IDB WORKING PAPER SERIES Nº IDB-WP-01141

Trade, Productivity, Innovation, and Employment: Lessons from the Impact of Chinese Competition on Manufacturing in Brazil

Mauricio Mesquita Moreira
Marisol Rodríguez Chatruc
Filipe Lage
Federico Merchán

Inter-American Development Bank
Integration and Trade Sector

August 2020

Inter-American Development Bank

Trade, Productivity, Innovation, and Employment: Lessons from the Impact of Chinese Competition on Manufacturing in Brazil

Mauricio Mesquita Moreira
Marisol Rodríguez Chatruc
Filipe Lage
Federico Merchán

Inter-American Development Bank
Integration and Trade Sector

August 2020

Cataloging-in-Publication data provided by the
Inter-American Development Bank
Felipe Herrera Library

Trade, productivity, innovation, and employment: lessons from the impact of Chinese competition on manufacturing in Brazil / Mauricio Mesquita Moreira, Marisol Rodríguez Chatruc, Filipe Lage, Federico Merchán.
p. cm. — (IDB Working Paper Series ; 1141)
Includes bibliographic references.
1. Imports-Brazil. 2. Manufacturing industries-Brazil. 3. Industrial productivity-Brazil. 4. Technological innovations-Brazil. 5. Labor market-Brazil. 6. Brazil-Commerce-China. 7. China-Commerce-Brazil. I. Mesquita Moreira, Mauricio. II. Rodríguez Chatruc, Marisol. III. Lage, Filipe. IV. Merchán, Federico. V. Inter-American Development Bank. Integration and Trade Sector. VI. Series.
IDB-WP-1141

JEL Codes: F14, F16, F61, O47
Keywords: import competition, productivity, innovation, employment.

http://www.iadb.org

Trade, Productivity, Innovation, and Employment: Lessons from the Impact of Chinese Competition on Manufacturing in Brazil*

Mauricio Mesquita Moreira, Marisol Rodríguez Chatruc, Filipe Lage and Federico Merchán**

Abstract

This paper uses the sudden surge in Chinese competition faced by Brazil's manufacturers in the 2000s to revisit the findings from the literature on how productivity, innovation, and employment were impacted by the Great Liberalization—a period of massive trade opening in the early 1990s in Latin America. Using manufacturing firm-level data and sectoral variation of Chinese competition, we focus on the most intense period of the shock—2000 to 2013—and on its procompetitive and employment effects. The results reinforce some of the key findings of the earlier literature, notably the positive, procompetitive effect of trade on total factor productivity (TFP). However, as in the 1990s, these gains do not seem to have been robust enough to prevent the country's TFP performance from being dismal. Likewise, they seem to be more consistent with level effects than growth effects. Inconclusive results on innovation also seem to point in this direction. The estimated effects on employment point to a relatively small negative shock, not unlike that of the early 1990s, that was centered on low-skilled labor and was consistent with the country's relative abundance of natural resources. Overall, the results seem to underline the limits of trade policy in boosting employment and long-term productivity growth. Policymakers should manage their expectations accordingly.

JEL Codes: F14, F16, F61, O47

Keywords: import competition, productivity, innovation, employment.

* Any opinions and conclusions expressed herein are those of the authors and do not necessarily represent the views of the IDB or its Board of Governors. We thank Nina Pavcnik, Lorenzo Caliendo, Emanuel Ornelas, Peter Schott, Juan Blyde, Christian Volpe, Ernesto Stein, and other participants in the first and second workshops of the IDB's Development in the Americas Report, which took place on July 25 and 26, 2018, and March 1 and 2, 2019, in Washington, DC. Cecilia Heuser has provided valuable inputs for earlier versions of this paper. We also thank IBGE for granting us access to manufacturing survey microdata.

** Mauricio Mesquita Moreira, Marisol Rodríguez Chatruc and Federico Merchan are economists at the Integration and Trade Sector of the IDB. Filipe Lage is an economist at the Banco Nacional de Desenvolvimento Econômico e Social (BNDES)

1. INTRODUCTION

Latin America's Great Liberalization of the early 1990s (Estevadeordal and Taylor, 2013) plays a prominent role in a prolific body of literature that relies on microdata to study the effects of trade on productivity, innovation, and employment. These studies, which focus mostly on manufacturing, generally find positive, statistically and economically significant impacts on the first two outcomes and relatively small, but geographically concentrated negative impacts on the third.[1]

There is significantly less evidence, though, on how these relationships evolved, particularly in the face of the significant technological and structural changes the global economy has undergone in the last two decades. This raises the question as to the extent to which these results were driven by specific contexts and, therefore, whether they can be seen as evidence of general, long-term relationships. One of the key structural changes—the emergence of China's lumpy economy (Schott, 2008), also known as "the China shock"—offers a natural experiment to help answer these questions.

In this paper, we look at how this experiment has played out in Brazil, a country that figures prominently in the Great Liberalization literature, and whose manufacturing sector—the second largest in the region, right behind Mexico's—was exposed to both the supply (import competition) and demand (commodity boom) side of the China shock.

We focus on the most intense period of the shock, 2000 to 2013, when China's share of world manufacturing exports rose from 7.6% to 19%, putting pressure on manufacturers everywhere, including Brazilian firms trying to sell at home and abroad.[2] In the same period, China's share of Brazilian manufacturing imports jumped from 3% to 21% and its participation in the country's domestic manufacturing market went from being negligible to nearly 6.6%.

The demand component of the shock also behaved explosively. Brazil's commodity exports to China grew by a factor of 20 during the period, driven by the latter's acute scarcity of natural resources. This took resources away from the manufacturing sector, raising factor prices and appreciating the real exchange rate by as much as 42%—not too far from a textbook case of Dutch disease (Corden, 1981).[3]

This shock has been the subject of a growing body of literature, which, following Autor et al.'s (2013) lead, mostly uses the shift-share approach (Bartik, 1992) and labor market data to assess the regional dimension of the impacts. For example, Costa et al. (2016) rely on the demographic census for their analysis and find that the areas most affected by Chinese competition experienced higher wage inequality and lower manufacturing wage growth, while those that benefited from the commodity boom saw wages growing faster.

Brummund and Connolly (2018) use labor market survey data (RAIS) to analyze the reallocation of formal workers in response to the China shock. They find that workers in areas that were more exposed to Chinese competition were more likely to transition from the manufacturing sector to nonemployment. Analogously, workers in areas that were less exposed to Chinese imports were more likely to transition from nonemployment to the formal sector, especially to nontraded sectors and manufacturing.

Paz (2019), in turn, looks at the sectoral dimension of the labor market shock, combining census and household survey data. He finds somewhat tentative results suggesting that higher import penetration decreases the total employment level and the share of informality in the manufacturing sector.

This paper focuses on the supply side of the shock. To our knowledge, it is the first to bring the firm dimension into the analysis and to look beyond labor market outcomes to capture productivity and innovation effects. It is part of a broader effort to revisit the trade and productivity nexus in Latin America, using firm-level data and the China shock as an identification strategy.[4]

[1] See, for example, Goldberg and Pavcnik (2016) and Shu and Steinwender (2018) for reviews.
[2] Since 2013, China's share has stabilized at around 20% of world manufacturing exports (WITS, with SITC REV 3 data).
[3] Brazil's Central Bank (BACEN). Consumer price deflator, year-on-year average.
[4] See, for instance, Blyde and Fentanes (2019) for Mexico; Pierola et al. (2019) for Peru; Molina (2019) for Colombia; Li and Mesquita Moreira (2019) for El Salvador.

Following the tradition of the Great Liberalization literature of the early 1990s, we use firm-level data from two manufacturing surveys, and we study the procompetitive effects of the trade shock (Feenstra, 2018). Our empirical strategy uses sectoral variation in Chinese import competition to identify the effect of the shock on firm-level outcomes such as innovation, productivity, and employment. We deal with the potential endogeneity of import penetration by using a similar measure for comparable countries as an instrument.

The results reinforce some of the key relationships identified in the Great Liberalization literature, notably the positive, procompetitive effect of trade on total factor productivity (TFP). Our estimates imply that a 1 percentage point (p.p.) increase in Chinese import penetration is associated with a 0.08% increase in TFP growth. Considering the overall change in import penetration during the period, this would explain—in a back-of-the-envelope calculation—half of TFP growth during the period, which totaled 1%. This is in the same order of magnitude of the effects found by Muendler (2004), Schor (2004), and López-Córdova and Mesquita Moreira (2004) for the early 1990s, but one-third of what Bloom et al. (2015) found for the China shock in Europe.

Unlike, Bloom et al. (2015), we do not find strong evidence that Chinese import competition was associated with product or process innovations, which raises questions about the long-term sustainability of the observed TFP gains and their impact on growth.[5]

The results on employment point to a sizable but far from catastrophic negative shock: a 1 p.p. increase in Chinese import penetration is associated with a 0.28% decrease in manufacturing employment growth, which in the context of the period means that manufacturing employment could have grown by an accumulated 9.3% instead of the observed 7.6%.

Although these results are considerably less robust than those on productivity, they seem consistent in direction and magnitude with those of the Great Liberalization (Menezes-Filho and Muendler, 2011; Dix-Carneiro and Kovak, 2017 and 2019), the recent evidence on the China shock in Latin America (Blyde et al., 2019; Paz, 2019; Pierola et al., 2019; Li, 2019; Molina, 2019), and the country's relative abundance of natural resources.

The paper is organized as follows. Section 2 frames and describes the China shock. Section 3 describes the data. Section 4 discusses the empirical strategy, followed by a discussion of our econometric estimates in section 5 and a robustness analysis in section 6. The last section concludes.

2. THE ANATOMY OF A SHOCK

The supply side of the shock can be described as a sudden increase in Chinese import competition driven by a decline in trade costs (China's accession to the WTO in 2001) and magnified by large differences in labor costs and productivity. But how significant was it? How did it compare with previous shocks? Which sectors were most affected?

Import penetration indices—defined as the share of imports in domestic demand and calculated based on both nominal and average real exchange rates—help to answer these questions. The use of the average real exchange rate aims to control for distortions created by purely nominal currency effects. For instance, an appreciation of the nominal exchange rate can lead to an immediate drop in the local currency value of imports and, therefore, to a lower import penetration index, even though there have been no real changes in either import volumes or domestic output.[6]

To compare the Great Liberalization and the China shock, Figure 1 shows import penetration indices for an extended period. Any comparison should be made with caution because changes in Brazil's manufacturing survey in the year 2000 led to a break in the time series.[7] The real Import Penetration Index (IPI), which nets out the large exchange rate appreciation after the year 2001, experienced a marked increase in the early 2000s, comparable to that of liberalization in the 1990s, although the latter started from a much smaller, nearly autarkic, base.

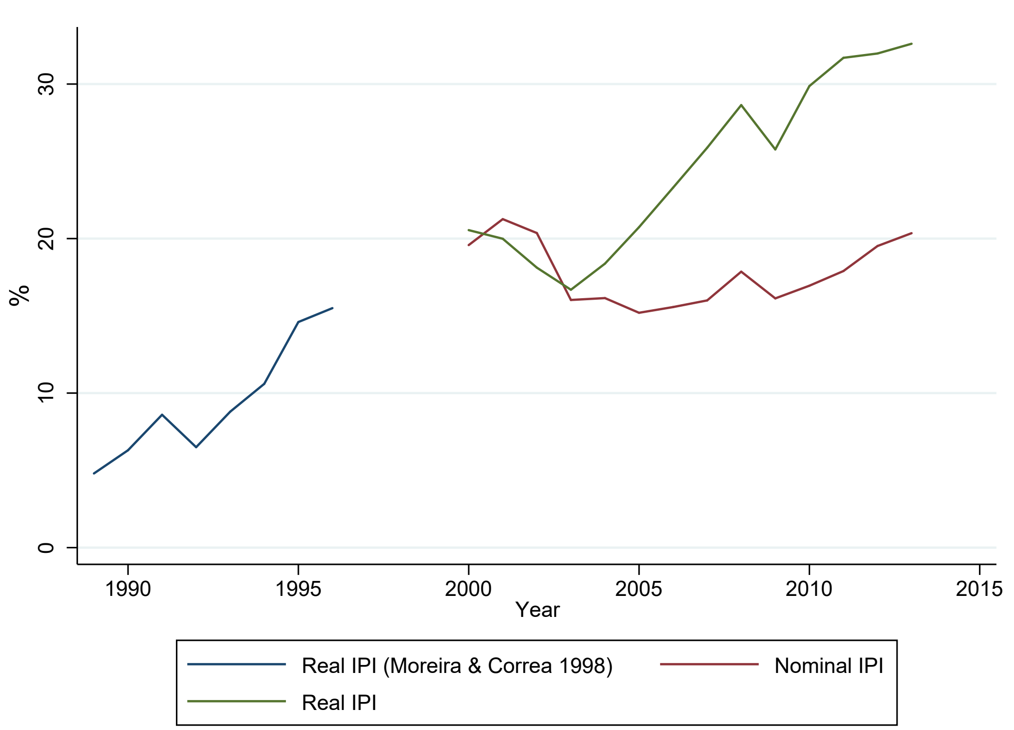
---

[5] Campbell and Mau (2020) have recently challenged the findings of Bloom et al. (2000) on patents, claiming that the paper has coding errors.

[6] See section 3 and the appendix for methodology.

[7] See https://www.ibge.gov.br/en/statistics/economic/industry-and-construction/16903-annual-survey-of-industry-product.html?=andt=o-que-e

FIGURE 1. IMPORT PENETRATION IN THE BRAZILIAN MANUFACTURING SECTOR (%), 1989–2013



Note: The IPI indices are equal to imports divided by apparent consumption (output minus exports plus imports). The 1989–1996 real IPI is taken from Moreira and Correa (1998), which uses SECEX trade data and the Brazilian Manufacturing Survey data (PIA-IBGE) for the early years (1989, 1990, 1992, and 1993) and the IBGE Monthly Industrial Survey for the remaining period (1994–1996). The post-2000 indices are based on SECEX and PIA-IBGE data. The real IPI uses the average real exchange rate in the period to convert import values to local currency.

Source: Moreira and Correa (1998) for the 1989–1996 data and own calculations for the rest of the period.

The similarities, however, stop there. The IPI responses played out in radically different macro and trade policy environments. During most of the liberalization period, inflation was sky-high (an annual average of 843%) and growth was low (1.5% on average), whereas during the China shock, inflation was mostly under control (6.6% on average) and average growth was significantly higher (3.2%). One of the few factors both shocks had in common was steep exchange rate appreciation.

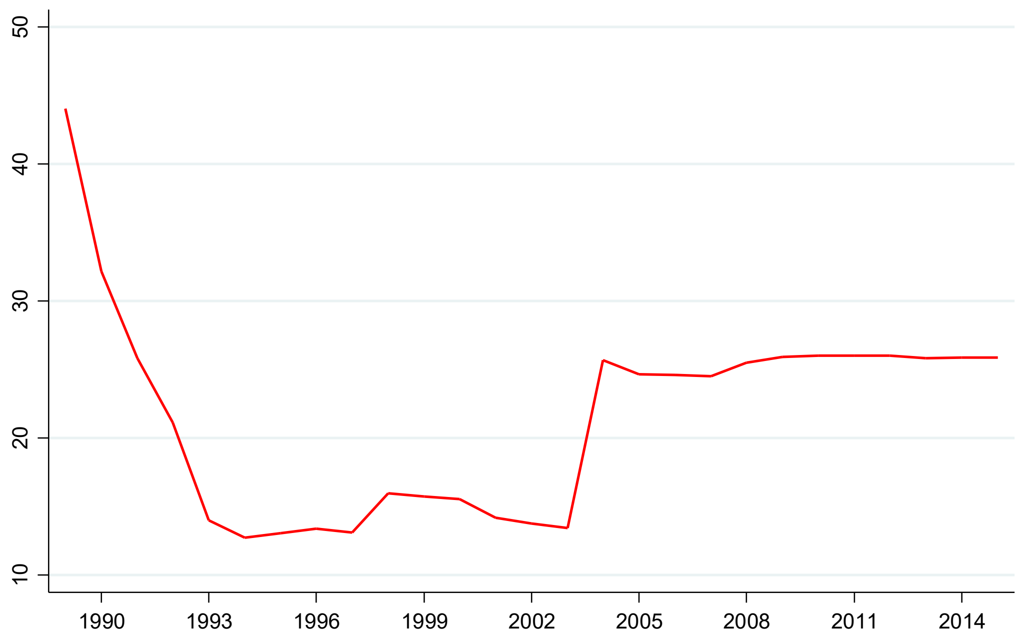
Trade policy also moved in different directions (Figure 2). During the first shock, nontariff barriers (NTBs) were phased out and tariffs dropped significantly in the first five years, following a preannounced schedule.[8] During the China shock, though, trade liberalization suffered a significant reversal in 2004, when the government extended a tax that was previously levied only on domestic sales to imports, which was widely attributed to the Chinese challenge. It also reintroduced several NTBs, including stricter local content requirements for government procurement and other discriminatory taxes for specific sectors, particularly vehicles.[9]

To shed light on the drivers of the IPI changes during the China shock, Figure 3 breaks this down into two groups: China and the rest of the world (ROW). As shown, the increase in China's real IPI is significantly higher than that of the ROW, explaining approximately half of the overall IPI increase, despite accounting for just 20% of the overall IPI at the end of the period. This suggests that the shock involved not only the displacement of local producers but also significant substitution of ROW exporters.

[8] See, for example, Mesquita Moreira and Correa (1998) for details of the 1990s trade liberalization.

[9] See Frischtak and Mesquita Moreira (2015) for details of trade policies during the China shock.

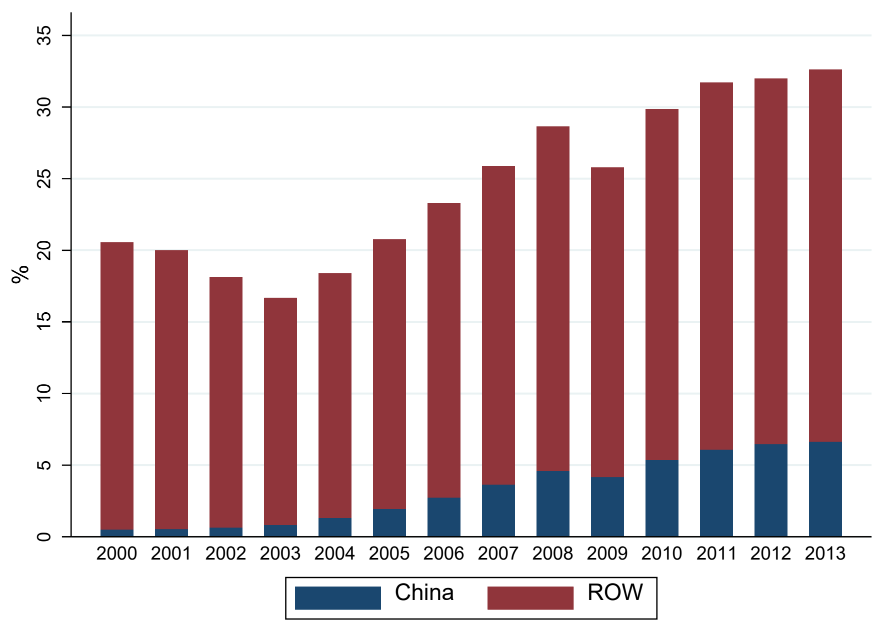
FIGURE 2. BRAZIL'S AVERAGE LEVEL OF PROTECTION



Note: The level of protection is measured by the MFN tariff (simple average) plus the PIS/COFINS sales taxes from 2004 onward. See text for details.

Source: Own calculation with WITS and Receita Federal data.

FIGURE 3. BRAZIL'S REAL IMPORT PENETRATION INDEX (%)—CHINA AND REST OF THE WORLD (ROW)

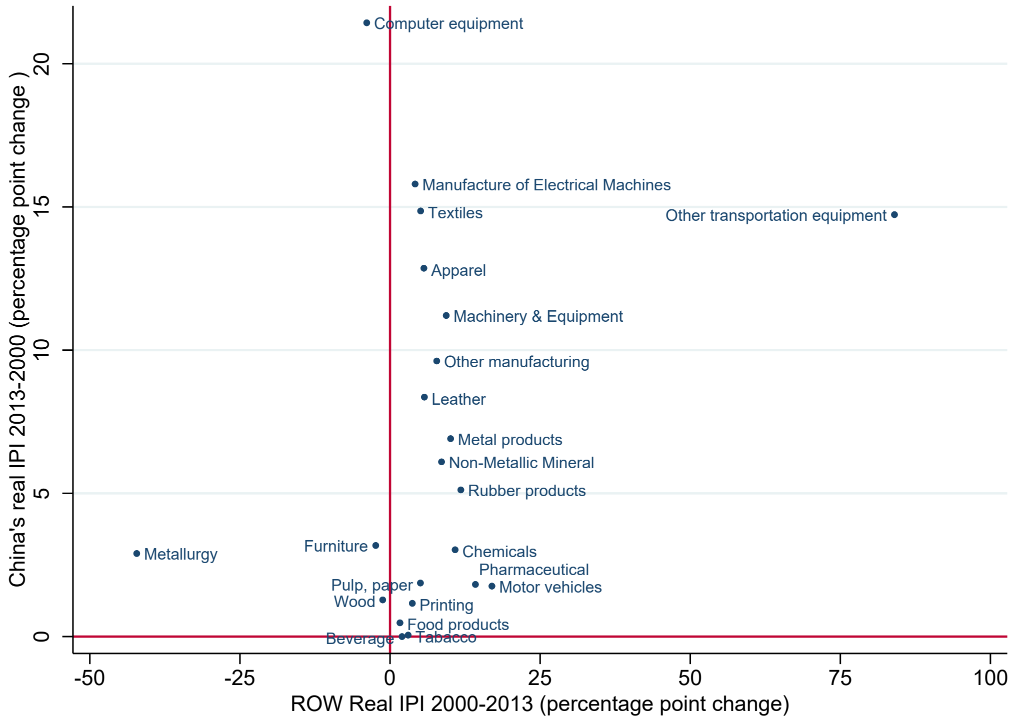


Source: Authors' calculation with data from IBGE/PIA and SECEX.

The shock had heterogeneous impacts across sectors, as Figure 4 shows. The sectors that were impacted the most were computers (+15.90 p.p.), textiles (+9.50 p.p.), and electrical machinery (+8.22 p.p.), reflecting China's diverse range of comparative advantages. Both the composition and magnitude of the changes diverge significantly from those of the ROW, where pharmaceuticals (+10.01 p.p.) and other modes of transportation (+37.15 p.p.) were the

most affected sectors. In some cases, such as computers and metallurgy, the effects went in different directions—a clear sign of substitution among foreign suppliers.

FIGURE 4. REAL IMPORT PENETRATION (IPI) CHANGES BY 2-DIGIT SECTOR. CHINA AND REST OF THE WORLD (ROW)



Source: PIA and SECEX, authors' calculations. The value for 2000 is the 2000–2001 average and the value for 2013 is the 2013–2012 average.

3. DATA

Our firm-level data comes from two sources: The deterministic stratum of the Annual Manufacturing Survey (*Pesquisa Industrial Anual*, PIA) and the Innovation Survey (*Pesquisa de Inovação,* PINTEC), both carried out by Brazil's statistics office, IBGE (*Instituto Brasileiro de Geografia e Estatistica*). PIA's deterministic stratum covers all formal manufacturing firms with 30 or more employees from 2000 to 2013, and their tax identifiers allow us to build a longitudinal database. On average, more than 30,000 firms are surveyed each year and the richness of the dataset allows us to construct the two main variables of interest: TFP and employment (total, white-, and blue-collar).

The PINTEC covers all firms with 500 or more employees and a random sample of firms with between 10 and 499 employees. It includes a range of innovation inputs and outcomes for five years: 2000, 2003, 2005, 2008, and 2011.[10] We focus on five variables of interest—patents, R&D workers, R&D expenditure, and product and process innovation—covering a sample of 20,903 firms.[11]

[10] PINTEC's stratified sampling strategy makes sure all firms defined as potentially innovative are included in the survey. These firms are defined by an indicator which reflects investments in machinery, R&D, and patents according to different government sources and surveys. See https://biblioteca.ibge.gov.br/visualizacao/livros/liv99007.pdf

[11] Using the firms' tax identifiers, we also merged the PINTEC and PIA databases to be able to control for some firm characteristics that change over time, such as size, factor intensity, and productivity. The sample drops to approximately 500 firms, however, drastically reducing the power of the estimations.

Patents is a binary variable that takes the value of 1 if a firm reported having registered a patent in the relevant period and 0 otherwise.[12] It is only available for 2000–200. *R&D workforce* is the number of employees directly involved in R&D activities.[13] *R&D expenditures* are personnel, software, equipment, and training expenses in constant 2000 prices.[14] *Product* and *process innovation* are binary variables that assume the value of 1 if a firm claimed to have innovated and 0 otherwise.[15] We use *TFP*, *employment*, and *capital–labor ratios* to control for variable firm characteristics.

Since we do not observe firms' prices, our measure of TFP is based on revenue, which, as is well known, is subject to biases driven by firm heterogeneity in prices (for inputs and outputs) and market power (mark-ups), even in narrowly defined sectors (Katayama et al., 2009; De Loecker, 2011; De Loecker et al., 2016). There seems to be no dispute, however, that the revenue and quantity-based measures of TFP are positively correlated.[16] TFP estimation is also known to entail problems of endogeneity and selection bias (Olley and Pakes, 1996), and we use several strategies to address these.[17] Employment outcomes are based on the number of high-skilled (white-collar) and low-skilled (shop-floor) workers.

To calculate import penetration measures, we use trade data from WITS and Brazil's Ministry of Trade (SECEX), at the 6-digit level of the Harmonized System. Since the firm and sectoral output data follow the 4-digits of International Standard Industrial Classification (version 4), we converted the trade data to this industrial classification using IBGE conversion tables and the methodology suggested by Pierce and Schott (2012). As mentioned earlier, to weed out the nominal currency effect, we converted the value of imports to local currency, using the real average exchange rate for the period.

Table 1 presents some descriptive statistics on manufacturing TFP growth during the period of the shock, as well as a decomposition of the main within-industry and between-industry components, following Foster, Haltiwanger, and Krizan (2001). Overall, productivity growth in the period is disappointing regardless of the methodology used.[18] The upper (GMM) bound points to meager annual growth of 0.08%.[19] The decomposition suggests that there are both Ricardian and Melitz (2003) elements behind this performance, but it is the former—the between-industry effect—that ensures growth in most methodologies. The positive, Melitz-type, within-industry contribution comes from a shift in market share from low- to high-productivity firms among those that remained in the market (signaled by positive covariance terms), but this effect was more than offset by negative within-firm, between-firm, and turnover (entry plus exit) effects.[20]

[12] Variables 163 to 164 in the PINTEC questionnaire.
[13] Variables 46 to 56 in the PINTEC questionnaire.
[14] Variables 31 to 37 in the PINTEC questionnaire.
[15] Variables 10 and 11 and 16 and 17, respectively, in the PINTEC questionnaire.
[16] Eslava et al. (2013), for instance, put this correlation at for 0.7 for Colombia, which allows us, at the very least, to say something about the direction of the China shock on productivity.
[17] To ensure the robustness of our results, we estimate TFP using four of the most frequently used of these methodologies: Olley and Pakes (1996), Levinshon and Petrin (2003), and GMM and Wooldridge (2009).
[18] As shown in the table below, there is a high coefficient of correlation between the TFP measures.

	OLS	GMM	Olley and Pakes
OLS	1		
GMM	0.7379	1	
Olley and Pakes	0.9275	0.8318	1

[19] See appendices AI and AII for a discussion of the TFP methodologies and decomposition.
[20] Using the Olley and Pakes (1996) methodology, for instance, the positive covariance term (8.4%) was more than offset by the within (-4.8%), between (-3.6%), and turnover (-2.3%) effects, leading to an overall within-industry contribution of -2.3%. When added to the between industry effect, overall TFP growth adds up to 0.9.

TABLE 1. MANUFACTURING TFP GROWTH: OVERALL, WITHIN-INDUSTRY, AND BETWEEN-INDUSTRY COMPONENTS (%)

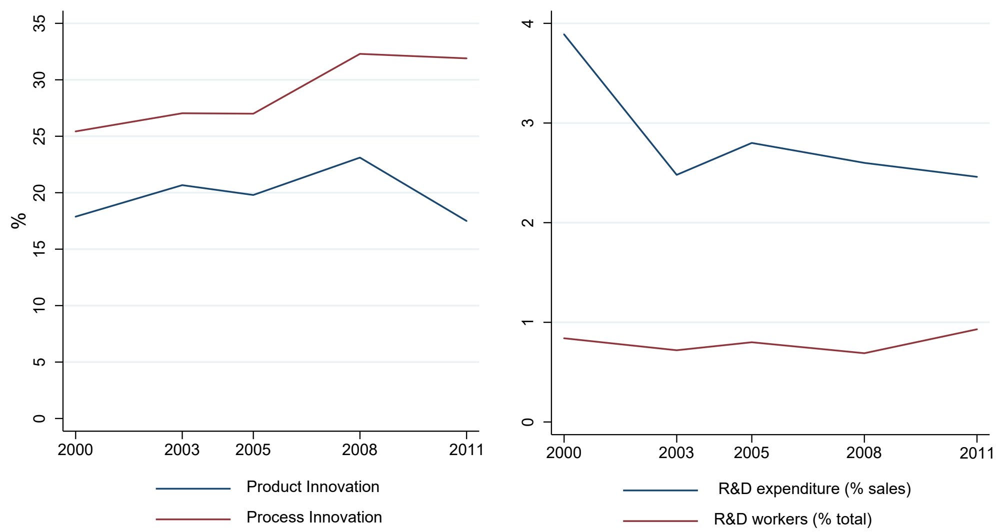
Methodology		Within industry					Between industry	Accumulated total
		Continuers			Turnover	Overall		
		Within firm	Between firm	Covariance				
Olley and Pakes	Abs	-4.8	-3.6	8.4	-2.3	-2.29	3.27	0.98
	Rel	-2.1	-1.6	3.7	-1			
GMM	Abs	-5.1	-4.7	10.3	-3.4	-2.94	4.1	1.16
	Rel	1.8	1.6	-3.5	1.1			
OLS	Abs	-0.73	-0.9	4	-2	-6.27	6.61	0.34
	Rel	1.2	0.1	-0.6	0.4			

Note: GMM stands for generalized methods of moments

Source: Own calculations.

The innovation indicators do not point to a strong performance either. As shown in Figure 5, the outcome indicators are mixed, with only process innovation showing a positive trend. On the input side, innovation expenditures followed a downward trend, whereas the share of workers engaged in innovation remained largely flat. Figure 6, in turn, shows that innovation during the period does not seem to have a clear relationship with Chinese import competition. The correlations with product and process innovation bear opposite signs (only the former is statistically significant), whereas in the case of inputs they are slightly negative (only that of R&D workers is statistically significant).

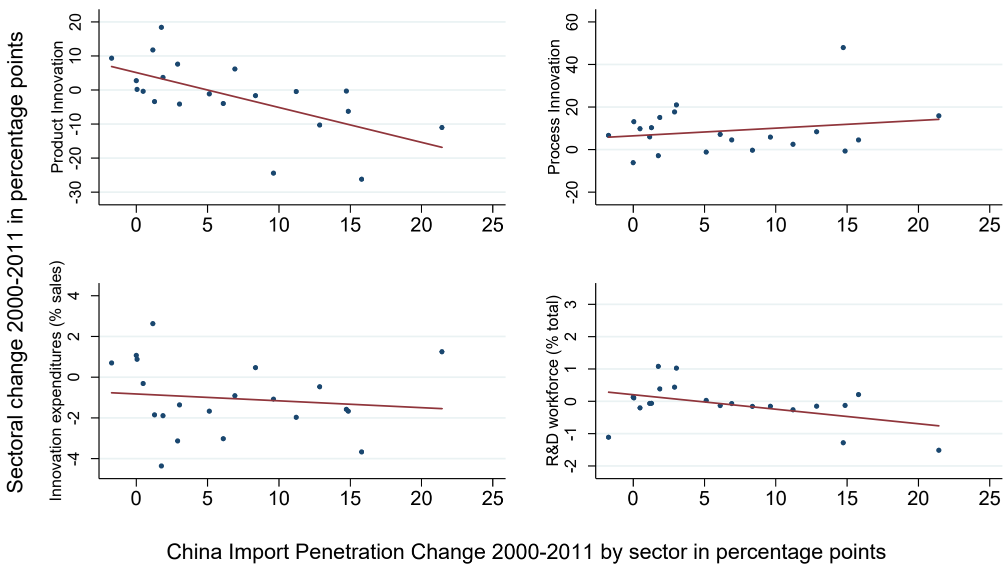
FIGURE 5. INNOVATION INDICATORS FOR MANUFACTURING FIRMS



Note: The graph on the left shows the percentage of manufacturing firms that implemented product or process innovations in the three years preceding the survey year. The graph on the right shows the firms' average share of innovation-related expenditures as a percentage of total sales and the share of the labor force working in innovation activities.

Source: Own calculations based on PINTEC data.

FIGURE 6. CHINESE IMPORT PENETRATION AND SECTORAL INNOVATION INDICATORS. BRAZIL, MANUFACTURING, 2000 AND 2011.



Note: Sectors are defined at the ISIC 2-digit level. Product and process innovation are the sectoral shares of firms engaged in these types of innovation. Innovation expenditure is the share of innovation-related expenditures in total sales. R&D workforce is the share of research and development workers in the sector's workforce. Linear regression coefficients are only statistically significant (5% level) for product innovation and the R&D workforce.

Source. Own calculations based on PINTEC data.

Table 2 shows that growth in employment was higher than in TFP but this was still no more than modest, reaching an annual rate of 0.61% (7.60% in the accumulated total).[21] However, this growth was twice as fast for high- as opposed to low-skilled workers, driven by firms at the higher end of the employment–size distribution. This raises the possibility of a shock that was biased against low-skilled workers, along Heckscher-Ohlin or skill-upgrading lines (Pavcnik, 2003).

TABLE 2. SUMMARY STATISTICS ON MANUFACTURING FIRM EMPLOYMENT

Period	**2000**	**2013**	**Growth***	
Variables	**P90 / P10****	**P90 / P10**	**Accumulated**	**Annual**
High-Skilled	30	54	12.8%	1.0%
Low-Skilled	10.4	10.5	6.1%	0.5%
Total	9.8	9.5	7.6%	0.6%

* Simple averages across firms with 30 or more employees. ** Ratio of the 90th versus the 10th percentile of the firm employment-size distribution.

Source: PIA, author's calculation.

[21] The number of firms in the manufacturing sector has risen over the period. While 20,710 firms provided information on their number of employees in 2000, 32,489 firms reported in 2013. This means that the increase in average firm size is not related to any reduction in the survey sample.

4. EMPIRICAL STRATEGY

Our empirical strategy relates changes in sectoral trade indicators to changes in firm outcomes. This, as shown elsewhere, can be linked to standard trade models with either Ricardian, Heckscher-Ohlin, or monopolistic competition foundations.[22]

Our baseline specification is close to that of Bloom et al. (2015), but we go one step further in trying to identify the procompetitive effects of the China shock. Aside from the standard variable designed to capture the effects of Chinese competition in the domestic market, we include two others to make sure, first, that the results are not being driven by competition from other countries with distinct comparative advantages, and; second, that we can differentiate between the domestic sales (competition at home) and export (competition abroad) channels of the procompetitive effect, which might have different policy implications.[23]

With those objectives in mind, we estimate a model in differences, with the following baseline specification:

$$\Delta \ln(Y_{i,j,t}) = c + \beta \Delta IPI_{jt}^{ch} + \ \delta_i + \delta_t \ \varepsilon_{it} \ \ (1)$$

where Y_{ijt} is our outcome of interest, either TFP (using the Olley and Pakes method), employment (total, skilled, and unskilled), or innovation (product innovation, process innovation, patent activity, innovation expenditures, and R&D workforce) for firm *i* in sector *j* (4-digit ISIC) at time *t*.[24] For employment and productivity outcomes, we use stacked three-year differences in the baseline specification and five-year differences for robustness. For innovation outcomes, we use the differences between survey rounds, which is equal to three years in most cases.

$ChinaIPI_{jt}$ is the real Chinese sector *j* IPI, built to capture the procompetitive effects of Chinese competition at home. It is defined as

$$IPI_{jt}^{ch} = \frac{M_{jt}^{ch}}{O_{jt} + M_{jt} - X_{jt}} \ \ (2)$$

where M_{jt}^{ch} measures Brazilian imports of sector *j* from China at time *t* and $O_{jt} + M_{jt} - X_{jt}$ measures the apparent consumption of sector *j* at time *t*, which is the sum of output (O_{jt}), plus imports (M_{jt}) – exports (X_{jt}).

Finally, δi and δt are firm and year fixed effects, respectively. The former controls for firm-time trends and the latter controls for economic events that impact all firms, such as exchange rate appreciations and GDP growth. Standard errors are clustered at the industry level, the level of variation of the shock.

To make sure $ChinaPen_{Xjt}$ is not capturing procompetitive effects coming from other channels such as import competition from the rest of the world (ROW) or Chinese competition in third markets, and also to understand the relevance of these other channels, we run specifications with two other variables of interest:

$$\Delta \ln(Y_{i,j,t}) = c + \beta \ \Delta \ ChinaIPI_{jt} + \theta \Delta RowIPI_{jt} + \gamma \Delta ChinaPenX_{jt} + \ \delta_i + \ \delta_t + \ \varepsilon_{it} \ (3)$$

where $\Delta RowIPI_{jt}$ is defined as in (2), but with ROW imports in the numerator; and $ChinaPenX_{jt}$ is defined as China's average share of sector *j*'s world exports to third markets, weighted by the share of each market in Brazil's exports, or:

$$ChinaPenX_{jt} = \sum_k w_{kj} \left(\frac{XChina_{kjt}}{X_{kjt}} \right) \ \ (4)$$

where $w_k = \frac{XBrazil_k}{\sum_k XBrazil_k}$. $XChina_{kjt}$ is China's exports to country *k* in sector *j* at time *t*, X_{kjt} is world exports to country *k* in sector *j* at time *t* and the weights (w_k) are the share of country *k* in Brazil's exports. This variable is

---

22 See for instance, in Bernard et al. (2006), Autor et al. (2013), Mion and Zhu (2013), Costa et al., (2013), and Dix-Carneiro and Kovak (2017).

23 The export channel can be seen as a component of the learning-by-exporting argument whereby exports, aside from scale gains (Lelieeva and Trefler, 2010), may offer more intense, sophisticated competition, which boosts the procompetitive effects on firm productivity and innovation.

24 Results are robust across different TFP methodologies, the results of which are highly correlated (see footnote 16).

designed to capture the procompetitive effects transmitted through the export channel. It reflects Brazilian firms' exposure to Chinese competition in foreign markets.

A threat to identifying β using ordinary least squares (OLS) is the fact that changes in firm outcomes and Chinese import penetration might be correlated with unobserved local supply or demand shocks. The direction of the bias, though, is unclear. For example, a demand shock such as tax incentives for the purchase of capital goods, as adopted by the Brazilian government in 2008 (Frischtak and Mesquita Moreira, 2015), could simultaneously boost local production and imports, understating the possible negative impacts of the China shock on employment. On the other hand, a supply shock arising, for instance, from energy rationing, like the one adopted by Brazil in the early 2000s (Costa et al., 2013), could hurt local production while boosting imports, potentially overstating the negative effects of the shock on output and employment.

To address this issue, we use an instrumental-variable strategy, in the spirit of Autor, Dorn, and Hanson (2013). That is, we instrument the China IPI index with the ratio of comparable countries' imports from China to Brazil's apparent consumption, as shown below:

$$Z_{jt} = Imp_{ojt}/AC_{jt} \quad (4)$$

where Z is our instrument for sector *j* at time t, Imp_{ojt} is comparable countries' imports of sector *j* from China, and AC_{jt} is Brazil's sector *j* apparent consumption, as defined by equation (4).

We selected the group of comparable countries based on their similarities to Brazil's level of income and comparative advantages. This group is made up of Argentina, Colombia, India, Indonesia, Mexico, Poland, Russia, South Africa, and Turkey.[25]

5. EMPIRICAL RESULTS

A. Productivity

The results point to a positive and statistically significant impact of Chinese competition on manufacturing TFP, reaffirming the significance of the procompetitive effects of trade found by the literature on the Great Liberalization of the 1990s. It contrasts, though, with findings of similar firm-level studies of the China shock in Mexico, Colombia, Peru, and El Salvador, which found negative procompetitive effects on TFP.[26]

Our results are robust to most OLS and all IV specifications (table 3). The IV coefficients tend to be larger than the OLS ones, suggesting that OLS specifications tend to underestimate the impact of the shock because of the endogeneity issues discussed earlier.

The impact is also economically significant. Our more demanding IV specification implies that a 1 p.p. increase in real Chinese IPI is associated with a 0.08% increase in manufacturing TFP.[27] Considering that real Chinese import penetration in Brazil increased 6.1 p.p. in 2000–2013, that would have increased TFP growth by 0.48%—a significant boost in a scenario where average cumulative productivity growth was approximately 1%. This is in the same order of magnitude of the effects found by Muendler (2004), Schor (2004), and López-Córdova and Mesquita Moreira (2004) for the 1990s.

There is no conclusive evidence that this import competition effect went beyond Chinese imports. The results for the ROW IPI were not statistically significant across all specifications, which might be linked to the low variation in this variable during the period.

By contrast, there is evidence of a positive procompetitive effect coming from Chinese competition in foreign markets, which is robust across all specifications. The coefficients are somewhat smaller than in the domestic

[25] Our results are robust to including other countries in this group, see section 6.
[26] See Blyde and Fentanes (2019) for Mexico; Pierola et al..
[27] The results are robust to nominal measures of Chinese import penetration.

competition case, but since there was more variation in the Chinese share of relevant third markets (9 p.p. over the period), the economic impact is likely to be higher.[28]

Whatever the precise magnitude of the overall shock, it seems clear that it was not enough to offset other possible negative shocks/constraints. As shown earlier in table 1, the average annual TFP growth in the period was, in the upper bound of the estimates, a meager 0.08%. This could have been a different story, if, for instance, the estimated coefficients were closer to those found by Bloom et al. (2015) for Europe's China shock—which are approximately three times higher. This mismatch between positive procompetitive effects and a lackluster overall TFP performance is also present during the 1990s trade shock, although TFP growth was notably higher.[29]

TABLE 3. EFFECTS OF TRADE COMPETITION ON TOTAL FACTOR MANUFACTURING PRODUCTIVITY

Dependent variable	**Three-year difference in log TFP**					
Estimation method	OLS			IV		
Specification	(1)	(2)	(3)	(1)	(2)	(3)
Trade competition (Three-year change)						
Δ Chinese IPI	0.077***	0.082***	0.057**	0.068***	0.099***	0.083***
	(0.029)	(0.030)	(0.029)	(0.018)	(0.030)	(0.028)
Δ ROW IPI		-0.003	-0.003		-0.003	-0.003
		(0.003)	(0.003)		(0.003)	(0.003)
Δ ChinaPenX			0.071***			0.066***
			(0.024)			(0.023)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	No	No	No	No	No	No
F-First stage Δ Chinese IPI	-		-	8.18	8.58	10.1
F-Weak test	-		-	27.5	23.6	27.2
Number of firms	28,427	28,427	28,427	22,720	22,720	22,720
Observations	149,152	149,152	149,152	143,445	143,445	143,445
R-squared	0.294	0.2942	0.295	0.231	0.231	0.233

Note: Dependent variable: Three-year diff log TFP calculated using the Olley and Pakes (1996) approach. Robust standard errors clustered at industry level in parentheses, *** p<0.01, ** p<0.05, * p<0.1. The IV includes countries that share similar characteristics with Brazil in terms of income per capita and comparative advantages: Argentina, Colombia, India, Indonesia, Mexico, Poland, Russia, South Africa, and Turkey. The number of observations is lower than that of the OLS specifications because singletons were excluded from the estimation (Correa, 2015). F-Weak test: Kleibergen Paap weak instrument statistic.

Source: Own calculations.

B. Innovation

Unlike productivity, the results for output and input measures of innovation are far from conclusive. The import and export channel coefficients are often negative but mostly not statistically significant or robust across specifications (tables 4 to 8).

The lack of clear results might be related to steeper identification challenges. Since all the output (product and process innovation) and one of the input measures (patents) are binary variables, we run a linear probability model (LPM) to avoid the biases of nonlinear estimations with fixed effects (Greene, 2004). The LPM model is seen as a good approximation for the average effects but also has its limitations as it assumes that probabilities have no bounds (Wooldridge, 2001).[30]

In addition, given that PINTEC's deterministic stratum (firms with 500 or more employees) is significantly smaller than PIA's (firms with 30 or more employees), we also include firms from its random sample (between 10 and 499

[28] Lage de Sousa (2018), using firm-specific export data for 1997–2010, supports the finding that Brazilian firms were significantly affected by Chinese competition abroad, particularly when compared to other Latin American countries such as Mexico and Peru.
[29] See, for instance, López-Córdova and Mesquita Moreira (2004).
[30] See also Bernard and Jensen (2004) for an application of the LPM.

employees). This strategy significantly increases the number of observations but at the cost of many singletons, since 46% of the firms participate in only one of the surveys. As singletons can overstate statistical significance and lead to incorrect inferences (Correa, 2015), we dropped them in the more demanding specifications, which drastically reduced the number of observations.

These caveats aside, the estimates on product innovation (table 4) seem to offer the most hope for clarity, as they are consistently negative for Chinese import competition across all specifications. This contrasts with most of the positive effects found for the rest of Latin America and elsewhere in the developing world, particularly in the 1990s, although this literature is mostly based on perception indicators and cross-sectional variation.[31]

The negative results are more consistent with those seen in the developed world (e.g., Author et al., 2017) and with the theoretical ambiguity involving this relationship. The theory sees these effects as being either positive (the escape-competition effect) or negative (the Schumpeterian effect) depending on the dispersion of technological proficiency among firms (Aghion et al., 2005). Brazilian manufacturing firms are generally seen as distant from the technological frontier, which suggests that negative results might not be surprising. Moreover, it seems consistent with the lackluster performance of sectoral innovation indicators during the period.

Negative and inconclusive effects can also be reconciled with the positive and robust productivity results discussed earlier. As argued elsewhere, innovation and productivity do not always move in the same direction (Hall, 2011) and indicators such as the number of patents—or R&D for that matter—do not capture the bulk of knowledge accumulation in developing countries, where firms are more likely to imitate and adapt existing technologies.

[31] See Mesquita Moreira and Stein (2019), chapter 4, for a review. See Gorodnichenko et al. (2010) for evidence on emergent markets.

TABLE 4. EFFECTS OF TRADE COMPETITION ON PRODUCT INNOVATION

Dependent variable	**Product innovation (binary variable, change between consecutive surveys)**					
	OLS			IV		
Estimation method	(1)	(2)	(3)	(1)	(2)	(3)
Trade competition variables						
Δ Chinese IPI	-0.27** (0.120)	-0.338*** (0.113)	-0.333*** (0.120)	-0.107*** (0.040)	-0.175*** (0.063)	-0.143** (0.06)
Δ ROW IPI		0.012* (0.006)	0.0074 (0.010)		0.0081 (0.005)	0.003 (0.010)
Δ ChinaPenX			-0.136 (0.120)			-0.145 (0.100)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	No	No	No	No	No	No
F-First stage Δ Chinese IPI	-	-	-	29.5	34.76	25.01
F-Weak test	-	-	-	101.9	88.29	97.4
Number of firms	20,903	20,903	20,544	9,683	9,683	9,475
Observations	37,161	37,161	36,408	25,941	25,941	25,339

Note: Results of a linear probability model. Robust standard errors clustered at industry level in parentheses, *** p<0.01, ** p<0.05, * p<0.1. The IV includes countries that share similar characteristics with Brazil in terms of income per capita and comparative advantages: Argentina, Colombia, India, Indonesia, Mexico, Poland, Russia, South Africa, and Turkey. The number of observations is lower than that of the OLS specifications because singletons were excluded from the estimation (Correa, 2015). F-Weak test: Kleibergen Paap weak instrument statistic.

Source: Own calculations.

TABLE 5. EFFECTS OF TRADE COMPETITION ON PROCESS INNOVATION

Dependent variable	**Process innovation (binary variable, change between consecutive surveys)**					
Specification	OLS			IV		
Estimation method	(1)	(2)	(3)	(1)	(2)	(3)
Trade competition variables						
Δ Chinese IPI	-0.134 (0.194)	-0.223 (0.161)	-0.279* (0.152)	-0.219* (0.124)	-0.382** (0.173)	-0.288 (0.219)
Δ ROW IPI		0.016 (0.017)	0.0079 (0.028)		0.019 (0.017)	0.008 (0.027)
Δ ChinaPenX			-0.097 (0.159)			-0.096 (0.134)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	No	No	No	No	No	No
F-First stage Δ Chinese IPI	-	-	-	29.5	34.76	25.01
F-Weak test	-	-	-	101.9	88.293	97.4
Number of firms	20,903	20,903	20,544	9,683	9,683	9,475
Observations	37,161	37,161	36,408	25,941	25,941	25,339

Note: Results of a linear probability model. Robust standard errors clustered at industry level in parentheses, *** p<0.01, ** p<0.05, * p<0.1. The IV includes countries that share similar characteristics with Brazil in terms of income per capita and comparative advantages: Argentina, Colombia, India, Indonesia, Mexico, Poland, Russia, South Africa, and Turkey. The number of observations is lower than that of the OLS specifications because singletons were excluded from the estimation (Correa, 2015). F-Weak test: Kleibergen Paap weak instrument statistic.

Source: Own calculations.

TABLE 6. EFFECTS OF TRADE COMPETITION ON INNOVATION EXPENDITURES

Dependent variable	**Change in innovation expenditure (in log, between consecutive surveys)**					
Specification	OLS			IV		
Estimation method	(1)	(2)	(3)	(1)	(2)	(3)
Trade competition variables						
Δ Chinese IPI	0.163	-0.756	-0.276	2.311*	1.247	0.83
	(1.530)	(1.650)	(1.680)	(1.260)	(1.570)	(1.800)
Δ ROW IPI		0.159	0.186		0.116	0.169
		(0.145)	(0.210)		(0.141)	(0.210)
Δ ChinaPenX			1.124			1.063
			(2.060)			(1.744)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	No	No	No	No	No	No
F-First stage Δ Chinese IPI	-		-	29.5	34.76	25.01
F-Weak test	-		-	21.38	25	26.36
Number of firms	9,340	9,340	9,165	4,611	4,611	4,512
Observations	17,732	17,732	17,371	13,003	13,003	12,718
R-squared	0.355	0.356	0.355	0.170	0.170	0.170

Note: Robust standard errors clustered at industry level in parentheses, *** p<0.01, ** p<0.05, * p<0.1. The IV includes countries that share similar characteristics with Brazil in terms of income per capita and comparative advantages: Argentina, Colombia, India, Indonesia, Mexico, Poland, Russia, South Africa, and Turkey. The number of observations is lower than that of the OLS specifications because singletons were excluded from the estimation (Correa, 2015). F-Weak test: Kleibergen Paap weak instrument statistic. Dependent variable in constant prices.

Source: Own calculations

TABLE 7. EFFECTS OF TRADE COMPETITION ON R&D WORKFORCE

Dependent variable	**Change in the R&D workforce (in log, between consecutive surveys)**					
Specification	OLS			IV		
Estimation method	(1)	(2)	(3)	(1)	(2)	(3)
Trade competition variables						
Δ Chinese IPI	-0.183	-0.444	-0.269	-0.084	-0.498	-0.630
	(0.496)	(0.589)	(0.608)	(0.269)	(0.407)	(0.500)
Δ ROW IPI		0.045	0.056		0.046	0.061
		(0.048)	(0.068)		(0.043)	-0.060
Δ ChinaPenX			-0.953			-0.933*
			(0.614)			(0.529)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	No	No	No	No	No	No
F-First stage Δ Chinese IPI	-	-	-	29.5	34.76	25.01
F-Weak test	-	-	-	21.38	25.052	26.37
Number of firms	9,341	9,341	9,166	4,612	4,612	4,513
Observations	17,734	17,734	17,373	13,005	13,005	12,720
R-squared	0.321	0.322	0.322	0.182	0.182	0.182

Note: Robust standard errors clustered at industry level in parentheses, *** p<0.01, ** p<0.05, * p<0.1. The IV includes countries that share similar characteristics with Brazil in terms of income per capita and comparative advantages: Argentina, Colombia, India, Indonesia, Mexico, Poland, Russia, South Africa, and Turkey. The number of observations is lower than that of the OLS specifications because singletons were excluded from the estimation (Correa, 2015). F-Weak test: Kleibergen Paap weak instrument statistic.

Source: Own calculations.

TABLE 8. EFFECTS OF TRADE COMPETITION ON PATENTS

Dependent variable	**Patent (binary variable, change between consecutive surveys)**					
Estimation method	OLS			IV		
	(1)	(2)	(3)	(1)	(2)	(3)
Trade competition variables						
Δ Chinese IPI	0.116 (0.119)	0.135 (0.091)	0.146 (0.133)	0.203*** (0.040)	0.255*** (0.058)	0.234*** (0.079)
Δ ROW IPI		-0.001 (0.003)	-0.002 (0.010)		-0.006 (0.007)	-0.003 (0.010)
Δ ChinaPenX			-0.0524 (0.012)			-0.056 (0.096)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	No	No	No	No	No	No
F-First stage Δ Chinese IPI	-		-	30.11	34.76	25.01
F-Weak test	-		-	101.9	88.3	97.4
Number of firms	20,903	20,903	20,544	9,683	9,683	9,475
Observations	37,161	37,161	36,408	25,941	25,941	25,339

Note: Results of a linear probability model. Robust standard errors clustered at industry level in parentheses, *** p<0.01, ** p<0.05, * p<0.1. The IV includes countries that share similar characteristics with Brazil in terms of income per capita and comparative advantages: Argentina, Colombia, India, Indonesia, Mexico, Poland, Russia, South Africa, and Turkey. The number of observations is lower than that of the OLS specifications because singletons were excluded from the estimation (Correa, 2015). F-Weak test: Kleibergen Paap weak instrument statistic.

Source: Own calculations.

C. Employment

The employment picture sits between the productivity and innovation results. It is not as clear as the former but is more conclusive than the latter. As can be seen in table 9, the results point to Chinese import penetration having a negative impact on the growth of manufacturing employment, but this impact is only statistically significant in the IV specifications. If we use the average of the IV coefficients (-0.20), a 1 p.p. increase in the real Chinese IPI reduces employment growth by 0.20%. Given that the Chinese IPI increased by 6.1 p.p., this would imply a 1.2% drop in employment—an economically significant amount considering that the period's cumulative growth was just 7.60%. When broken down by type of labor, the results suggest that this negative effect is driven by low-skilled jobs (tables 10 and 11).

TABLE 9. EFFECTS OF TRADE COMPETITION ON FIRM EMPLOYMENT

Dependent variable	**Three-year difference in firm employment (in logs)**					
Estimation method	OLS			IV		
Specification	(1)	(2)	(3)	(1)	(2)	(3)
Trade competition (Three-year change)						
Δ Chinese IPI	0.061 (0.044)	0.074 (0.045)	0.068 (0.051)	-0.198*** (0.037)	-0.192*** (0.060)	-0.208*** (0.067)
Δ ROW IPI		-0.008 (0.007)	-0.008 (0.008)		-0.008 (0.008)	-0.000 (0.009)
Δ ChinaPenX			0.018 (0.063)			0.069 (0.06)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	No	No	No	No	No	No
F-First stage Δ Chinese IPI	-		-	8.179	8.58	10.1
F-Weak test	-		-	17.69	14.868	16.18
Number of firms	36,887	36,887	36,887	30,352	30,352	30,352
Observations	200,668	200,668	200,668	194,133	194,133	194,133
R-squared	0.366	0.3661	0.366	0.339	0.3393	0.339

Note: Robust standard errors clustered at industry level in parentheses, *** p<0.01, ** p<0.05, * p<0.1. The IV includes countries that share similar characteristics with Brazil in terms of income per capita and comparative advantages: Argentina, Colombia, India, Indonesia, Mexico, Poland, Russia, South Africa, and Turkey. The number of observations is lower than that of the OLS specifications because singletons were excluded from the estimation (Correa, 2015). F-Weak test: Kleibergen Paap weak instrument statistic.

Source: Own calculations.

TABLE 10. EFFECTS OF TRADE COMPETITION ON HIGH-SKILLED FIRM EMPLOYMENT

Dependent variable	**Three-year difference in high-skilled firm employment (in logs)**					
Estimation method	OLS			IV		
Specification	(1)	(2)	(3)	(1)	(2)	(3)
Trade competition (Three-year change)						
Δ Chinese IPI	0.025 (0.078)	0.017 (0.080)	-0.009 (0.079)	-0.023 (0.037)	-0.0831 (0.094)	-0.105 (0.098)
Δ ROW IPI		0.005 (0.010)	0.006 (0.010)		0.007 (0.012)	0.008 (0.011)
Δ ChinaPenX			0.079 (0.053)			0.097* (0.054)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	No	No	No	No	No	No
F-First stage Δ Chinese IPI	-	-	-	8.179	9.5	10.1
F-Weak test	-	-	-	18.58	15.572	16.99
Number of firms	35,827	35,827	35,827	29,299	29,299	29,299
Observations	191,809	191,809	191,809	185,281	185,281	185,281
R-squared	0.253	0.253	0.253	0.217	0.2167	0.217

Note: Robust standard errors clustered at industry level in parentheses, *** p<0.01, ** p<0.05, * p<0.1. The IV includes countries that share similar characteristics with Brazil in terms of income per capita and comparative advantages: Argentina, Colombia, India, Indonesia, Mexico, Poland, Russia, South Africa, and Turkey. The number of observations is lower than that of the OLS specifications because singletons were excluded from the estimation (Correa, 2015). F-Weak test: Kleibergen Paap weak instrument statistic.

Source: Own calculations.

TABLE 11. EFFECTS OF TRADE COMPETITION ON LOW-SKILLED EMPLOYMENT

Dependent variable	**Three-year difference in low-skilled firm employment (in logs)**					
Specification	OLS			IV		
Estimation method	(1)	(2)	(3)	(1)	(2)	(3)
Trade competition (Three-year change)						
Δ Chinese IPI	0.07 (0.049)	0.082 (0.050)	0.086 (0.056)	-0.195*** (0.040)	-0.196*** (0.075)	-0.205** (0.083)
Δ ROW IPI		-0.007 (0.010)	-0.008 (0.010)		0.000 (0.011)	0.000 (0.011)
Δ ChinaPenX			-0.014 (0.068)			0.039 (0.068)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	No	No	No	No	No	No
F-First stage Δ Chinese IPI	-		-	8.179	8.58	10.1
F-Weak test	-		-	17.68	14.858	16.16
Number of firms	36,827	36,827	36,827	30,303	30,303	30,303
Observations	200,210	200,210	200,210	193,686	193,686	193,686
R-squared	0.314	0.314	0.314	0.285	0.4236	0.285

Note: Robust standard errors clustered at industry level in parentheses, *** p<0.01, ** p<0.05, * p<0.1. The IV includes countries that share similar characteristics with Brazil in terms of income per capita and comparative advantages: Argentina, Colombia, India, Indonesia, Mexico, Poland, Russia, South Africa, and Turkey. The number of observations is lower than that of the OLS specifications because singletons were excluded from the estimation (Correa, 2015). F-Weak test: Kleibergen Paap weak instrument statistic.

Source: Own calculations.

As with the productivity results, there is not enough evidence to argue that the employment effects went beyond Chinese imports. The coefficient of the ROW IPI is not statistically significant in all specifications. By contrast, and equally consistently with the productivity outcomes, there is evidence of a negative employment effect coming from Chinese competition in third markets. Unlike the domestic competition results, though, the effects are only statistically significant (IV specifications) for skilled labor. This might be consistent with the fact that Brazilian's exports tend to be biased toward more resource- and capital-intensive goods, as well with the more general findings that exporters, *ceteris paribus*, tend to use skilled labor more intensively (Bernard et al., 2007; Brambilla et al., 2015).

6. ROBUSTNESS

To test the robustness of our most conclusive TFP, innovation, and employment results, we rerun equations (1) and (3) using: (i) firm-level controls; (ii) different instruments; (iii) five-year rather than three-year differences, and (iv) industry rather than firm fixed effects.

A. Firm controls

Since we use first-differencing specifications with firm fixed effects, the firm-specific characteristics that evolve smoothly overtime are controlled for (Wooldridge, 2001). However, variable characteristics that do not follow this pattern might bias the results. To address this concern, we include a vector of covariates (V'_{ijt}) in both equations that includes: (a) employment to control for differences in firm size in those specifications where the dependent variable is productivity; (b) capital-labor and high-to-low-skilled wage ratios for differences in firm technology, and (c) TFP, for differences in productivity, where the dependent variable is employment. All controls are three-year moving average to smooth out the volatility and address endogeneity concerns.

Table 12 presents the results for TFP. As can be seen, the effect remains positive and significant in most cases, particularly in the IV specifications. The coefficients are in the same order of magnitude as those presented in table 3. Unfortunately, we could not replicate the same robustness exercise for the innovation variables because the merging of the PIA and PINTEC surveys left us with too few firms and observations ((PINTEC does not have the information

need to build the controls). The sample size dropped from around 20,000 to less than 1,500 firms, leaving all coefficients statistically insignificant.[32]

TABLE 12. EFFECTS OF TRADE COMPETITION ON TOTAL FACTOR MANUFACTURING PRODUCTIVITY. FIRM CONTROLS.

Dependent variable	**Three-year change in log TFP**			
Estimation method	OLS		IV	
Specification	(1)	(2)	(3)	(4)
Trade competition (Three-year change)				
Δ Chinese IPI	0.056*	0.036	0.065***	0.075***
	(0.029)	(0.029)	(0.013)	(0.026)
Δ ROW IPI		-0.001		-0.005
		(0.003)		(0.003)
Δ ChinaPenX		0.069***		0.062**
		(0.025)		(0.024)
Firm characteristics				
Δ L Size	-0.002	-0.002	-0.002	-0.002
	(0.002)	(0.002)	(0.002)	(0.002)
Δ K/L	-0.006***	-0.006***	-0.006***	-0.006***
	(0.001)	(0.001)	(0.001)	(0.001)
Δ Skill	0.008***	0.008***	0.008***	0.008***
	(0.002)	(0.002)	(0.002)	(0.002)
Year fixed effects	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	No	No	No	No
F-First stage Δ Chinese IPI	-	-	8.06	11.7
F-Weak test	-	-	54.6	56.0
Number of firms	21,659	21,659	17,672	17,672
Observations	106,477	106,477	102,490	102,490
R-squared	0.304	0.305	0.255	0.257

Note: Dependent variable: Three-year diff log TFP calculated using the Olley and Pakes (1996) approach. Robust standard errors clustered at industry level in parentheses, *** p<0.01, ** p<0.05, * p<0.1. The IV includes countries that share similar characteristics with Brazil in terms of income per capita and comparative advantages: Argentina, Colombia, India, Indonesia, Mexico, Poland, Russia, South Africa, and Turkey. The number of observations is lower than that of the OLS specifications because singletons were excluded from the estimation (Correa, 2015). F-Weak test: Kleibergen Paap weak instrument statistic.

Source: Own calculations.

For employment, we focus on the most robust, low-skilled result, as shown in table 13. The sign and magnitude of the coefficients are in line with those of the specifications without controls (table 11). The impact of Chinese competition on low-skilled employment remains negative and significant in the IV specifications.

[32] Results available upon request.

TABLE 13. EFFECTS OF TRADE COMPETITION ON LOW-SKILLED EMPLOYMENT. FIRM CONTROLS.

Dependent variable	Three-year difference in low-skilled firm employment (in logs)			
Specification	OLS		IV	
Estimation method	(1)	(2)	(3)	4)
Trade competition (Three-year change)				
Δ Chinese IPI	0.041	0.059	-0.2***	-0.187**
	(0.050)	(0.063)	(0.045)	(0.075)
Δ ROW IPI		-0.009		-0.002
		(0.007)		(0.008)
Δ ChinaPenX		-0.014		0.033
		(0.070)		(0.068)
Firm characteristics				
Δ Skill	-0.597***	-0.597***	-0.597***	-0.597***
	(0.027)	(0.027)	(0.027)	(0.027)
Δ TFP	-0.083**	-0.083**	-0.079**	-0.080**
	(0.034)	(0.034)	(0.034)	(0.034)
Year fixed effects	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	No	No	No	No
F-First stage Δ Chinese IPI	-	-	7.78	11.14
F-Weak test	-	-	27.95	27.46
Number of firms	28,074	28,074	22,628	22,628
Observations	148,420	148,420	142,974	142,974
R-squared	0.394	0.394	0.364	0.364

Note: Robust standard errors clustered at industry level in parentheses, *** p<0.01, ** p<0.05, * p<0.1. The IV includes countries that share similar characteristics with Brazil in terms of income per capita and comparative advantages: Argentina, Colombia, India, Indonesia, Mexico, Poland, Russia, South Africa, and Turkey. The number of observations is lower than that of the OLS specifications because singletons were excluded from the estimation (Correa, 2015). F-Weak test: Kleibergen Paap weak instrument statistic.

Source: Own calculations.

B. Alternative instruments, industry fixed effects, and five-year differences

The use of an alternative IV based on upper-and-middle-income (UPMI) countries does not fundamentally alter the TFP results.[33] As shown in table 14, the impact of Chinese competition on both domestic and third markets is still positive and statistically significant. The only notable differences are coefficients that are generally higher than in the baseline specification.[34]

---

[33] As defined by the World Bank.

[34] We also experimented with other country groups, obtaining qualitatively similar results. The other IVs include a group of commodity exporters, adding Canada and Australia to the baseline IV, and a group with all the Latin American countries. Results are available upon request.

TABLE 14. EFFECTS OF TRADE COMPETITION ON MANUFACTURING TFP. FIRM FIXED EFFECTS. IV ROBUSTNESS AND FIRM CONTROLS

Dependent variable	**Three-year change in log TFP**				
Estimation method	IV–UPMI				
Specification	(1)	(2)	(3)	(4)	(5)
Trade competition (Three-year change)					
Δ Chinese IPI	0.112**	0.162***	0.129**	0.123*	0.144**
	(0.052)	(0.054)	(0.051)	(0.066)	(0.069)
Δ Non-Chinese IPI		-0.005*	-0.004		-0.004
		(0.003)	(0.003)		(0.003)
Δ ChinaPenX			0.057**		0.0493*
			(0.024)		(0.026)
Firm characteristics					
Δ L Size				-0.002	-0.002
				(0.002)	(0.002)
Δ K/L				-0.006***	-0.006***
				(0.091)	(0.001)
Δ Skill				0.008***	0.008***
				(0.002)	(0.002)
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	No	No	No	No	No
F-First stage Δ Chinese IPI	6.9	7.40	8.86	12.58	8.156
F-Weak test	15.9	11.98	10.98	21.98	14.28
Number of firms	22,720	22,720	22,720	17,672	17,672
Observations	143,445	143,445	143,445	102,490	102,490
R-squared	0.231	0.2305	0.232	0.255	0.255

Note: Dependent variable: Three-year diff log TFP calculated using the Olley and Pakes (1996) approach. Robust standard errors clustered at industry level in parentheses, *** p<0.01, ** p<0.05, * p<0.1. IV-UPMI includes upper middle-income countries as defined by the World Bank. F-Weak test: Kleibergen Paap weak instrument statistic.

Source: Own calculations.

The use of industry rather firm fixed effects also points in the same direction (table 15). The TFP results with 5-year differences, though, are not as supportive or conclusive (table 16). They suggest that the positive, procompetitive effects tend to fade away in the medium to long term.

TABLE 15. EFFECTS OF TRADE COMPETITION ON MANUFACTURING TFP. INDUSTRY FIXED EFFECT AND FIRM CONTROLS

Dependent variable	**Three-year change in log TFP**							
Estimation method	OLS				IV			
Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Trade competition (Three-year change)								
Δ Chinese IPI	0.073***	0.058**	0.072***	0.055**	0.036*	0.052**	0.087**	0.059***
	(0.023)	(0.024)	(0.027)	(0.027)	(0.021)	(0.021)	(0.014)	(0.019)
Δ Non-Chinese IPI		-0.004**		-0.003*		-0.003*		-0.003
		(0.002)		(0.002)		(0.001)		(0.002)
Δ ChinaPenX		0.068***		0.072***		0.069***		0.071***
		(0.024)		(0.025)		(0.023)		(0.024)
Firm characteristics								
Δ L Size			0.010***	0.010***			0.010***	0.010***
			(0.002)	(0.002)			(0.002)	(0.002)
Δ K/L			-0.005***	-0.005***			-0.005***	-0.005***
			(0.001)	(0.001)			(0.001)	(0.001)
Δ Skill			0.008***	0.008***			0.008***	0.008***
			(0.002)	(0.002)			(0.002)	(0.002)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	No	No	No	No	No	No	No	No
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-First stage Δ Chinese IPI	-	-	-	-	8.761	11.31	8.514	12.95
F-Weak test	-	-	-	-	28.72	28.62	50.35	53.91
Observations	149,152	149,152	106,477	106,477	149,152	149,152	106,477	106,477
R-squared	0.027	0.029	0.037	0.038	0.027	0.029	0.036	0.038

Note: Dependent variable: Three-year diff log TFP calculated using the Olley and Pakes (1996) approach. Robust standard errors clustered at industry level in parentheses, *** p<0.01, ** p<0.05, * p<0.1. IV includes countries that share similar characteristics with Brazil in terms of income per capita and comparative advantages: Argentina, Colombia, India, Indonesia, Mexico, Poland, Russia, South Africa, and Turkey. F-Weak test: Kleibergen Paap weak instrument statistic.

Source: Own calculations.

TABLE 16. EFFECTS OF TRADE COMPETITION ON TOTAL FACTOR MANUFACTURING PRODUCTIVITY. FIRM FIXED EFFECTS. FIVE-YEAR DIFFERENCE AND FIRM CONTROLS

Dependent variable								
Estimation method	OLS				IV			
Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Trade competition (Three-year change)								
Δ Chinese IPI	0.070* (0.036)	0.052 (0.040)	0.061 (0.037)	0.047 (0.037)	0.085*** (0.015)	-0.025 (0.049)	-0.056* (0.032)	-0.060 (0.047)
Δ ROW IPI		-0.003 (0.003)		-0.003 (0.003)		-0.002 (0.003)		-0.000 (0.004)
Δ ChinaPenX		0.070*** (0.247)		0.058**		0.085*** (0.0243)		0.788*** (0.264)
Firm characteristics								
Δ L Size			0.003 (0.002)	0.003 (0.002)			0.003 (0.002)	0.003 (0.002)
Δ K/L			-0.005*** (0.001)	-0.005*** (0.001)			-0.005*** (0.001)	-0.005*** (0.001)
Δ Skill			0.005** (0.002)	0.005** (0.002)			0.005** (0.002)	0.005** (0.002)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	No	No	No	No	No	No	No	No
F-First stage Δ Chinese IPI	-	-	-	-	11.42	12.85	12.61	15.76
F-Weak test	-	-	-	-	39.94	35.35	54.65	62.93
Number of firms	28,427	28,427	21,659	21,659	22,720	22,720	13,572	13,572
Observations	105,431	149,152	106,477	106,477	101,106	139,192	80,835	80,835
R-squared	0.294	0.265	0.298	0.305	0.365	0.48	0.66	0.68

Note: Dependent variable: Three-year diff log TFP calculated using the Olley and Pakes (1996) approach. Robust standard errors clustered at industry level in parentheses, *** p<0.01, ** p<0.05, * p<0.1. The IV includes countries that share similar characteristics with Brazil in terms of income per capita and comparative advantages: Argentina, Colombia, India, Indonesia, Mexico, Poland, Russia, South Africa, and Turkey. F-Weak test: Kleibergen Paap weak instrument statistic.

Source: Own calculations.

For innovation, we focus on the product dimension of the effects, which, as discussed earlier, are the least ambiguous of all the outcomes.[35] The use of the UPMI IV, though, brings even more uncertainty to the results, with none of the IV specifications reaching any level of statistical significance (table 17). The specifications with industry rather firm fixed effects (table 18) do not offer any support either, no matter which IV is used. Given that PINTEC surveys are not available on a regular, annual basis, we do not look at the results with longer, five-year differences.

[35] We all also carried out similar tests for all the other innovation outcomes. The results are also inconclusive and are available upon request.

TABLE 17. EFFECTS OF TRADE COMPETITION ON PRODUCT INNOVATION. FIRM FIXED EFFECTS. IV ROBUSTNESS

Dependent variable	**Product innovation (binary variable, change between consecutive surveys)**		
Specification	IV–UPMI		
Estimation method	(1)	(2)	(3)
Trade competition (Three-year change)			
Δ Chinese IPI	-0.219 (0.156)	-0.37 (0.240)	-0.324 (0.210)
Δ ROW IPI		0.013 (0.008)	0.007 (0.010)
Δ ChinaPenX			-0.136 (0.100)
Year fixed effects	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes
Industry fixed effects	No	No	No
F-First stage Δ Chinese IPI	5.932	7.64	6.616
F-Weak test	8.479	5.55	7.212
Number of firms	9,683	9,683	9,475
Observations	25,941	25,941	25,339

Note: Robust standard errors clustered at industry level in parentheses, *** p<0.01, ** p<0.05, * p<0.1. IV-UPMI includes upper middle-income countries as defined by the World Bank. F-Weak test: Kleibergen Paap weak instrument statistic.

Source: Own calculation

TABLE 18. EFFECTS OF TRADE COMPETITION ON PRODUCT INNOVATION. INDUSTRY FIXED EFFECTS

Dependent variable	**Product innovation (binary variable, change between consecutive surveys)**			
Estimation method	OLS		IV	
Specification	(1)	(2)	(3)	(4)
Trade competition (Three-year change)				
Δ Chinese IPI	-0.176*** (0.064)	-0.236*** (0.060)	-0.024 (0.015)	-0.069 (0.046)
Δ ROW IPI		0.009 (0.005)		0.006 (0.005)
Δ ChinaPenX		0.016 (0.079)		0.011 (0.080)
Year fixed effects	Yes	Yes	Yes	Yes
Firm fixed effects	No	No	No	No
Industry fixed effects	Yes	Yes	Yes	Yes
F-First stage Δ Chinese IPI			43.91	33.87
F-Weak test	-	-	91.75	91.89
Number of firms	20,903	20,544	9,683	9,683
Observations	37,161	36,408	37,161	36,408

Note: Robust standard errors clustered at industry level in parentheses, *** p<0.01, ** p<0.05, * p<0.1. IV-1 includes countries that share similar characteristics with Brazil in terms of income per capita and comparative advantages: Argentina, Colombia, India, Indonesia, Mexico, Poland, Russia, South Africa, and Turkey. IV-2 includes upper middle-income countries as defined by the World Bank. F-Weak test: Kleibergen Paap weak instrument statistic.

Source: Own calculations.

For employment, we again focus on the low-skilled results that drive the overall negative impact of Chinese competition. Table 19 shows that these negative effects are robust to a different UPMI instrument. As with TFP, the coefficient of the China IPI is usually slightly higher, though it tends to lose some of its statistical significance. In line with the baseline results, there is no evidence of a ROW effect or any effect through the export channel. A specification with industry rather than firm fixed effects points in the same direction, lending support to the negative effects found in the baseline (table 20). Finally, when five-year rather than three-year differences are used, the negative impact of Chinese competition on the domestic market remains statistically significant, suggesting that these, unlike the TFP effects, are not just a short-term proposition (table 21).

TABLE 19. EFFECTS OF TRADE COMPETITION ON LOW-SKILLED EMPLOYMENT: FIRM FIXED EFFECTS. IV ROBUSTNESS AND FIRMS CONTROLS

Dependent variable	**Three-year change in unskilled firm employment (in logs)**				
Estimation method	IV–UPMI				
Specification	(1)	(2)	(3)	(4)	(5)
Trade competition (Three-year change)					
Δ Chinese IPI	-0.287* (0.149)	-0.31** (0.150)	-0.343* (0.177)	-0.358** (0.171)	-0.422* (0.232)
Δ ROW IPI		-0.003 (0.009)	0.004 (0.009)		0.004 (0.008)
Δ ChinaPenX			0.064 (0.076)		0.077 (0.081)
Firm characteristics					
Δ Skill				-0.596*** (0.026)	-0.596*** (0.026)
Δ TFP				-0.076** (0.034)	-0.077** (0.034)
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	No	No	No	No	No
Number of firms	6.899	7.4	8.861	6.297	8.537
F-First stage Δ Chinese import penetration	12.7	9.5	8.81	15.99	10.99
F-Weak test	30,303	30,303	30,303	22,628	22,628
Observations	193,686	193,686	193,686	142,974	142,974
R-squared	0.285	0.4506	0.285	0.363	0.363

Note: Robust standard errors clustered at industry level in parentheses, *** p<0.01, ** p<0.05, * p<0.1. IV-UPMI includes upper middle-income countries as defined by the World Bank. F-Weak test: Kleibergen Paap weak instrument statistic.

Source: Own calculations.

TABLE 20. EFFECTS OF TRADE COMPETITION ON LOW-SKILLED EMPLOYMENT: INDUSTRY FIXED EFFECTS AND FIRM CONTROLS

Dependent variable	**Three-year change in firm low-skilled employment (in logs)**							
Estimation method	OLS				IV			
Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Trade competition (Three-year change)								
Δ Chinese IPI	0.096**	0.093*	0.064	0.072	-0.103***	-0.131*	-0.209***	-0.216***
	(0.042)	(0.049)	(0.048)	(0.056)	(0.039)	(0.070)	(0.047)	(0.075)
Δ ROW IPI		-0.004		-0.008		0.002		-0.0006
		(0.009)		(0.007)		(0.010)		(0.008)
Δ ChinaPenX		0.029		0.016		0.067		0.066
		(0.051)		(0.057)		(0.053)		(0.057)
Firm characteristics								
Δ Skill			-0.618***	-0.618***			-0.618***	-0.618***
			(0.023)	(0.023)			(0.023)	(0.023)
Δ TFP			0.125***	0.124***			0.129***	0.127***
			(0.031)	(0.031)			(0.031)	(0.031)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	No	No	No	No	No	No	No	No
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-First stage Δ Chinese IPI	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-Weak test	-	-	-	-	8.761	11.53	8.407	12.24
Number of firms	-	-	-	-	20.13	18.58	27.88	27.71
Observations	200,210	200,210	148,420	148,420	200,210	200,210	148,420	148,420
R-squared	0.016	0.016	0.121	0.121	0.016	0.016	0.120	0.120

Note: Robust standard errors clustered at industry level in parentheses, *** p<0.01, ** p<0.05, * p<0.1. IV-1 includes countries that share similar characteristics with Brazil in terms of income per capita and comparative advantages: Argentina, Colombia, India, Indonesia, Mexico, Poland, Russia, South Africa, and Turkey. F-Weak test: Kleibergen Paap weak instrument statistic.

Source: Own calculations.

TABLE 21. EFFECTS OF TRADE COMPETITION ON LOW-SKILLED EMPLOYMENT. FIRM FIXED EFFECTS, FIVE-YEAR DIFFERENCE

Dependent variable	**Five-year change in unskilled firm employment (in logs)**							
Estimation method	OLS				IV			
Specification	(1)	(3)	(4)	(5)	(1)	(3)	(4)	(5)
Trade competition (Three-year change)								
Δ Chinese IPI	0.117*	0.108	0.102	0.083	-0.379***	-0.404***	-0.439***	-0.466***
	(0.060)	(0.068)	(0.071)	(0.082)	(0.068)	(0.103)	(0.080)	(0.111)
Δ ROW IPI		0.012		0.012		0.000		0.000
		(0.011)		(0.010)		(0.013)		(0.013)
Δ ChinaPenX		0.073		0.105		0.174**		0.213**
		(0.792)		(0.861)		(0.795)		(0.083)
Firm characteristics								
Δ Skill			-0.591***	-0.592***			-0.592***	-0.592***
			(0.033)	(0.033)			(0.032)	(0.032)
Δ TFP			-0.048	-0.520			0.038	-0.451
			(0.042)	(0.041)			(0.040)	(0.040)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	No	No	No	No	No	No	No	No
F-First stage Δ Chinese IPI	-	-	-	-	11.16	12.85	9.62	12.00
F-Weak test	-	-	-	-	34.14	6.60	37.99	37.97
Number of firms	27,793	27,793	27,237	21,648	30,303	22.960	17,535	17,535
Observations	138,894	137,682	104.817	104.817	134,061	134,061	100,704	100,704
R-squared	0.342	0.342	0.413	0.413	0.484	0.285	0.472	0.515

Note: Robust standard errors clustered at industry level in parentheses, *** p<0.01, ** p<0.05, * p<0.1. The IV includes countries that share similar characteristics with Brazil in terms of income per capita and comparative advantages: Argentina, Colombia, India, Indonesia, Mexico, Poland, Russia, South Africa, and Turkey. F-Weak test: Kleibergen Paap weak instrument statistic.

Source: Own calculations.

7. CONCLUSION

The results of this paper reinforce one of the key relationships identified in the Great Liberalization literature, notably the positive, procompetitive effect of trade on TFP. However, the same mismatch between micro and macro results persists. The positive effects were clearly not enough to help Brazil deliver a robust manufacturing TFP performance, which underlies the limits of these gains. Likewise, the fact that the statistical significance of these effects tends to fade when longer differences are used does not bode well for their impact on growth. The prevalence of once-and-for-all effects also seems consistent with evidence of a negative impact on at least some dimensions of innovation, although the results here are much less conclusive.

These concerns are amplified by recent findings elsewhere in Latin America—Mexico (Blyde and Fentanes, 2019), Peru (Pierola et al., 2019), Colombia (Molina, 2019), and El Salvador (Li and Mesquita Moreira, 2019)—which raises questions as to how widespread this relationship is. These studies adopt a similar firm-level empirical strategy and find that Chinese import competition had either negative or no effects at all on TFP.

The results for employment point to a relatively small negative shock that is not significantly different to those of Great Liberalization shock of the early 1990s. However, this does not rule out significant impacts on certain regions or communities, with unwelcome social and political-economic consequences. At a more general level, the sequence of negative trade shocks since the early 1990s seems to dispel any remaining hopes of a trade-led jobs boom in manufacturing, particularly for low-skilled labor. This is consistent with a country whose relative abundance of natural resources has only been reinforced by the emergence of Asia's labor-abundant and resource-scarce mega-economies.

What do these results mean for trade policy in Latin America and elsewhere in the developing world? They certainly do not suggest that countries would be better off by closing their economies, but they should give protrade policymakers

reason for caution, particularly when managing expectations of productivity and employment gains. There is evidence that productivity gains can be real, but they are far from a foregone result and certainly not a panacea. Employment loses can mean lower incomes and long unemployment spells for some workers, which points to the importance of alleviation policies.[36] There is only so much that trade policy can do on its own to boost productivity, employment, and growth.

REFERENCES

Aghion, P., N. Bloom, R. Blundell, R. Griffith, and P. Howitt. 2005. "Competition and Innovation: An Inverted-U Relationship." *The Quarterly Journal of Economics* 120(2): 701–728.

Autor, D.H., D. Dorn. and G.H. Hanson. 2013. "The China Syndrome: Local Labor Market Effects of Import Competition in the United States." *The American Economic Review* 103(6): 2121–2168.

Autor, David, D. Dorn, G.H. Hanson, G. Pisano, and P. Shu. 2017. "Foreign Competition and Domestic Innovation: Evidence from U.S. Patents." NBER Working Paper No. 22879.

Bernard, A.B., and J.B. Jensen. 2004. "Why Some Firms Export" The Review of Economics and Statistics 86(2): 561–569

Bernard, A.B., J.B. Jensen, and P.K. Schott. 2006. "Survival of the Best Fit: Exposure to Low-Wage Countries and the (Uneven) Growth of US Manufacturing Plants." *Journal of International Economics* 68(1): 219–237.

Bernard, Andrew, B., J.B. Jensen, S.J. Redding, and P.K. Schott. 2007. "Firms in International Trade." *Journal of Economic Perspectives* 21 (3): 105–130.

Bloom, N., M. Draca, and J. Van Reenen. 2015. "Trade Induced Technical Change? The Impact of Chinese Imports on Innovation, IT, and Productivity." London School of Economics and Centre for Economic Performance.

Blyde, J., M. Busso, V. Faggioni, and D. Romero. 2019. "The Impact of Chinese competition on Mexican Labor Outcomes." Background paper for *Trading Promises for Results: What Global Integration can do for Latin America and the Caribbean*. IDB: Washington, DC.

Blyde. J. and O. Fentanes. 2019. "The Heterogeneous Impacts of Chinese Competition on Mexican Manufacturing Plants," Background paper for *Trading Promises for Results: What Global Integration can do for Latin America and the Caribbean*. IDB: Washington, DC.

Blyde, J., J. C. Pires, M. Rodríguez Chatruc, and N. Russell, 2019. "Training and Labor Adjustment to Trade." IDB Working Paper Series 1069.

Brambilla, I., N. Depetris-Chauvin, and G.G. Porto. 2015. "Wage and Employment Gains from Exports: Evidence from Developing Countries." Working papers 2015–28. CEPII Research Center.

Brummund, P., and L. Connolly. 2018. "Who Creates Stable Jobs? Evidence from Brazil." *Oxford Bulletin of Economics and Statistics* 81(3).

Corden, M. 1981., "The Exchange Rate, Monetary Policy and North Sea Oil: The Economic Theory of the Squeeze on Tradeables." *Oxford Economic Papers* 33: 23–46.

Correia, S. 2015. "Singletons, Cluster-Robust Standard Errors and Fixed Effects: A Bad Mix." Duke University, Mimeo, https://scorreira.com/research/singletons.pdf

Costa, F. 2013. "Can Rationing Affect Long Run Behavior? Evidence from Brazil." London School of Economics. Mimeo.

Costa, F., J. Garred, and Pessoa, J.P. 2016. "Winners and Losers from a Commodities-for-Manufactures Trade Boom." *Journal of International Economics* 102: 50–69.

[36] Policies such as job training could facilitate the transition of laid off workers to other sectors (Blyde et al, 2019).

De Loecker, J. 2011. "Product Differentiation, Multiproduct Firms, and Estimating the Impact of Trade Liberalization on Productivity." *Econometrica* 79(5): 1407–1451.

Dix-Carneiro, R., and B.K. Kovak. 2017. "Trade Liberalization and Regional Dynamics." *American Economic Review* 107(10): 2908–46.

———. 2019. "Margins of Labor Market Adjustment to Trade." *Journal of International Economics* 117(março): 125–42.

Campbell, D. L and K. Mau, 2020. "On 'Trade Induced Technical Change: The Impact of Chinese Imports on Innovation, IT and Productivity'," Working Papers w0264, New Economic School (NES).

Eslava, Marcela, J. Haltiwanger, A. Kugler, and M. Kugler. 2013. "Trade and Market Selection: Evidence from Manufacturing Plants in Colombia." *Review of Economic Dynamics* 16(1): 135–158.

Estevadeordal, A., and A.M. Taylor. 2013. "Is the Washington Consensus Dead? Growth, Openness, and the Great Liberalization, 1970s–2000s." *Review of Economics and Statistics* 95(5): 1669–90.

Feenstra, Robert C. 2018. "Alternative Sources of the Gains from International Trade: Variety, Creative Destruction, and Markups." *Journal of Economic Perspectives* 32(2): 25–46.

Foster, L., J.C. Haltiwanger, and C.J Krizan. 2001. "Aggregate Productivity Growth: Lessons from Microeconomic Evidence". NBER Working Paper No. w6803. Available at SSRN: https://ssrn.com/abstract=140599

Frischtak, C. and M. Mesquita Moreira. 2015. "Where Is Brazil Going? Taking Stock of Recent Trends in Industrial and Trade Policies and the Challenges Ahead." In C. Frischtak, *Meddling with Growth: Brazil's Micro-Policies in the Age of Turbulence.* LAP Lambert Academic, Munich.

Goldberg, Pinelopi K., and N. Pavcnik, 2016. "The Effects of Trade Policy," NBER Working Papers 21957.

Gonçalves, J., E. Gonçalves, and R. Freguglia. 2019. "The Missing Link Between Innovation and Performance in Brazilian Firms: A Panel Data Approach." *Applied Economics.* Taylor and Francis

Gorodnichenko, Y., J. Svejnar, and K. Terrell. 2010. "Globalization and Innovation in Emerging Markets." *American Economic Journal: Macroeconomics* 2: 194–226 doi= http://www.aeaweb.org/articles.php? =10.1257/mac.2.2.194

Greene, William. 2004. "The Behaviour of the Maximum Likelihood Estimator of Limited Dependent Variable Models in the Presence of Fixed Effects." *Econometrics Journal* 7: 98–119.

Hall, B.H. 2011. "Innovation and Productivity." NBER Working Paper no. 17178.

Katayama, H., S. Lu, and J.R. Tybout. 2009. "Firm-Level Productivity Studies: Illusions and a Solution," *International Journal of Industrial Organization* 27(3), 406–413.

Lage de Sousa, F. 2018. "Flooding of Chinese Goods and Their Impacts on Exports of Other Countries: A Firm-Level Investigation." BNDES Discussion Papers 125.

Levinsohn, J., and Petrin, A. 2003. "Estimating Production Functions Using Inputs to Control for Unobservables." *Review of Economic Studies* 70(2): 317–341

Li, K., and M. Mesquita Moreira. 2019. "China Import Competition and El Salvador Manufacturing Firm Performance." IDB Working Paper Series IDB-WP-01082, IDB, Washington, DC.

Li, K., 2019. "China Import Competition and El Salvador Labor Market," Background paper for *Trading Promises for Results: What Global Integration can do for Latin America and the Caribbean*. IDB: Washington, DC.

Li, K., and M. Mesquita Moreira. 2019. "China Import Competition and El Salvador Manufacturing Firm Performance," Background paper for *Trading Promises for Results: What Global Integration can do for Latin America and the Caribbean*. IDB: Washington, DC.

López-Córdova, E., and M. Mesquita Moreira. 2004. "Regional Integration and Productivity: The Experiences of Brazil and Mexico". In Antoni Estevadeordal, Dani Rodrik, Alan M. Taylor and Andres Velasco. *Integrating the Americas. FTAA and Beyond.* David Rockefeller Center for Latin American Studies. Harvard University Press.

Melitz, M.J. 2003. “The Impact of Trade on Intra-industry Reallocations and Aggregate Industry Productivity.” *Econometrica* 71(6): 1695–1725.

Mesquita Moreira, M., and E. Stein. 2019. *Trading Promises for Results: What Global Integration can do for Latin America and the Caribbean*. IDB: Washington, D.C.

Mesquita Moreira, M. and P.G Correa. 1998. “A First Look at the Impacts of Trade Liberalization on Brazilian Manufacturing Industry.” *World Development* 26(10): 1859–1874.

Mion, G., and Zhu, L. 2013. “Import Competition from and Offshoring to China: A Curse or Blessing for Firms?” *Journal of International Economics* 89(1): 202–215.

Molina, D. 2019. “The China Effect on Colombia’s Manufacturing Labor Market.” Background paper for *Trading Promises for Results: What Global Integration can do for Latin America and the Caribbean*. IDB: Washington, DC.

Muendler, M.A. 2004. “Trade, Technology and Productivity: A Study of Brazilian Manufacturers 1986–1998” CESifo Working Paper No. 1148.

Olley, S., and A. Pakes. 1996. “The Dynamics of Productivity in the Telecommunications Industry.” *Econometrica* 64(6): 1263–1298.

Paz, L.S. 2019. “The China Shock Impact on Brazil’s Manufacturing Labor Market.” Background paper for *Trading Promises for Results: What Global Integration can do for Latin America and the Caribbean*. IDB: Washington, DC.

Pierce, J., and P. Schott. 2012. “A Concordance Between Ten-Digit U.S. Harmonized System Codes and SIC/NAICS Product Classes and Industries.” *Journal of Economic and Social Measurement* 37(1, 2): 61–96.

Pierola, M.D., and D. Sanchez-Navarro. 2019. “The Impact of Import Competition on the Labor Market. The Case of the Peruvian Manufacturing Sector,” Background paper for *Trading Promises for Results: What Global Integration can do for Latin America and the Caribbean*. IDB: Washington, DC.

Pierola, M.D., Sanchez-Navarro, D., and E. Mercado. 2019. “The Impact of Import Competition on Firm Performance in the Peruvian Manufacturing Sector.” Background paper for *Trading Promises for Results: What Global Integration can do for Latin America and the Caribbean*. IDB: Washington, DC.

Schor, A. 2004. “Heterogeneous Productivity Response to Tariff Reduction. Evidence from Brazilian Manufacturing Firms.” *Journal of Development Economics* 75(2): 373–396.

Schott, P.K. 2008. “The Relative Sophistication of Chinese Exports.” *Economic Policy* 53.

Van Beveren, I. 2012. “Total Factor Productivity Estimation: A Practical Review.” *Journal of Economic Surveys* 26(1): 98–128.

Wooldridge, Jeffrey M. 2009. “On Estimating Firm-Level Production Functions Using Proxy Variables to Control for Unobservables.” *Economics Letters* 104(3): 112–114.

Wooldridge, Jeffrey. 2001. *Econometric Analysis of Cross Section and Panel Data*. MIT Press: Cambridge, USA.