes: product drop in case of small Brazilian firms because of Chinese import competition and product add by large firms. Before starting to analyze the core competency, it is useful to define a product as a core product of a firm, for which the average sales is maximum: it takes the value 1, while the others are 0. The interaction of the core product dummy with the measure of Chinese import competition will also be analyzed.

To find the maximum average share in total Output Value over time, it was used the share of each product in each firm to calculate the variable that will be used, defined as:

$$\text{Core=Max (shareVP}_{ijt}\text{)=Max(}\ VP_{ijt}/(\sum VP_{jt})) \qquad (7)$$

Where *VP* is the Output Value (by PIA Product) of product *i* by firm *j* at time *t*. The share of a product in total *VP* of all products of firm *j* is already used as a measure of core competence: the higher is the VP share of a product, the closer the product is to a firms's core competence. The estimated equation is:

$$\ln(\text{NP})_{ijt} = \beta_0(\text{core})_{ijt} + \beta_1*(firmscontrols)_{it} + \beta_2*(IMP\_CH_{jt} * core_{ijt}) + \eta_t + \mu_j + \theta_{jt} + \omega_i + \xi_{ijt} \qquad (8)$$

Where all variable are the same as defined above and ω_i is the product fixed effect used to control for the unobservable product characteristics in all of the regressions. The results are in Table 12.

In Columns (1)-(2) the objective is to verify whether Brazilian firms are focusing on their core product(s), at the expense of the peripheral products, because of import competition from China. The coefficient of the interaction term is not statistically significant at column (1), and shows no effect in case of Chinese competition. Column (2) does the same estimation with same criteria dividing the firms by size (based on their VP, as done previously). The interaction with fourth quartile coefficient is positive and significant which means that Chinese import competition induces large firms to expand their productive scope by expanding the core (main) products. Import competition was expected to induce small firms to focus on their core products by dropping their peripheral products, which would mean negative and significant coefficients for IMP_CH*core and its interaction with Q_1 and Q_2. But these results have not been found.

Table 12: Effect of Chinese Import Competition on Product Variety of Brazilian Firms, Core Competency, Product Composition, 2005-2009

Dependent variable:	**ln(NP)**		**Δ shareVP (core)**	
	1	2	3	4
Core	-0.1035***	-0.1034***	0.6971***	0.6972***
	(5.59)	(-23.57)	(98.49)	(98.50)
IMP_CH*core	-0.0010		-0.0293	
	(-0.07)		(-1.21)	
IMP_CH*Q1*core		-0.0258		-0.0157
		(-1.35)		(-0.38)
IMP_CH*Q2*core		-0.0258		0.0011
		(-1.52)		(0.03)
IMP_CH*Q3*core		0.0131		-0.0362
		(0.71)		(-1.17)
IMP_CH*Q4*core		0.0536**		-0.0778***
		(2.05)		(3.34)
Firm Controls	Yes	Yes	Yes	Yes
Number OBS	184,934	184,934	105,977	105,977
IndustryFE	Yes	Yes	Yes	Yes
ProductFE	Yes	Yes	Yes	Yes
YearFE	Yes	Yes	Yes	Yes
IndustryFE*time trend	Yes	Yes	Yes	Yes

Notes: The dependent variable in columns (1) and (2), (3) and (4), is the natural logarithm of number of products manufactured by a firm in in each plus 1 and change in the sales share of a firm per product. IMP_CH is the Chinese Import Share of total imports by Brazil at industrial level (Three digit CNAE); IMP_CH*Q is an interaction of IMP_CH´s and the quartiles of Output Value (VP). Firm Controls include LnTPF, logarithm of TPF, lnPO, logarithm of Number of employees, and X a dummy for exportation, equal 1 if firm exports. Core is defined as the core product of a firm. It takes a value 1 for that product , for which average VP i maximum. Numbers in the parenthesis are robust standard errors. Intercepts are not reported. *,**,*** denotes 10%, 5% and 1% level of significance.

Next step forward is to make the same estimation, but now using the change in the sales share of core product in total sales (of all products) of a firm as the dependent variable. This idea of Chakraborty and Henry (2019) is based on Bernard et al. (2006, 2011) and Dhingra (2013) and aims to investigate the fact that import competition leads not only to dropping of marginally viable products but also to a shift in the distribution of firm output towards high-profitable products and could also induces firms to lower product innovation through within-brand cannibalization. Columns (3)-(4) show the results of impact Chinese import competition on changes in sales share of firm *j* for core product i at time *t*. The right-hand side variables remain the same. Column (3) does not show a significant relationship

between the interaction of the Chinese import competition measure with the core product dummy, and the change in sales share for the core product. At column (4), once heterogeneity of firm size is considerate, the coefficients show the existence of a negative and significant relationship between the interaction of the import competition index and the core product dummy, for the fourth quartile, and the change in sales share for a core product. This finding indicates that increases in import competition from China result in a decrease in the sales share for the core products of the firms belonging to fourth quartile. Overall, the results suggest that higher levels of import competition from China tend to induce large multi-product firms to focus on the production of their core products (for India it was what happened, as estimated by Chakraborty and Henry (2019)). For Brazil, the results found were in the opposite direction. The decrease in sales share for a core product of a firm due to Chinese competitive pressure is to the tune of 7.7%. One possible explanation is the positive impact of Chinese imports of intermediate goods. The use of cheaper intermediate goods could be one possible explanation for this significant and positive effect on large firms, since they could expand their productive scope, with lower costs.

Conclusions

The substantial rise of China as one of Brazil´s largest trading partners, becoming the main partner after 2009, motivated this investigation into the impact of increased Chinese competitive pressure on product variety of Brazilian manufacturing firms. The use of detailed product-firm-level data, PIA-Product and PIA Enterprise, both from IBGE, and an international database, BACI, as a source of import-export by product-country, made this research possible. The period analyzed was from 2005 to 2009.

Using OLS and instrumental variables approach, the results are consistent and there is robust evidence that Chinese competition changes the productive scope of Brazilian manufacturing firms. Small firms clearly exhibit significant evidence of *creative destruction* as a result of import competition from China: the coefficients say that a 10 percentage point increase in Chinese share of imports by Brazil reduces the product scope of manufacturing firms by about 8.8%, on average. The smallest firms of Brazilian manufacturing drop their products during 2005-2009.

On the other hand, large firms have expanded their product-mix by 11.3%, on average. A positive effect was found on large firms and this result was not found on previous investigations for other countries, such as India, for example. There was also no significant effect of Chinese imports on product scope of the Brazilian firms at aggregate level, in almost all specifications. Divide firms into a size distribution was very important to clearly observe the results of the impact of Chinese imports on

Brazilian manufacturing. The results show that not all firms drop products in response to an increase of import competition from China, instead heterogeneous responses were verified across firms.

After these results, the investigation considered two categories of imports: final goods and intermediate goods. The results for aggregate level confirm that the coefficients of Chinese import competition are not significant, not for final goods or intermediate goods, and again the importance of heterogeneity of firms is marked. Similar to the results of aggregate imports, small firms (firms belonging to the 1st and 2nd Quartiles) drop their product as a result of increased competition from Chinese imports, both of final and intermediate goods. And for firms belonging to the fourth quartile, the impact of Chinese imports of intermediate goods was positive and significant.

Once again the results presented show consistent evidence that it is the firms from the lower-half of the size distribution that drop products in response to Chinese competition, total imports or final/intermediate. Chinese competition was expected to help firms access a cheaper and diverse set of intermediate inputs, but significant results have been seen only for large firms, which increase the productive scope through greater access to imported Chinese intermediates goods. The results are consistent across some robustness checks and IV analysis, where the control for homogeneity of the import competition index occurred with the use of Latin America imports from China, as an instrument.

An expected result is that firms drop their peripheral/marginal products and concentrate on the core ones. During this period in Brazilian manufacturing, import competition from China did not induce small firms to focus on their core products by dropping peripherical products. The significant result about core competence is that increases in import competition from China result in a decrease in the share of sales for the core products of the firms belonging to fourth quartile. One possible explanation is the positive impact of Chinese imports of intermediate goods for these firms. The use of cheaper intermediate goods could expand its productive scope, with lower costs.

One implication of these findings is that future work should focus on detailing the positive relationship between the variation in the productive scope detected for large firms and the impact of Chinese imports, in addition to the use of a longer database. China as a huge global player is a reality and the efficient use of productive factors, through access of imported goods (the same analysis could be done for others countries) is necessary to increase manufacturing productivity in Brazil. Some considerations, as mentioned by Jenkins (2014), about the increase in competition from China in manufactured goods and possible negative effects should be analyzed beyond the questions of market-share. The results of the analysis based on heterogeneous firms should be relevant for policy makers and firms in Brazil since the impact on smaller firms was detected and some advantage seems to be

used only by large firms. Despite these considerations, precaution must also be taken before any kind of domestic political and/or public resistance to isolate the domestic market from international competition. The relocation process is the key to productivity growth and policy makers should aim to accommodate it.

References

ÁLVAREZ, R.; CLARO, S. David Versus Goliath: The Impact of Chinese Competition on Developing Countries. **World Development**, v. 37, n. 3, p. 560–571, mar. 2009.

ALVES, J. D. ; **FERREIRA, M. S.** . Impacto do Crescimento do Comércio Internacional na Indústria Brasileira: Competição Desigual ou Reestruturação? In: 35º Encontro Brasileiro de Econometria, 2013, Foz do Iguaçu. Anais do 35º Encontro Brasileiro de Econometria, 2013.

Alves, J. D., Ferreira, M. S. (2018). Multiproduct firms, firm dynamics, and the productive mix of brazilian manufacturing firms. *Estudos Economicos*, *48*(3). https://doi.org/10.1590/0101-41614831jam

AMITI, Mary; KONINGS, Jozef. Trade liberalization, intermediate inputs, and productivity: evidence from Indonesia. **American Economic Review**, v. 97, n. 5, p. 1611–1638, 2007.

ARKOLAKIS, Costas, MUENDLER, Marc-Andreas. The extensive margin of exporting products : a firm-level analysis. **NBER Working paper series**. Cambridge, n. 16.641, p.1-52, 2010.

Autor, D., Dorn, D., Hanson, G.. The China syndrome: Local labor market effects of import competition in the United States. American Economic Review 2013, 103(6): 2121–2168.

AW, Bee Yan; CHUNG, Sukkyun; ROBERTS, Mark J. Productivity and turnover in the export market: micro evidence from Taiwan and South Korea. **World Bank Economic Review**, v. 14, n. 1, p. 65–90, 2000.

BARTELSMAN, Eric. J.; DOMS, Mark. Understanding Productivity : Lessons from Longitudinal Microdata. **Journal of Economic Literature**, v. 38, n. 3, p. 569–594, 2000.

Barua, S. (2016). *Essays on Trade, Multi-product Plants, Manufacturing Performance and Labor Market*. http://wrap.warwick.ac.uk/80029.

Bellone, F., Selin Hazir, C., & Matsuura, T. (2019). Import Competition and Product Churning: Evidence from Japanese Plant-product-level. In *RIETI Discussion Paper Series*. https://www.rieti.go.jp/en/

Bernard, A. B., Redding, S. J. and Schott, P. K., 2011. Multi-product Firms and Trade Liberalization. Quarterly Journal of Economics 126, 1271–1318.

BERNARD, Andrew B., JENSEN J. Bradford; REDDING, Stephen J.; SCHOTT, Peter. K. The Empirics of Firm Heterogeneneity and International Trade. Cambridge, **NBER Working Paper Series,** n. 17627, p. 1-38, 2011.

BERNARD, Andrew B.; EATON, Jonathan; JENSEN, J. Bradford; KORTUM, Samuel. Plants and Productivity in International Trade. **American Economic Review**, v. 93, n. 4, p. 1268–1290, set. 2003.

BERNARD, Andrew B.; JENSEN, J. Bradford; REDDING, Stephen J.; SCHOTT, Peter K. The Empirics of Firm Heterogeneity and International Trade. **Annual Review of Economics**, v. 4, p. 283-313, jul. 2012.

BERNARD, Andrew B.; JENSEN, J. Bradford; SCHOTT, Peter K. Survival of the Best Fit: Exposure to Low-Wage Countries and the (Uneven) Growth of U.S. Manufacturing Plants. **Journal of International Economics**, v.68, n. 1, p. 219-237, 2006.

BERNARD, Andrew. B.; REDDING, Stephen J.; SCHOTT, Peter K. Comparative advantage and heterogeneous firms. **Review of Economic Studies**, v. 74, n. 1, p. 31–66, 2007.

BERNARD, Andrew. B.; REDDING, Stephen J.;, SCHOTT, Peter K. Multiple-Product Firms and Product Switching. **American Economic Review**, v. 100, n. 1, p. 70–97, mar. 2010.

BERNARD, Andrew; EATON, J. JENSEN, J. e KORTUM, S. Plants and Productivity in International Trade. **American Economic Review**, v.93, n. 4, p.1268-1290, 2003.

Bloom, N., Draca, M. Van Reenen, J. Trade Induced Technical Change? The Impact of Chinese Imports on Innovation, IT and Productivity, *The Review of Economic Studies*, Volume 83, Issue 1, January 2016, Pages 87–117, https://doi.org/10.1093/restud/rdv039

BLYDE, Juan; IBERTI, Gonzalo. Trade Costs, Resource Reallocation and Productivity in Developing Countries. **Review of International Economics**, v. 20, n. 5, p. 909–923, nov. 2012.

BONELLI, Regis. Labor Productivity in Brazil during the 1990s. Rio de Janeiro: **IPEA, Texto para Discussão**, n. 906, p. 1-42, 2002.

BONELLI, Regis; PESSOA, Samuel A. Desindustrialização no Brasil: um resumo da evidência. IBRE: FGV, **Rio de Janeiro: Texto para discussão**, n.7, 2010.

CABRAL, Sonia; MANTEU, Cabral. Gains from import variety : the case of Portugal. **Banco de Portugal: Working Paper Series**, p.85-102, 2010.

Chakraborty, P., & Henry, M. (2019). Competition and Product Variety of Indian Firms. *Journal of Comparative Economics*, Volume 47, Issue 2, June 2019, pages 367-395.

De Loecker, J., 2011. Product Differentiation, Multi-Product Firms and Estimating the Impact of Trade Liberalization on Productivity. Econometrica 79, 1407-1451.

EATON, Jonathan.; KORTUM, Samuel. Technology, geography, and trade. **Econometrica**, v. 70, n. 5, p. 1741–1779, 2002.

FEENSTRA, Robert C. New Evidence on the Gains from Trade. **Review of World Economics**, v. 142, n. 4, p. 617–641, dez. 2006.

FEENSTRA, Robert. New Product Varieties and the Measurement of International Prices, **American Economic Review**, 84(1), 157–177, 1994.

FERREIRA, Pedro C.; ROSSI JR., José L. New evidence from Brazil on trade liberalization and productivity growth. **International Economic Review**, v. 44, n. 4, p. 1383–1406, 2003.

FERREIRA, Pedro Cavalcanti; ROSSI, José Luiz. New evidence from Brazil on trade liberalization and productivity growth**. International Economic Review**, v.44, n.4, p. 1343-1406, 2003.

Goldberg, P., Khandelwal, A., Pavcnik, N. and Topalova, P., 2011. Multiproduct Firms and Product Turnover in the Developing World: Evidence from India. Review of Economics and Statistics 92, 1042-1049.

GOLDBERG, Pinelopi K.; KHANDELWAL, Amit K.; PAVCNIK, Nina, TOPALOVA, Petia. Imported intermediate inputs and domestic product growth: evidence from India. **Quarterly Journal of Economics**, v. 125, n. 4, p. 1727–1767, 2010.

GOLDBERG, Pinelopi K.; KHANDELWAL, Amit. K.; TOPALOVA, Petia.; PAVCNIK, Nina. Trade liberalization and new imported inputs. **American Economic Review: Papers & Proceedings**, v. 99, n. 2, p. 494-500, 2009.

HAY, Donald. The post-1990 Brazilian trade liberalization and the performance of large manufacturing firms: productivity, market share and profits. **The Economic Journal**, v. 111, p. 620-641, 2001.

HELPMAN, Elhanan, MELITZ, Marc J., YEAPLE, Stephen R. Export Versus FDI with Heterogeneous Firms. **American Economic Review**, v. 94, n. 1, p. 300–316, 2004.

HELPMAN, Elhanan; MELITZ, Marc J.; RUBINSTEIN, Yona. Estimating trade flows: Trading partners and trading volumes. **Quartely Journal of Economics**, v. 123, n. 2, p. 441–487, 2008.

Holmes, T. and Schmitz, T., 2010. Competition and Productivity: A Review of Evidence. Annual Review of Econonomics 2, 619–42.

Hur, J., & Yoon, H. (2018). *Product Dynamics and Trade Liberalization: Evidence from the Korea-US FTA*. http://hias.ad.hit.ac.jp/HIASdiscussionpaperscanbedownloadedwithoutchargefrom:http://hdl.handle.net/10086/27202https://ideas.repec.org/s/hit/hiasdp.html

HUMMELS, David; KLENOW, Peter L. The variety and quality of a nation's exports. **American Economic Review,** v. 95, n. 3, p. 704–72, 2005.

INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA - IBGE. **Matriz de Insumo-Produto Brasil, Contas Nacionais**. Rio de Janeiro: IBGE, n. 23, 2008.

INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA - IBGE. **Pesquisa Industrial Anual (PIA) - Serie Relatórios metodológicos**. Rio de Janeiro: IBGE, n. 26, 2004.

INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA - IBGE. **Pesquisa Industrial Anual (PIA):** 2006. Rio de Janeiro: IBGE, v. 25, 2008.

INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA- IBGE. **Pesquisa Industrial Anual (PIA):** 1996. Rio de Janeiro: IBGE, v.15, 1998.

Jenkins, R., & De Freitas Barbosa, A. (2012). Fear for Manufacturing? China and the Future of Industry in Brazil and Latin America. *The China Quartely*. https://doi.org/10.1017/S0305741011001482

LILEEVA, Alla; TREFLER, Daniel. Improved Access to Foreign Markets Raises Plant-Level Productivity ... for Some Plants. **Quarterly Journal of Economics**, v. 125, n. 3, p. 1051–99, 2010.

LISBOA, Marcos B.; MENEZES FILHO, Naércio A.; SCHOR, Adriana. The Effects of Trade Liberalization on Productivity Growth in Brazil: Competition or Technology? **Revista Brasileira de Economia**, v. 64, n. 3, p. 277-289, 2011.

LIU, Runjuan. Import competition and firm refocusing. **Canadian Journal of Economics**, v. 43, n. 2, p. 440–466, 2010.
Bas, M., Paunov, C.. What gains and distributional implications result from trade liberaliza- tion?. 2019. halshs-02052739

MAYER, Thierry.; OTTAVIANO, Gianmarco. I. P. The Happy Few: The Internationalisation of European Firms. **Intereconomics**, v. 43, n. 3, p. 135–148, may. 2008.

MELITZ, Marc J. The impact of trade on intra-industry reallocations and aggregate industry productivity. **Econometrica,** v. 71, n. 6, p. 1695–1725, 2003.

MELITZ, Marc J.; TREFLER, Daniel. Gains from Trade when Firms Matter. **Journal of Economic Perspectives**, v. 26, n. 2, p. 91–118, 2012.

MENEZES-FILHO, Naércio A.; MUENDLER, Marc. **Labor** reallocation in response to trade reform**. NBER Working Paper Series**, n.17372, p.1-50, 2011.

MION, Giordano. ZHU, Linke**.** Import competition from and offshoring to China: A curse or blessing for firms? **Journal of International Economics**, v. 89, n.1, p. 202-2015, 2013.

MUENDLER, Marc A. Trade, Technology, and Productivity: A Study of Brazilian Manufactures: 1986-1998. **CESifo Working Paper,** n. 148, Mar. 2004.

Oliveira, S. B. de. (2018). *Firm dynamics in Brazil: trade shocks, resource misallocation and life cycle growth*. Thesis, PUC-Rio, 2018, 126 p.

PAVCNIK, Nina. Trade Liberalization, Exit, and Productivity Improvements: Evidence from Chilean Plants. **The Review of Economic Studies**, v. 69, n. 1, p. 245–269, 2002.

SCHOR, Adriana. Efeitos da redução tarifária da década de 1990 sobre a distribuição intrassetorial da produção e da produtividade na indústria brasileira. **Pesquisa e Planejamento Econômico**, v. 36, n. 1, p. 73–107, 2006.

SCHOR, Adriana. Heterogeneous productivity response to tariff reduction. Evidence from Brazilian manufacturing firms. **Journal of Development Economics**, v. 75, n. 2, p. 373–396, dez. 2004.

Shu, P., & Steinwender, C. (2018). *THE IMPACT OF TRADE LIBERALIZATION ON FIRM PRODUCTIVITY AND INNOVATION*. http://www.nber.org/papers/w24715

UTAR, H.; RUIZ, L. B. T. International competition and industrial evolution: Evidence from the impact of Chinese competition on Mexican maquiladoras. **Journal of Development Economics**, v. 105, p. 267–287, nov. 2013.

Verhoogen, E. Firm-Level Upgrading in Developing Countries. CDEP-CGEG WORKING PAPER SERIES, Columbia, March, 2020.

Appendix

Table A.1 – Variable used, description, and source

Variable	Description	Source
Number of Employees (EMP)	Employees in 12/31 in the reference year: people effectively employed in the company on the date hereof.	PIA Enterprise
Exportation (X)	Dummy variable derived from the target percentage of company sales. Equals 1 if the target percentage for Mercosur and other countries is greater than 0. Assumes value 0 otherwise.	PIA Enterprise
Total Factor Productivity (TFP)	TFP of each firm was estimated from 2005 to 2009 according to Olley and Pakes (1996) and Levinsohn and Petrin (2003). For more details, see the appendix and Alves and Ferreira (2013)	PIA Enterprise
Output Value (VP)	Output Value is the sum of Output Values per informant and product code. In the aggregate, the variable constructed for each product , follows the criteria: Output Value = average value of sales (sales value / quantity sold) x quantity produced.	Pia Product

Source: PIA-Enterprise and PIA-Product, IBGE. Author elaboration.

Table 8A: Effect of Chinese Import Competition on Product Variety of Brazilian Firms, 2005-2009

	Dependent variable: ln(NP+1)					
	1	2	3	4	5	6
IMP_CH_{jt}	-0.0364	-0.0301	-0.0311			
	(-1.51)	(-1.23)	(-1.27)			
IMP_CH_{jt}*Q1				-0.1582***	-0.1528***	-0.1539***
				(-4.69)	(-4.50)	(-4.54)
IMP_CH_{jt}*Q2				-0.1077***	-0.1017***	-0.1025***
				(-3.54)	(-3.31)	(-3.34)
IMP_CH_{jt}*Q3				-0.0207	-0.0139	-0.0147
				(-0.76)	(-0.51)	(-0.54)
IMP_CH_{jt}*Q4				0.0475	0.0569*	0.0556*
				(1.41)	(1.67)	(1.63)
Firm Controls$_{(t-1)}$	Yes	Yes	Yes	Yes	Yes	Yes
Number OBS	21,633	21,633	21,633	21,633	21,633	21,633
IndustryFE	Yes	Yes	Yes	Yes	Yes	Yes
YearFE	Yes	Yes	Yes	Yes	Yes	Yes
IndustryFE*time trend	No	Yes	No	No	Yes	No
IndustryFE*YearFE	No	No	Yes	No	No	Yes

Table 9A: Effect of Chinese Import Competition on Product Variety of Brazilian Firms, Instrumental Variable (middle-income countries), 2005-2009

Dependent variable: ln(NP+1)						
	1	2	3	4	5	6
IMP_CH	-0.0916***	-0.0823***	-0.0831***			
	(-2.79)	(-2.44)	(-2.46)			
IMP_CH*Q1				-0.2678***	-0.2552***	-0.2565***
				(-5.93)	(-5.59)	(-5.62)
IMP_CH*Q2				-0.1965***	-0.1842***	-0.1851***
				(-5.10)	(-4.70)	(-4.72)
IMP_CH*Q3				-0.0655*	-0.0532	-0.0541
				(-1.84)	(-1.46)	(-1.48)
IMP_CH*Q4				0.0346	0.0482	0.0469
				(0.88)	(1.20)	(1.17)
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes
Number OBS	21,633	21,633	21,633	21,633	21,633	21,633
IndustryFE	Yes	Yes	Yes	Yes	Yes	Yes
YearFE	Yes	Yes	Yes	Yes	Yes	Yes
*IndustryFE*time trend*	No	Yes	No	No	Yes	No
*IndustryFE*YearFE*	No	No	Yes	No	No	Yes

Table 10A: Effect of Chinese Import Competition on Product Variety of Brazilian Firms, Instrumental Variable, heterogeneity, 2005-2009

Dependent variable: ln(NP)						
	1	2	3	4	5	6
$IMP\_CH_{jt}^{Final}$	-0.0729	-0.0724	-0.0719			
	(-1.54)	(-1.53)	(-1.52)			
$IMP\_CH_{jt}^{Intermediate}$	-0.0227	-0.0135	-0.0152			
	(-0.86)	(-0.51)	(-0.57)			
$IMP\_CH_{jt}^{Final}$ *Q1				-0.1388**	-0.1412**	-0.1409**
				(-2.30)	(-2.34)	(-2.34)
$IMP\_CH_{jt}^{Final}$ *Q2				-0.1188*	-0.1199*	-0.1191*
				(-1.92)	(-1.94)	(-1.92)
$IMP\_CH_{jt}^{Final}$ *Q3				-0.0521	-0.0521	-0.0512
				(-0.97)	(-0.97)	(-0.96)
$IMP\_CH_{jt}^{Final}$ *Q4				-0.0362	-0.0334	-0.0332
				(-0.72)	(-0.66)	(-0.66)
$IMP\_CH_{jt}^{Intermediate}$ *Q1				-0.2008***	-0.1906***	-0.1925***
				(-3.70)	(-3.70)	(-3.74)
$IMP\_CH_{jt}^{Intermediate}$ *Q2				-0.1056***	-0.0966***	-0.0982***
				(-3.13)	(-2.86)	(-2.91)
$IMP\_CH_{jt}^{Intermediate}$ *Q3				-0.0099	0.0002	-0.0017
				(-0.31)	(-0.01)	(-0.05)
$IMP\_CH_{it}^{Intermediate}$ *Q4				0.1040**	0.1177**	0.1152**
				(2.25)	(2.51)	(2.46)
Firm Controls(t-1)	Yes	Yes	Yes	Yes	Yes	Yes
Number OBS	21,633	21,633	21,633	21,633	21,633	21,633
IndustryFE	Yes	Yes	Yes	Yes	Yes	Yes
YearFE	Yes	Yes	Yes	Yes	Yes	Yes
IndustryFE*time trend	No	Yes	No	No	Yes	No
IndustryFE*YearFE	No	No	Yes	No	No	Yes