2023, Volume 46, Issue 91, 22-38 / ISSN 2304-4306

ECONOMÍA

revistas.pucp.edu.pe/economia

FONDO EDITORIAL

www.fondoeditorial.pucp.edu.pe

Preferential Trade Agreements and Productivity: Evidence from Peru

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Abstract

This paper analyzes the impact of reducing output tariffs (i.e., domestic tariffs on import of final goods) and input tariffs (i.e., domestic tariffs on imports of intermediate goods) on total factor productivity growth of Peruvian manufacturing firms. Peru's annual survey of manufacturing data from 2003–2017 is used to explore the reduction of tariffs during three preferential trade agreements: United States, China, and the European Union. Lower output tariffs could decrease productivity by reducing firm's market share or could increase productivity by inducing tougher import competition, while cheaper imported inputs can raise productivity via learning, variety, and quality effects. The results show that a decrease in output tariffs decreases Peruvian firms' productivity growth for non-exporters (i.e., domestic firms producing goods that are also imported) while increasing productivity growth for exporters (i.e., domestic firms producing export goods). In contrast, a reduction in input tariffs increases firm productivity for all firms.

Article History: Received: 22 March 2022 / Revised: 15 July 2022 / Accepted: 01 August 2022
Keywords: Total Factor Productivity; Free Trade Areas
JEL Classification: D24, F13

https://doi.org/10.18800/economia.202301.002

1. Introduction

Over the past decade, trade liberalization has become a crucial part of many countries' development strategies particularly for Latin America and Caribbean economies. Trade liberalization might have a positive impact on a country's economy, due to the pro-competitive effects of trade (Bernard et al., 2003; Topalova and Khandelwal, 2011) or a negative impact in the economy due to a decrease in a firm's incentive to make productivity-enhancement investments (Vives, 2007). The liberalization process either through unilateral tariffs reduction or preferential trade agreements (PTAs) may affect quite differently, on the one hand, if tariff reductions affect the final and intermediate (or input) goods of firms, and on the other hand, whether firms, exports or compete with imported goods. In consequence, the main contribution of this paper is to estimate the effects of the three most important PTAs implemented by Peru on manufacturing firms' total factor productivity (TFP), distinguishing the effects between exports and non-exports firms in period 2003–2017.

Since 2009 Peru has signed more than thirteen preferential trade agreements, particularly with three of the most important trading partners, the United States, which agreement entered into force in February 2009, China, which agreement came into effect in March 2010, and the European Union, which agreement entered into force in March 2013. Trade with these countries explain more than 50% of the total trade flows of Peru (WTO, 2020). At the same time studies have shown that productivity growth in Peru has been low in the last two decades and that the manufacturing industry is highly concentrated (World Bank , 2015; Tello, 2022a). This paper will try to understand if there is a connection between these two facts.

The paper uses a reduced-form approach to estimate the effect of trade liberalization on firm-level productivity similarly to Pavcnik (2002), Amiti and Konings (2007) and Fernandes (2007). The paper's specification focus on the pre- and post-reform period to exploit plausibly exogenous intertemporal variation in trade protection across industries.

The estimation of the firm-level TFP is based in an extension of the Olley and Pakes, and Levinsohn parameters of industry-level production functions methods using the methodology of De Loecker (2011a).[1] This methodology quantifies the productivity response to a reduction in trade protection while relying on demand shifters and exogenous trade protection measures to control for demand and price effects. Thus, the usual biases of the productivity estimations based upon real output and revenues are reduced since prices changes from the liberalization process are controlled. Next, the relationship between changes in trade policies and changes in firm productivity is examined.[2]

Overall, the estimations results indicate that firms in industries that experienced a reduction in output tariffs (i.e., domestic tariffs on import of final goods), ceteris paribus, have lower levels of productivity growth relative to firms that do not experience this reduction. However, when the effect of the output tariffs is divided by exporter (i.e., domestic firms producing export goods) and non-exporter (i.e., domestic firms producing goods that are also imported) status, (the idea being

[1] Van Beveren (2012) presents a detailed discussion on the variety of TFP estimation measures and methods. The De Loecker (2011a) method attempt to measure the physical productivity (details in Tello, 2022b).

[2] Details in Appendix.

that exporting firms are more equipped to take advantage of the pro-competitive forces of trade liberalization than non-exporting firms), it is found that exporting firms experienced an increase in productivity after a reduction in output tariffs, while non-exporting firms experience a decrease in productivity growth. There are several possible explanations for this: non-exporting domestic firms may not be able to realize productivity gains because they are unable to successfully innovate (or adapt foreign technologies) in the domestic market; these firms might face binding financial constraints that prevent the expansion of efficient industries as well as investments in new technology. In contrast, exporting firms might have previous experience adopting foreign technology while satisfying the foreign demands and have higher credit availability.

Regarding input tariffs (i.e., domestic tariffs on import of intermediate goods), the main benefits that accrue from lowering input tariffs is to make foreign (or imported) inputs more accessible. A higher usage of foreign inputs can increase firm productivity due to learning effects from the foreign technology embodied in the imported inputs, higher-quality inputs, and from more input varieties. It is found that a reduction of input tariffs is associated with an increase of productivity growth for all firms, however exporters seem to reap higher benefits than non-exporters. Although we are unable to identify directly which firms is an importer, we hypothesize that exporter firms are more likely to be importers firms as well, hence reaping the highest direct benefit of a decrease in input tariffs.

The paper is organized as follows. Section 2 presents a brief review of literature. Section 3 describes the trend of GDP and manufacturing sector of Peruvian economy in period 2001–2017. Section 4 describes the datasets used in our regressions. Section 5 presents the empirical methodology and the results. Section 6 provides some conclusions and suggested avenues for further work.

2. Brief Literature Review on Trade Liberalization and TFP

There is a relatively large theoretical and empirical literature on the factors that influence the firm productivity. Most of the empirical literature, however, it has been concentrated on firms from developed economies with just a few studies for developing economies. According to a review by Syverson (2011) there are several factors that influence firms' productivity. One of them is competition (domestic and trade competition). Syverson, presents three mechanisms by which competition may increase or decrease productivity. The first is a selection mechanism by which competition moves market share toward more efficient (i.e., lower-cost and generally therefore lower-price) producers, shrinking relatively high-cost firms, sometimes forcing their exit, and opening up room for more efficient producers. The second mechanism acts through efficiency increases within plants or firms. Heightened competition induces firms to take costly productivity raising actions that they may otherwise not. The third, but negative mechanism of competition, is the Schumpeterian caveat. Vives (2007) points out, under certain conditions, a higher level of competition can diminish a firm's incentives to make productivity-enhancing investments.

In addition to the channels above-described trade competition can affect productivity through the input-market channel or declines in the effective price of intermediate and capital inputs when those become more available. Preferential trade agreements are one of the most used forms in LAC to foment trade competition. Trade agreements cover 70% of all trade in Latin America and the Caribbean (LAC). Of the 270 free trade agreements (FTAs) currently in effect around the world, more than 70 include LAC countries.[3] Gretton (2018) postulates that the drift toward preferential trading arrangements is at odds with the most favored nation (MFN) and national treatment principles of the GATT, and has led to a debate as to whether preferential agreements are 'building blocks' or 'stumbling blocks' on the road to MFN trade and productivity improving economic reforms. He argues that the proliferation of preferential arrangements and the formation of new trading blocs does not support the 'building block' case.[4]

Another plausible effect on productivity is provided by the study of Armstrong (2015). He points out that the Australia-United States Free Trade Agreement (AUSFTA) has resulted in a likely net loss of trade due to the trade divergence element of the agreement outweighing the bilateral trade creating element. In this regard, Gretton (2018) indicates that trade preferences and origin rules of bilateral and regional scenarios would have a few effects that would impede economic efficiency and lower productivity. They could lead some firms to adopt a more costly input mix and higher cost structure in order to obtain preferential access for finished products; and induce changes in the location of investment between members of a preferential agreement and between members and non-members. They could also add to the risk of doing business arising from the potential for delay in documentation and clearance and failure to meet origin requirements as well as from the complexity of doing business arising from procedures for conferring origin. All these negative effects may discourage to improve firms' productivity.[5]

Empirical studies on trade liberalization and productivity on Peruvian firms are not abundant. Three relevant studies for this paper are developed by Céspedes et al. (2016), Castellares (2015, 2016), and Schiffbauer and Sampi (2019). Céspedes et al. (2016) finds that firms that participate in international trade, either as exporters and/or importers, have consistently higher productivity compared to firms that do not trade. Castellares (2015, 2016) finds that more productive firms upgrade their product quality to differentiate them from low-cost and low-quality Chinese apparel goods. Conversely, less productive Peruvian firms, which are not able to increase their quality, react by reducing their prices. In addition, they find evidence that the average quality of Peruvian apparel products increases during 2001 to 2007. This means, that access to markets and competition could improve productivity for competitive firms through product upgrading. The third study by Schiffbauer and Sampi (2019) find that enforcing competition within the con-

[3] https://blogs.iadb.org/integration-trade/en/five-reasons-why-trade-agreements-in-latin-america-and-the-caribbean-matter/.

[4] Peru since 2009 has signed more than thirteen preferential trade agreements domestic and export producers do not always have complete information on the changes in tariffs, technical barriers to trade or the rules of origin.

[5] A recent study of Arrieta (2021) on the Preferential Trade Agreement between USA and Peru concludes that the Peru-USA PTA generated intra-bloc trade creation for the tradable goods between both countries. Also, the PTA produced export trade diversion and import trade creation. Overall, the Peru-USA FTA is an "intra-bloc trade creation agreement" that boosted bilateral trade flows. This would mean that the trade creation effect of Peru-USA PTA may have produced an increase on firms' productivity. This hypothesis is validated by the evidence shown below.

trolled institutional environment of a country—through the elimination of subnational barriers to entry—boosted the (revenue) productivity of establishments operating in reform municipalities and sectors relative to establishments in non-reform municipalities/sectors. However, it did not raise the establishments' markups, which declined, suggesting that physical productivity improved. Additional evidence of the relationship between productivity and trade liberalization is presented in the next sections.

3. Trend in Peruvian Economy: GDP and Manufactures

Table 1 compares some Peruvian economy indicators before and after the reforms. GDP growth rate averaged 4.43% in the post-reform period while in the pre-reform period averaged 6.76%. The growth rate of real value-added for the manufacturing sector was of 7.38% in the pre-reform period, whereas in the post liberalization period the rate decreased to 1.89%. This sluggish growth in the manufacturing sector implied a reduction in the growth rate of total imports, imports of capital goods, and the imports of manufacturing goods from USA, CHN, and EU in the post liberalization period.

According to Rodríguez et al. (2018), the main factor explaining the decrease in the GDP growth rate, which affected also investment, public expenditure growth, and consumption, was a decrease in the terms of trade, led by export prices. The rate of growth of export prices and terms of trade between 2003 and 2008 were 18.5% and 7.7% respectively, and in period 2009–2017 decreased to 2.1% and 1.4%. Furthermore, in period 2012–2017, both rates of growth were negative (BCRP, 2022). Consequently, in a period of trade liberalization, through PTAs, the potential gains on productivity may have been neutralized due to a decreasing trend of rate of growth of the terms of trade.

Despite of the decrease of the economic growth and the manufacturing sector, it is worth noting that manufactured goods from China gained a greater level of access to domestic market against

Table 1
Peru: GDP growth rate, Manufacturing Value Added, Imports and TFP 2003–2017.

Variables	Pre reform period 2003–08	Post-reform period 2009–17
Average Annual GDP (US$ millions 07)	92,709	141,839
Average Annual GDP growth rate (%)	6.76	4.43
Average Annual Manufacturing Value-Added (US$ millions 07)	15,078	20,513
Average Annual Manuf. Value-Added growth rate (%)	7.38	1.89
Average Annual Imports growth rate (%)	13.71	4.17
Average Annual Imports of Capital growth rate (%)	17.68	5.30
Average Annual USA import growth rate (%)	10.59	0.27
Average Annual EU import growth rate (%)	13.12	3.79
Average Annual CHN import growth rate (%)	31.37	10.06

Note: EU, corresponds to 27 countries (do not include United Kingdom).
Source: BCRP (2022), UNCTAD (2022), Conference Board (2022).

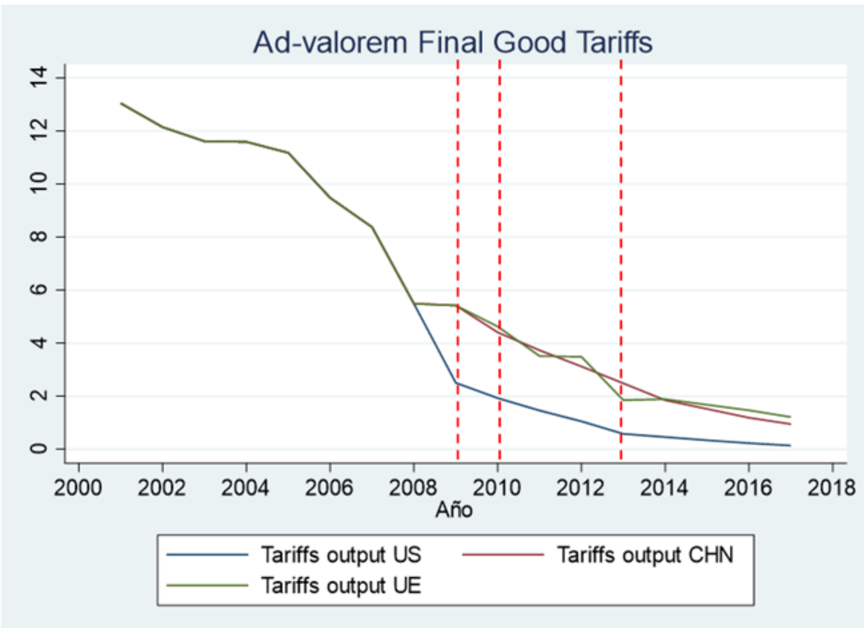
USA/EU manufacturing import. In 2003, manufactured imports from China accounted for 7.6% of total imports whereas USA accounted for 17.1%. In 2017, the respective shares increased to 22.8% for China and decreased to 9.1% for USA Similar to USA the share of manufacturing imports coming from the European Union went from 12.2%, in 2003 to 11.1% in 2017.

4. Data

Given this economic context, our analysis is based upon two main databases. The Annual Economic Survey from the period 2003–2017 (INEI-EEA, 2022) which contains firm-level data on employment, performance and export status and the trade and tariffs data from the National Tax Administration (SUNAT, 2022).

4.1 Output and Input Tariffs

Figures 1 and 2 show the evolution of trade barriers under the three preferential trade agreements (PTAs). The dashed red lines in each graph represent the timing of these preferential trade agreements. The USA-Peru FTA entered into force on February 1, 2009; the China-Peru FTA entered into force on March 1, 2010 and the EU-Peru FTA entered into force March 1, 2013. Figure 1 shows a yearly average of the 4-digit ISIC tariffs, these tariffs were computed as a weighted average (using import values as weights) of the HS-8 digit tariffs. Figure 2, shows yearly average of the input or intermediate goods tariffs per 4-digit ISIC sector. The input tariffs are calculated using the following formula $\tau_{st}^{input} = \sum_j w_{sj} \tau_j^{output}$, where τ_j^{output} are the 4-digit ISIC final good tariffs and w_{sj} are the share of total inputs that sector s uses from sector j

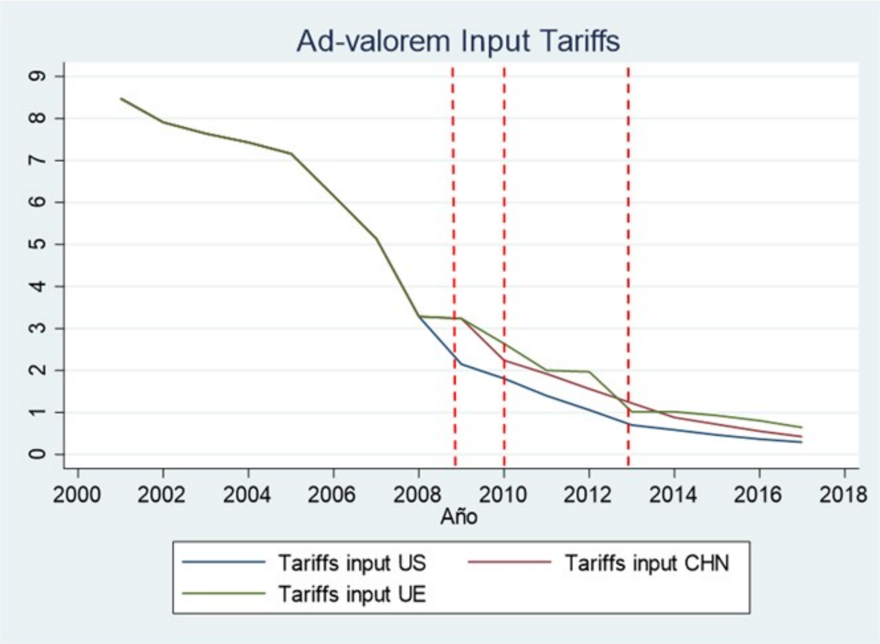


Source: SUNAT (2022).

Figure 1. Output (final goods) ad-valorem tariffs.

according to the 2007 Peruvian input-output matrix (INEI, 2023). Note that in the pre-FTA era, before 2009, the tariff rates are the same for USA, CHN and EU since Peru imposed the MFN tariffs rates for these countries.

Figure 1 shows that post-liberalization the USA output tariffs are on average lower than the ones imposed to China or EU. The average decrease in output tariffs rate three years post USA-Peru FTA was 4.45%, while the respective decrease in output tariffs three years after the FTA with China and EU was 2.94% and 2.02% respectively. We see similar pattern when looking at the input tariffs in Figure 2. The decrease input tariffs is more pronounced for USA goods than for goods coming from China or EU. The average decrease in input tariffs rate three years post USA-Peru FTA was 2.22%, while the respective decrease in input tariffs three years after the FTA with China and EU was 2% and 1.16% respectively.



Source: SUNAT (2022)

Figure 2. Input (intermediate goods) ad-valorem tariffs.

4.2 Firm-level Data

We use the Annual Economic Survey from the period 2003–2017 (INEI-EEA, 2022) which contains firm-level data on sales, employment, investment and cost of intermediate inputs, needed to estimate firm-level productivity. Table 2 summarizes these outcomes across firms in our sample. The average firm in our sample has 270 workers and around 22 million dollars of sales. The distribution of employment and sales is right-skewed since this survey samples large firms almost surely, while randomly sampling small to medium size firms.

Table 2
Indicators of manufacturing Peruvian firms 2003–2017.

Variables	N	Mean	P25	P50	P75
Firm's employment	6,240	269.6	53	125	281
Firm's Real Sales ($M)	6,240	22.18	3.213	6.659	16.21
Firm's Real Value of Added ($M)	6,240	18.93	1.684	4.339	9.979
Firm's Real Value of Capital ($M)	6,240	22.38	1.331	3.741	12.45
Firm's Real Value of Investment ($M)	5,804	4.295	0.0291	0.236	1.202
Firm's Real Value of inputs for Production ($M)	6,240	4.408	0.388	1.089	3.122
Firm's Productivity index standardized by sector	6,240	-0.00884	-0.723	-0.0449	0.672
Firm's Productivity growth (2002-2017)	6,240	-0.0473	-0.415	-0.0801	0.259
Industry Price Cost Margin	6,240	0.476	0.344	0.489	0.592
USA real imports by ISIC-Rev4 ($M)	6,240	13.18	0.494	4.376	18.25
CHN real imports by ISIC-Rev4 ($M)	6,172	16.15	0.712	7.438	25.28
UE real imports by ISIC-Rev4 ($M)	6,235	11.38	0.720	3.826	15.62
Share of the Import real value of capital goods out of total imports by ISIC-Rev4 of the firm	6,240	0.104	0	0	0.00523
Share of Firms with 100 or more workers	6,240	0.577			
Share of firms with 20-99 workers	6,240	0.308			
Share of firms with less than 20 workers	6,240	0.115			
Number of firms that exports	6,240	0.454			
Number of Foreign firms (at least 50% of total firms' assets are foreign)	6,240	0.166			

Note: All variables that are expressed in real terms are in Million of 2007 dollars. They are computed using an industry price deflator, except for the Capital and investment wherein the GDP price deflator was used. PN is the value of the variable in the percentile N, ordered by the magnitude of the variable.
Source: INEI-EEA (2022), SUNAT (2022). Authors' work.

5. Specification and Estimations Results

We begin by examining the impact of the preferential trade agreements on firm productivity growth. To estimate total factor productivity, we follow De Loecker (2011a,b,c) methodology.[6] This methodology uses observed demand shifters to separate out the price relative to the productivity effects when sales are observed and physical output is not observed, as in our case. As input to this methodology we need to propose a vector of demand shifters, for this end we use the real output of the 4-digit ISIC sector that firms belong to, in addition to trade protection instruments, tariffs and non-tariff measures at the 4-digit ISIC sector. The coefficients of the regression estimates are presented in Table A.1. To be able to compare productivity measures across firms in different industries, we construct a firm-level productivity index that is transitive, we obtain such an index by subtracting from an individual firm's productivity the productivity of a reference plant[7] in the firm's respective sector.

[6] Details in Appendix.
[7] The reference firm productivity is the mean productivity across firms in a particular sector.

In the second stage, firms' TFP estimates are used to run the following specification:

$$\Delta ln\text{TFP}_{ist} = \alpha + \beta_1 post^{PREF} + \beta_2 \tau_{st}^{output,PREF} + \beta_3 \tau_{st}^{input,PREF} + \beta_4 DX_{it} + \beta_5 post^{PREF} + \beta_6 lnM_{st}^{PREF} + \beta_7 post^{PREF} lnM_{st}^{PREF} + \delta_{it} + \theta_{st} + \alpha_i + \gamma_t + \varepsilon_{it}. \quad (1)$$

The dependent variable of equation (1) is the productivity growth rate for firm i in sector s at time t. $post^{PREF}$ is a dummy equal to 1 in the period after the trade liberalization agreement, where PREF is either USA ($post^{PREF}$ = 1 when year = 2009), China ($post^{PREF}$ = 1 when year = 2010), or European Union ($post^{PREF}$ = 1 when year = 2013). $\tau_{st}^{output,PREF}$ measures the output tariffs or the final good tariffs that Peru imposes to its foreign partner at the 4-digit ISIC-Rev4 level. The tariffs are computed as a weighted average (using Peru's imports as the weights) of the HS-8 digit tariffs. Intermediate good tariffs or input tariffs are measured by $\tau_{st}^{input,PREF}$ at the 4-digit ISIC-Rev4. These tariffs are computed using a weights from the 2007 Peruvian input-output matrix (INEI, 2023). DX_{it} is a dummy equal to 1 if the firm exports in year t and 0 otherwise. We also include import penetration controls in our specification, lnM_{st}^{PREF} or $ln(PREF\_Imports)$. This measures the log of imports in a particular 4-digit ISIC sector.

In addition, equation (1) includes a set of controls (δ_{it}) such as firm's size (Firm size 100+ workers and Firm size 20-100 workers); firm's capital-labor ratio ($ln(K/L)$) which relevant since firms with different capital intensive might have different productivity growth rates; a dummy, DFO (Foreign-owned Firm Dummy), if the firm had 50% or more of the firm's total capital foreign owned; and the vector θ_{st} which contains industry-year controls, including the number of non-tariff barriers per 4-digit ISIC sector by preferential trade agreement (*PREF_Non-Tariff Barriers*) and the share of foreign capital in an industry (*Share of Foreign K in industry s*) which is constructed by dividing the imported capital in industry s by total imports in industry s. Finally, we included firm and year fixed effects.

Implicitly, our analysis compares firms with similar characteristics (trade status, size, capital-labor intensities, foreign-owned, etc.), some of whom are in industries subject to final goods tariffs reductions, and thus directly compete with the liberalized foreign products, and some of whom are in industries subject to intermediate goods tariffs reductions, and thus see a reduction in the foreign inputs price. Note that there will be some firms in industries where both tariffs, output and input, decline at the same time, these firms will have these two forces at play.

Table 3 presents baseline estimates of equation (1) for the three preferential trade agreements, USA in column (1), China in column (3) and European Union in column (5). For the three PTA in all the regressions, there is a positive and significant relationship between output tariffs and productivity growth, and a negative relationship between input tariffs and productivity growth, although with differences in the degree of statistically significant. This means that a decrease in tariffs for final goods imported from the USA, CHN or EU will decrease Peruvian firms' productivity growth, suggesting than on average Peruvian firms are worse-off when competing directly with foreign firms. However, reduction in the input tariffs implies an increase in firm productivity growth, pointing to the positive role of the indirect input market channel in fostering productivity growth. To interpret the magnitude of these coefficients, we will use the average reduction in tariffs three-year post USA-FTA of 1% for output tariffs and 1% for input tariffs.

Table 3

Trade liberalization and TFP growth rate 2003–2017.

Variables	(1) Fixed Effects Peru-USA	(2) Fixed Effects Peru-USA	(3) Fixed Effects Peru-CHN	(4) Fixed Effects Peru-CHN	(5) Fixed Effects Peru-EU	(6) Fixed Effects Peru-EU
Tariffs_output_PREF	0.0189***	0.0282***	0.00663	0.0204*	0.00516	0.0204**
	(0.00585)	(0.00942)	(0.00696)	(0.0106)	(0.00568)	(0.00938)
Tariffs_input_PREF	-0.0164*	-0.0307**	-0.00359	-0.0231	-0.0141	-0.0362**
	(0.00953)	(0.0139)	(0.0122)	(0.0176)	(0.00999)	(0.0158)
*Tariffs_output_PREF*Exporter*		-0.0173*		-0.0248**		-0.0262**
		(0.00997)		(0.0119)		(0.0114)
*Tariffs_input_PREF*Exporter*		0.0270*		0.0318*		0.0357**
		(0.0147)		(0.0175)		(0.0173)
Post_PREF	0.0916	0.0885	0.0829	0.0636	-0.258	-0.308
	(0.275)	(0.274)	(0.227)	(0.227)	(0.285)	(0.287)
*Post*ln(PREF_Imports)*	0.00946	0.00926	0.00794	0.00811	0.0236	0.0256*
	(0.0138)	(0.0139)	(0.0105)	(0.0104)	(0.0145)	(0.0146)
ln(PREF_Imports)	-0.0277	-0.0263	-0.0140	-0.0140	-0.0240	-0.0236
	(0.0351)	(0.0352)	(0.0170)	(0.0169)	(0.0247)	(0.0245)
ln(K/L)	-0.132**	-0.132**	-0.133**	-0.134**	-0.132**	-0.131**
	(0.0527)	(0.0529)	(0.0531)	(0.0534)	(0.0528)	(0.0529)
Share of Foreign K in industry s	0.382	0.474	0.339	0.387	0.277	0.326
	(0.478)	(0.503)	(0.491)	(0.496)	(0.486)	(0.495)
Exporter Dummy	-0.0129	-0.0148	-0.0164	0.0198	-0.00940	0.0179
	(0.0431)	(0.0472)	(0.0436)	(0.0507)	(0.0439)	(0.0506)
Foreign-owned Firm Dummy	-0.0657	-0.0642	-0.0615	-0.0607	-0.0662	-0.0662
	(0.0494)	(0.0494)	(0.0504)	(0.0504)	(0.0495)	(0.0494)
PREF_Non-Tariff Barriers	-0.000106	0.000367	0.00309	0.00279	-0.124*	-0.119*
	(0.0131)	(0.0134)	(0.00287)	(0.00289)	(0.0676)	(0.0640)
Firm size 100+ *workers*	-0.520***	-0.516***	-0.514***	-0.514***	-0.516***	-0.519***
	(0.129)	(0.129)	(0.130)	(0.130)	(0.129)	(0.129)
Firm size 20-100 workers	-0.401***	-0.401***	-0.396***	-0.399***	-0.392***	-0.399***
	(0.113)	(0.113)	(0.114)	(0.115)	(0.114)	(0.114)
Observations	6,240	6,240	6,172	6,172	6,235	6,235
R-squared	0.102	0.102	0.100	0.100	0.102	0.103
Number of IRUC-Firm	1,375	1,375	1,359	1,359	1,375	1,375
Firm FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES

Notes: Robust standard errors in parentheses ***p 0.01, **p 0.05, *p 0.1. All the regressions include firm FE, year FE and a constant.

A manufacturing firm subject to the average decrease in output tariffs will have a reduction of within-firm productivity growth of 1.89%, while if the same firm only faces the average decrease in input tariffs, within-firm productivity growth will increase by 1.64%. If the firm faces both at the same time, it's net productivity growth will decrease by 0.25%.

These effects of output and input tariffs are statistically significant for the PTA Peru-USA. For, China-FTA and EU-FTA their respective coefficients were not statistically significant suggesting that the increase in competition from China or EU and reduction in intermediate inputs prices coming from China and EU did not play a significant role in affecting firm productivity in Peru.

Nonetheless, when heterogeneity of effects by firm characteristics particularly whether firms export or not is considered, the tariffs effects in such cases are more robust for all the PTA. The idea is the following, the pro-competitive forces caused by a reduction in output tariffs might be only beneficial for firms that are able to compete with foreign firms, adapting foreign technologies and innovating. If exporters are more likely to adapt and innovate then we should see their productivity increase due to the increase in domestic competition. To test this hypothesis, we include in Table 3 the interaction between input and output tariffs and the exporter dummy in columns (2), (4) and (6) for the FTA with USA, China, and EU respectively. In all the specifications, the coefficient of the interaction between the output tariff dummy and the export status is negative and statically significant. The negative coefficient for this interaction means that a reduction in output tariffs increase firm productivity growth for exporters relative to non-exporters. The net effect of a reduction in output tariffs is positive and significant for exporters that compete with USA imports but negative and significant for exporters that compete with China and EU. Thus, if Chinese output tariffs decreased by 2.94% (which is the average decrease in tariffs 3 years post China-FTA) then within-firm productivity growth increase of 1.3% for exporters while it will decrease by 6.0% for non-exporters. If the EU output tariffs decreased by 2.02% (which is the average decrease in tariffs 3 years post EU-FTA) then within-firm productivity growth increase of 1.28% for exporters while it will decrease by 4.5% for non-exporters. This concurs with the idea that in Peru only exporters are able to reap the benefits of competition, and thus can do policies (product/process innovation or adapting new technologies) to increase their productivity while non-exporters are not able to compete with foreign products.

Regarding to the differential impact of a reduction of input tariffs between exporters and non-exporters by looking at the interaction coefficient of input tariff and exporter dummy, except for the exporters that compete with USA imports, the results indicate there is no differential effect of a reduction of input tariffs on exporters vs non-exporters for the PTA of China and EU. This means that intermediate inputs tariff reduction of goods coming from EU and China benefit both exporters and non-exporters firms in a similar manner (in the sense that input tariff reduction will increase TFP growth of both type of firms). These findings are consistent with the trade literature that argues that reductions in input tariffs facilitates firms' access to a wider range of cheaper, potentially higher quality inputs that can contribute to improve firms' productivity (Amiti and Konings, 2007).

From the rest of control variables, the coefficients estimate indicate that the rate of growth of total factor productivity are higher for small (less than 20 workers) and/or low capital-labor ratios firms. Also, reductions in the number of non-tariff barriers also affect positive and significantly the TFP to firms with compete with EU import.

6. Conclusions

This paper has analyzed the effect of three different episodes of trade liberalization on firms' productivity of the Peruvian manufacturing sector. This study is the first to distinguish between a reduction in final good tariffs and intermediate goods tariffs in the context of Peru. Our results imply that a reduction in output tariffs is related to an increase in productivity growth for exporters while a decrease in productivity growth for non-exporters. Suggesting that exporting firms are more equipped to take advantage of the pro-competitive forces of trade liberalization than non-exporting firms.

In addition, we show that the effect of reducing input tariffs significantly increases productivity for all firms, however slightly more so for exporters than non-exporters. We hypothesized that exporters are more likely to be importers, and thus are able to reap direct benefits of a reduction in the input tariffs. These direct benefits can come from lower price foreign inputs, higher-quality foreign inputs and/or through learning by importing effects. Other complementary results point out that the rate of growth of total factor productivity are higher for small (less than 20 workers) and/or low capital-labor ratios firms. Also, reductions in the number of non-tariff barriers also affect positive and significantly the TFP to firms with compete with EU imports.

As final note, the analysis of the impact of PTAs and trade liberalization in general, has many fronts, one is TFP, others relevant research topics are the impacts on domestic market competition, and firms' innovation, areas worthwhile to investigate in the future.

Appendix

TFP De Loecker (2011a,b,c) Estimation[8]

The stochastic production function (SPF) to be estimated is a Cobb-Douglas SPF with three inputs: capital, labor, and materials.

$$\ln(q_{it}) = \alpha_l ln(l) + \alpha_k ln(k) + m ln(m) + \omega_{it} + u_{it};\ i = 1 \dots N;\ t = \text{ 2002–2017}. \tag{A.1}$$

For each i firm at period t and ln the neperian or natural logarithm, l, k, m are labor, real value of capital and materials (US$ 2007) respectively.

Then De Loecker (2011a), assumes, on the one hand, a CES demand function for each product that a firm i at period t produces. This demand depends upon the product price, the price, and quantity or production of the sector 's' which the product belongs to. In the estimation, 4 sectors are considered: aquaculture; agroindustry and processed of primary goods; light manufactures; and technology-intensive sector. On the other, he assumes that inputs of each product for any firm is a fixed share of the production value of the firm. These assumptions, allow aggregate firms production or sales value and the following equation is obtained.[9]

$$\widetilde{r}_{it} = \beta_l l_{it} + \beta_m m_{it} + \beta_k k_{it} + \beta_{np} np_i + \tau qr_{it} + \sum_s \beta_s q_{st} + \omega^*_{it} + \epsilon^*_{it}. \tag{A.2}$$

For each firm i at period t, $\widetilde{r}$ is the natural logarithm of real output (US$ 2007); np is the number of products produced by a firm; qr is the average of the USA, China, and European Union tariffs; and q_{st} is the total output real value (US$ 2007) of sector s at period t;[10] ω^*_{it} is the natural logarithm of the TFP of the firm; and ϵ^*_{it} is the stochastic error which has two components, the idiosyncratic shock or stochastic error of the demand of firm i at period t, and the idiosyncratic shock or the stochastic error of the production for a firm i at period t. It should be noted that:

$$\beta_l = \left(\frac{n_s + 1}{n_s}\right)\alpha_l;\ \beta_m = \left(\frac{n_s + 1}{n_s}\right)\alpha_m; \beta_k = \left(\frac{n_s + 1}{n_s}\right)\alpha_k; \beta_s = \frac{1}{|n_s|};\ \text{and}\ \omega^*_{it} = \frac{\omega_{it}\,(n_s + 1)}{n_s}. \tag{A.3}$$

The aim of the De Loecker (2011a) is to estimate eq. (A.2) to identify the parameters of eq. (A.1). To accomplish this, the estimation is divided in three stages.

First stage

A quadratic polynomic $\phi_{np,t}(\beta_l, \beta_m, \beta_k, \tau, \beta_s)$ is introduced by transforming eq. (A.2) to:

$$\widetilde{r}_{it} = \phi_{np,t}(\beta_l, \beta_m, \beta_k, \tau, \beta_s) + \omega^*_{it} + \epsilon^*_{it} \tag{A.4}$$

[8] Taken from Tello (2022b).

[9] According to De Loecker (2011b), observing firm-specific product information of a firm's product mix has three different empirical advantages. First, it enables to construct segment-specific demand shifters (Q_{st}) to identify segment-specific substitution parameters. Second, it allows to introduce trade barriers (for example, tariffs or quotas for product categories). Third, the detailed segment structure is used to proxy for unobserved demand shocks. The number of products produced by a firm np_i is used to create segment specific demand shifters which are consistent with the demand system.

[10] Each firm only produces products of one sector. De Loecker (2011a) also includes firms that produces in more than one sector.

$\widehat{\varphi}_{it}$ is obtained as the predicted value of an OLS regression of the eq. (A.4), also $\widehat{\varphi}_{it-1}$ is generated.

Second stage

From eq. (A.4) the transformed TFP, and the estimated of ω^{*}_{it}, is obtained by:

$$\widehat{\omega}^{*}_{it}\left(\beta_l,\beta_m,\beta_k,\beta_s,\tau\right) = \widehat{\phi_{it}} - \widehat{\beta}_l l_{it} + \widehat{\beta}_m m_{it} + \widehat{\beta}_k k_{it} + \widehat{\tau}_{np} np_i + \widehat{\tau} qr_{it} + \sum_s \widehat{\beta}_s q_{st} \tag{A.5}$$

Wherein, $\widehat{\beta}_l, \widehat{\beta}_m, \widehat{\beta}_k, \widehat{\tau}_{np}, \widehat{\tau}, y\widehat{\beta}_s$ are estimated by OLS of eq. (A.2).

Third stage

To estimate the parameters of the SFP by GMM, it is necessary to find that stochastic errors be uncorrelated with the set of factors of the SFP consequently De Loecker (2011a) assumes that the transformed TFP depends on this variable lagged one time and trade protection (qr) and then the stochastic error $v\left(\beta_l,\ \ \beta_m,\beta_k,\beta_s,\tau\right)$ of such assumption is defined by:

$$v\left(\beta_l,\beta_m,\beta_k,\beta_s,\tau\right)_{it} = \widehat{\omega}^{*}_{it}\left(\beta_l,\beta_m,\beta_k,\beta_s,\tau\right) - \widehat{g}_t\left(\omega_{it-1}, tr_{it-1}\right) \tag{A.6}$$

Wherein $\widehat{g}_t\left(\omega_{it-1},\ tr_{it-1}\right)$ is estimated by non-parametric regression estimation. The set of parameters of the SFP is estimated by assuming:

$$E\left\{ v_{it}\left(\beta_m,\beta_k,\beta_l,\beta_s,\tau\right)' \begin{pmatrix} m_{it} \\ k_{it} \\ l_{it} \\ q_{st} \\ qr_{it} \end{pmatrix} \right\} = 0 \tag{A.7}$$

And minimizing over $\left(\beta_m,\beta_k,\beta_l,\beta_s,\tau\right)$ the function:

$$N_f^{-1} T^{-1} \sum_{i=1}^{Nf} \sum_{t=1}^{T} v_{it}\left(\beta_m,\beta_k,\beta_l,\beta_s,\tau\right)' \begin{pmatrix} m_{it} \\ k_{it} \\ l_i \\ q_{st} \\ qr_{it} \end{pmatrix} \tag{A.8}$$

Obtained the estimate of the SPF, the TFP of each firm at period t is computed by:

$$\widehat{\omega}_{it} = \left(\widetilde{r}_{it} - \widehat{\beta}_l l_{it} - \widehat{\beta}_m m_{it} - \widehat{\beta}_k k_{it} - \widehat{\beta}_{np} np_i - \widehat{\beta}_s q_{st} - \widehat{\tau} qr_{it} \frac{\widehat{\eta}_s}{\widehat{\eta}_s + 1} \right) \tag{A.9}$$

Table A.1 presents the De Loecker (2011a) parameters estimation.

Table A.1
De Loecker (2011a) parameters of the SPS and others estimates.

Variables	(1) Real Output Value Function (A.2)	(2) SFP (A.1) Aquaculture sector (q_{1t})	(3) SFP (A.1) Agroindustry and Processed of Primary Goods sector (q_{2t})	(4) SFP (A.1) Light Manufacturing Sector (q_{3t})	(5) SFP (A.1) Technology-Intensive Sector (q_{4t})
	β, β_s, τ	α_1; η_1	α_2; η_2	α_3; η_3	α_4; η_4
Capital (k_{it})	0.358	0.797	0.667	0.705	0.697
Labor (l_{it})	0.216	0.482	0.404	0.427	0.422
Materials (m_{it})	0.348	0.776	0.6499	0.687	0.679
Number of products (np_{it})	-0.023				
Output real value of Aquaculture sector (q_{1t})	0.552	-1.813			
Output real value of Agroindustry and Primary goods sector (q_{2t})	0.464		-2.154		
Output real value of Light Manufacturing sector (q_{3t})	0.493			-2.029	
Output real value of Technology-intensive sector (q_{4t})	0.487				-2.052
Tariffs (qr)	-0.022				
Observations	9,882	152	3277	2884	3569

Source: INEI-EEA (2022), SUNAT (2022). Authors' work.

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