

# *Internationally linked firms and productivity in Pakistan: a look at the top end of the distribution*

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# Internationally Linked Firms and Productivity in Pakistan: A Look at the Top End of the Distribution

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**ABSTRACT** *This paper examines productivity drivers for Pakistani publicly listed firms from 2012 to 2017, with a focus on policy and outcome measures of integration in upstream sectors. We find that increased import duties on intermediates, and reduced FDI in upstream services, are associated with a reduction in productivities downstream. Gains from lower input tariffs accrue to firms that cannot secure duty exemptions—domestic-oriented firms and smaller exporters. Gains from upstream services FDI accrue mostly to firms that are further from the productivity frontier. Our results suggest that productivity growth in Pakistan would benefit from increased exposure of upstream sectors to global markets.*

**KEYWORDS:** Total factor productivity; exporters; tariffs; foreign direct investment; intermediate inputs; duty exemptions

**JEL CLASSIFICATION CODES:** D22; D24; F14; F15; F23; F61

## 1. Introduction

Are firms in Pakistan becoming better at what they do? If so, what drives productivity improvements? A growing body of empirical literature has investigated the effect of reduced distortions in upstream on the productivity of firms operating downstream either in the form of restrictions on trade or investment. Typically, restrictions to trade—for example, in the form of tariffs – affect upstream markets producing goods inputs, while restrictions to (foreign) investment could affect both goods and services input provision. One branch of the literature has focused on the role of trade policy distortions and shows that lower tariffs on intermediate inputs increase productivity via learning, quality, and variety effects (Amiti & Konings, 2007; Goldberg, Khandelwal, Pavcnik, & Topalova, 2010; Topalova & Khandelwal, 2011; Yu, 2015). Another branch of the literature focuses on distortions in upstream services sectors – in the form of restrictive policies or implementation hurdles that reduce the scope for increased FDI (Arnold, Javorcik, Lipscomb, & Mattoo, 2016; Beverelli, Fiorini, & Hoekman, 2017; Duggan, Rahardja, & Varela, 2013; Fernandes & Paunov, 2012; Javorcik, 2004).

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This paper examines the extent to which integration of upstream sectors with the global marketplace affects productivity growth in downstream sectors. We exploit variation in import duties, as well as in FDI penetration, along the period of analysis to construct measures of integration upstream. We then examine how policy distortions affecting both merchandise and services inputs have affected productivity growth in firms operating downstream taking into account the role played by import duty exemptions on intermediates used by exporters.

The case of Pakistan is particularly relevant for three reasons. First, it allows us to explore the productivity impact of *de jure* and *de facto* distortions in upstream markets that prevent integration with the global marketplace, and that are typically found in low-to-middle income countries. Second, it allows us to consider the role that imperfectly functioning import duty exemption schemes for exporters have in mitigating the possible negative effects of trade restrictions. The literature on trade reforms and productivity that focuses on the channel operating through liberalization of intermediate input trade has largely neglected the fact that exporters are typically and in principle eligible for intermediate input duty exemptions (e.g. Topalova & Khandelwal, 2011 for India; or Amiti & Konings, 2007 for Indonesia).<sup>1</sup> Failure to acknowledge this fact can lead to the underestimation of the positive effects of input tariff reductions for non-exporters, and overestimation of the effect for exporters.<sup>2</sup> Third, from a policy perspective, there is an active debate in Pakistan on the convenience of international integration for productivity upgrading of domestic firms, yet the evidence is scarce. This paper contributes to this debate by providing rigorous evidence on a particular channel linking frictions in upstream sectors with downstream productivity.

Indeed, the evidence on productivity and its links to global integration for Pakistan is limited and constrained by data availability. Wadho, Goedhuys, and Chaudhry (2019) focus on 600 firms in the textiles sector and find that export-intensive firms grow more slowly due to being on average larger and older than other firms. Choudhary, Lemos, and Van Reenen (2018) using a cross-section of 4,500 firms find that Pakistani firms that are more export-oriented have more structured management practices, themselves a proxy for productivity. Finally, Kinda (2012) uses a different cross-section of firms in Pakistan and finds that firms that sell more of their production to multinationals tend to be more efficient. Few other studies provide a macro-level overview of productivity in Pakistan (Haseeb & Chaudhry, 2014; Siddique, 2020). Hence, to the best of our knowledge, this is the first study to unveil firm-level evidence on productivity dynamics and to explore the linkages between the productivity of Pakistani firms and integration in the global marketplace. This adds to the understanding of firms' productivity dynamics in lower-middle-income countries, in which firms operate in markets subject to several frictions that constrain their technological choices and affect their performance.

In this paper, we rely on firm-level data on 322 firms listed on the stock exchange (publicly listed firms) in non-banking sectors in Pakistan over the period 2012–2017. Publicly listed firms are among the largest in the economy, accounting for 13 per cent of Pakistan's GDP in 2017. We complement this dataset with information on foreign ownership status at the firm level, and tariffs and FDI at the sector level. We adopt a standard approach in the literature to estimate productivity and measure changes in input tariffs and upstream FDI presence. Yet, while the literature has investigated the role of upstream tariffs and FDI separately, this paper accounts for both forms of integration upstream and, at the same time, controls for output tariffs and FDI in a firm's own sector. This allows us to isolate the effect of input tariffs from other trade liberalization reforms, and to provide a comprehensive analysis of the effect of reducing frictions in upstream markets on the performance of firms in downstream markets. While we are unable to provide causal estimates, given the lack of suitable instruments, our results are robust to a range of robustness checks. Besides including both firm fixed effects, to deal with firm-level unobserved heterogeneity, and sector-time trends (2-digit level), to control for differential trends in productivity across sectors, we investigate correlations between tariff changes and sector characteristics, and provide estimates for a sub-period when tariff changes were driven by

an IMF intervention, which mitigates potential confounding effects due to the selective protection of certain sectors.

We find that protection upstream, in the form of import duties on intermediate inputs or restrictions de jure or de facto that reduce the penetration of FDI in upstream services sectors, is associated with a reduction in productivity downstream. These effects fall predominantly on non-exporters, relatively smaller firms, and least productive firms. As mentioned above, exporters in Pakistan are granted exemptions on import duties paid on imported intermediates and capital equipment. In principle, duty exemptions are available for exporters of any size. In practice, however, securing them is costly for firms due to administrative burdens. And since duty refunds take time to be processed, exporters face financial costs (World Bank, 2019b). We provide suggestive evidence that firms who are less likely to make use of duty exemptions benefit from reduced input tariffs through both an increase in the volume and variety of imported intermediates. Our evidence on FDI in upstream service sectors is consistent with a learning mechanism where less technologically advanced firms benefit from FDI upstream through better quality, cheaper, and more varied services inputs, as well as from the technology embedded in these services. Suggestive evidence also shows a positive relationship between FDI in services and innovative activities of firms downstream, as an underlying mechanism behind the link between FDI in services upstream and productivity downstream.

The remainder of this paper is structured as follows. Section 2 presents background information on trade and investment integration in Pakistan. Section 3 and 4 describe the data used and the empirical strategy. Section 5 presents the results and discusses the underlying channel, and Section 6 concludes.

## 2. Background on trade policy

Table 1 shows average output and input tariffs over time. Input tariffs are substantially lower than output tariffs. This is explained by the fact that Pakistan's import tariff structure exhibits marked cascading – that is, tariffs on intermediates and raw materials are substantially lower than tariffs on final goods (in fact, many inputs have zero tariff). In 2013 there was a generalized increase in tariffs across most sectors. This was the consequence of a pronounced fiscal and balance of payments crisis. Indeed, during the fiscal year 2013, the fiscal deficit reached 8 per cent of GDP, while external financing dried up. In the following period, sectors with relatively lower tariffs experienced further small increases in tariffs, while sectors with higher tariffs

**Table 1.** Average output tariffs, input tariffs by the year

Year	Output tariffs		Input tariffs	
	Mean	SD	Mean	SD
2010	11.25	11.27	2.54	2.52
2011	10.16	11.13	2.27	2.37
2012	9.58	11.10	2.02	2.30
2013	10.95	11.46	2.53	2.37
2014	9.60	9.92	2.14	2.00
2015	9.34	9.47	2.19	1.77
2016	9.49	9.82	2.27	1.80
2018	9.03	9.98	1.88	1.70
Between-sector SD		10.43		2.07
Within-sector SD		1.68		0.53

Sources: UN TRAINS. No data is available for 2017.

Note: SD stands for standard deviation.

in 2013 experienced larger reductions ([Figure A1](#)). This movement towards the reduction of dispersion was driven by the Extended Fund Facility (EFF) agreed with the IMF in August 2013 and implemented throughout the end of 2016, in which the government committed to the simplification of tariff rates, moving to four slabs (which implied some increases and some reductions in tariffs).<sup>3</sup>

Over the period 2013–2018, the use of import duty exemptions became more prevalent. In 2012, for example, 34 per cent of imports claimed some form of exemption ([World Bank, 2019b](#)). In 2016/17 the exemptions reached 50 per cent of imports. Exporters are entitled to import duty exemptions on intermediates and capital equipment used to produce exportable products. There are two main forms of accessing them; either by being eligible for a duty suspension mechanism, for those firms that are mainly export-oriented (export-oriented units) or by being eligible for a refund of the paid duty (for example, the duty tax remission for exporters, DTRE). Most firms use the latter form and argue that the process of securing the refund is long and cumbersome.

### 3. Data

Data on publicly listed firms are obtained from the Financial Statements Analysis of Companies (Non-Financial) Listed on the Pakistan Stock Exchange. The dataset contains balance sheets, income statements, and export flow data, and covers all firms, 410 in total, that were publicly listed during the period of analysis, 2012–2017. Firms are assigned to 13 sectors, based on the sector classification used by the Pakistan Bureau of Statistics, which is broadly aligned with the 2-digit ISIC classification. We exclude from the analysis firms that are in the coke and petroleum sector, in services, or are state-owned companies (40 firms), hence we end up with 11 sectors. Of the remaining 370 companies, 323 companies are observed throughout the period, while 38 companies exited at various points during the period and only 9 entered the sample after 2012. Finally, we lose 48 firms due to missing information to compute productivity and end up with a sample of 322 firms for the analysis.<sup>4</sup> Firm-level data are matched to the Orbis data set from Bureau van Dijk (BvD) to obtain information on foreign ownership for all firms in the sample. All nominal variables are deflated using sectoral deflators provided by the Pakistan Bureau of Statistics. We define foreign ownership as the presence of at least one direct foreign shareholder as reported by BvD. This is because the value of the share is not often available, which prevents us from adopting a more common definition of foreign ownership based on the share of equity owned by foreign shareholders being higher than 10 per cent ([Guadalupe, Kuzmina, & Thomas, 2012](#); [Javorcik, 2004](#)). We discuss possible implications below. We construct a measure of innovation by considering the presence of intangible assets, which include patents, copyrights, trademarks, exploration accounts, and knowledge accounts. The innovation ratio is defined as the ratio of intangible assets over total assets. Tariffs are obtained from the UN TRAINS database, while FDI inflows are obtained from the State Bank of Pakistan. Descriptive statistics are shown in [Table A1](#).

Publicly listed firms are among the largest in the economy, accounting for 13 per cent of Pakistan's GDP in 2017. Firms in our sample employ on average 380 employees and are spread across 11 sectors, with a larger presence in the textiles sector. In terms of sales, the median publicly listed firm is more than six times larger than a relatively large medium-sized firm in Pakistan, yet about 16 per cent of firms in our sample would classify as medium-sized firms.<sup>5</sup> [Table A1](#) shows that the share of foreign-owned firms varies across sectors. The textile sector shows the largest share of foreign-owned firms (73%), and 70 per cent of firms participate in the export market, yet only 20 per cent of publicly listed firms in this sector have invested in intangible assets. Overall, about 62 per cent of publicly listed firms have exported at least once over the period, suggesting that they are more likely to export than an average private company.<sup>6</sup>

#### 4. Empirical strategy

We estimate total factor productivity (TFPR) using the Akerberg, Caves, and Frazer (2015) methodology, which is based on a two-step estimation procedure that helps overcome the issue of functional dependence when the elasticity of labor is estimated in the first stage, as in Olley and Pakes (1996), and Levinsohn and Petrin (2003). The choice of variables used to estimate productivity is constrained by the available data. Hence, we use total wages instead of the number of employees, which is usually used in productivity estimates. A measure of TFP based on the number of employees (from BvD) is available for a subsample of firms for which data are available (68%) and is highly correlated with our wage-based TFP measure (65%). The cost of materials is used as a proxy to control for unobserved productivity shocks and real sales are used to measure output. The lack of firm-level prices and employment prevents us from estimating quantity-based productivity (TFPQ). Foster, Haltiwanger, and Syverson (2008) indicate that when using sector-level deflators, differences in plant-specific prices show up in TFP measures. In particular, they distinguish between physical productivity (TFPQ) and revenue productivity (TFPR). TFPR tends to overestimate the productivity of firms producing higher price products while underestimating that of firms producing lower price (quality) products since real sales are obtained by using the same deflator at the sector level. The authors, however, also show that traditional measures of TFPR and TFPQ are highly correlated. Also, since our sample is composed of large publicly listed firms, variations in product quality are likely to be smaller than in more heterogeneous samples.<sup>7</sup> The coefficients of the production functions are shown in Table A2 of the Appendix.

To establish whether there is a causal relationship between firm productivity and global integration in upstream sectors, we exploit the specific timing and the differential degree of tariff changes and FDI inflows across upstream industries and adjust the approach proposed by Amiti and Konings (2007) to accommodate both changes in input tariffs and upstream FDI. We begin by regressing our measure of total factor productivity of listed firms on input tariffs and estimate the following equation:

$$TFPR_{ist} = \beta_1 T_{st-1}^{UP} + \partial_1 T_{st-1}^O + \partial_1 Z_{st-1} + \gamma_1 X_{ist-1} + \delta_1 Z_{st-1} + v_t + d_{st} + u_i + \varepsilon_{ist} \quad (1)$$

where  $TFPR$  is the measure of productivity described above for firm  $i$ , in sector  $s$ , at time  $t$ , and  $T^{UP}$  is a measure of input tariffs at the sector level, which is described in Equation (2) and  $T^O$  represents output tariffs also at the sector level. All our specifications include firm ( $u$ ) and time ( $v$ ) fixed effects, and sector time trends, at 2 digit level ( $d$ ). Besides output tariffs ( $T^O$ ), we also include controls at the firm ( $X$ ) and sector ( $Z$ ) level, such as the share of exports and foreign ownership at the firm level, lagged FDI flows at the sector level and FDI in upstream manufacturing sectors. We control for FDI in upstream manufacturing sectors to account for other trade liberalization reforms that could potentially confound the effects of input tariffs. The model is estimated with a standard linear fixed effects estimator, all independent variables are lagged on period and standard errors are clustered at the sector level.<sup>8</sup>

Input tariffs ( $T^{UP}$ ) are calculated as weighted averages of output tariffs ( $T^O$ ) as described in the following equation:

$$T_{st}^{UP} = \sum_j w_{sj} T_{jt}^O \quad (2)$$

where weights,  $w_{sj}$ , are fixed over time and constructed from the input–output (IO) table as input shares, which shows the importance of input  $j$  in sector  $s$  in terms of input costs. Hence, the expectation is that firms using certain inputs more intensively benefit from increased integration of these sectors with the global marketplace through competition and technology transfer effects. To construct these measures, tariffs, which are at the product level (8-digit HS), are



first matched to GTAP sectors. Second, to compute input tariffs, tariffs are aggregated using GTAP-based input shares as shown in Equation (2). Finally, input tariffs are further aggregated to match the sector classification available in our firm-level data using IO-based output shares as weights.

In a second specification (Equation 3) we add FDI in upstream service sectors,  $FDI^{UP}$ , to capture vertical linkages from the openness of services to FDI. The construction of our measure of upstream FDI is shown in Equation (4). We are particularly interested in the effect of this variable as listed firms are more likely to outsource services. Indeed, typical services feasible for outsourcing, such as sales, distribution, and other administrative costs, represent a significant share of production costs (11%) for these publicly listed firms.

$$TFPR_{ist} = \beta_2 T_{st-1}^{UP} + \beta_2 T_{st-1}^O + \beta_3 FDI_{st-1}^{UP} + \gamma_2 X_{ist} + \delta_2 Z_{st-1} + v_t + d_{st} + u_i + \varepsilon_{ist} \quad (3)$$

Our measures of upstream FDI ( $FDI^{UP}$ ) is obtained, analogously to our measures of upstream tariffs ( $T^{UP}$ ), by computing weighted averages of FDI inflows in upstream sectors, as described in the equation below:

$$FDI_{st}^{UP} = \sum_j w_{sj} FDI_{jt} \quad (4)$$

Where weights,  $w_{sj}$ , are fixed over time and constructed from the 2007 GTAP input–output (IO) table as input shares, which shows the importance of input  $j$  on sector  $s$ . FDI data from the State Bank of Pakistan are provided at a sectoral classification similar to the one available in our firm-level data. Hence, we aggregate GTAP sectors to match the FDI classifications before applying Equation (4).

#### 4.1. Endogeneity of trade policy and FDI penetration

Since our measures of input tariffs ( $T^{UP}$ ) and upstream FDI ( $FDI^{UP}$ ) are weighted averages of tariffs and FDI inflows, endogeneity considerations are needed both regarding the weights and the openness measures.

In terms of weights, the main identification assumption is that input shares are exogenous to changes in TFPR, not to its level. The use of IO table-based weights has several advantages. Weights are at the sector level and are based on both imported and domestic inputs. This reduces possible endogeneity concerns about productivity-related input adjustments at the firm level. Sectors are also aggregated at a two-digit level (or higher level), which limits input substitutability. In addition, the inclusion of both imported and domestic inputs when computing input shares ensures that weights reflect actual sector-level input requirements rather than tariff-induced input choices, which could bias results. This latter concern is further mitigated by using predetermined fixed weights, i.e. before the tariff changes used in our estimations took place. In addition, we include both firm fixed effects, to deal with firm-level unobserved heterogeneity, and sector-time trends (2-digit level), to control for differential trends in productivity across sectors, in all our specifications.

Our measures of trade openness are at the sector level, hence are less prone to endogeneity concerns due to time-varying firm-level unobserved effects. Yet, we are still concerned about tariffs and FDI inflows being driven by time-varying sector-level characteristics, which could also influence productivity growth. For example, it is possible that sectors that are underperforming (overperforming), lobby for protection in the form of lower tariffs on their inputs. If their productivity performance is not captured by sector-time trends, this would lead to a positive (negative) bias. In our context, a positive bias indicates that the effect of tariffs would be biased

towards zero. To address potential endogeneity concerns we have followed the two main approaches proposed in the literature.

The first approach is based on adopting instrumental variables. Common instruments include initial tariff levels (Amiti & Konings, 2007; Defever, Imbruno, & Kneller, 2020) or tariffs of neighbouring countries. The correlation between tariff levels and tariff changes is supported, for example, by the argument that it is difficult to remove the high protection status quo from an industry with high tariffs (Yu, 2015). In our context, both types of instruments are weak predictors of output and input tariff changes. The lack of correlation, however, can be partly explained by the fact that tariff changes in Pakistan were driven by the IMF's structural benchmarks agreed with the government, to simplify the tariff structure. The lack of instrumental variable estimates raises concerns about identification. To mitigate these concerns, we have followed a second approach proposed in the literature, which exploits a narrow timeframe characterised by plausibly exogenous tariff changes (Goldberg & Pavcnik, 2016; Topalova & Khandelwal, 2011). Examples in the literature are tariff changes induced by IMF interventions (Topalova & Khandelwal, 2011), or by the government's intention to reduce the dispersion of tariffs across industries (Goldberg & Pavcnik, 2005). In our context, we can exploit the implementation of the EFF program agreed with the IMF, as further explained below.

We begin by examining whether changes in tariffs and FDI were correlated with pre-existing sector-level performance to exclude the possibility that trade policy decisions were driven by differences in productivity levels across sectors. Indeed, if trade and investment policymakers responded to their perception of the performance of Pakistani sectors and their ability to face competition, then firms' productivity would be causing trade and investment policy changes rather than the reverse. To test that hypothesis, we follow the approach used by Topalova and Khandelwal (2011) for tariffs and estimate the following equation at the sector level:

$$U_{st} = \beta_1 \overline{TFPR}_{st-1} + v_t + u_s + \varepsilon_{st}, \quad (5)$$

Where  $U$  is either average output tariffs, input (or upstream) tariffs, or FDI in services for sector  $s$  at time  $t$ , and  $\overline{TFPR}$  is the weighted average of productivity of firms in the sector. We include both time ( $v$ ) and sector ( $u$ ) fixed effects.

The top panel of Table 2 shows the correlation between output and input tariffs and sector-level productivity in the previous year. Considering future output tariffs, overall, we find a negative and significant correlation with current levels of sector-level productivity, suggesting that future trade policy may have reflected differences in sector-level performance. When exploring this association further, however, we observe that this was only true during the period 2012–2014 when most tariffs were increased. This suggests that, during this period, protectionist measures might have been used to protect weaker sectors. When considering input tariffs, we do not find an overall significant correlation with pre-existing sector-level productivity, which mitigates potential endogeneity concerns regarding this variable. Yet, when restricting the analysis to the 2012–2014 period we again find a negative and significant correlation. From 2014 onwards, both input and output tariff changes do not seem to correlate with sector performance. Results on FDI show no significant correlations between sectoral productivity and future FDI penetration in the own sector or in upstream service sectors, neither for the entire period nor for the two periods separately. The lack of significant correlations mitigates potential endogeneity concerns.

In addition, we also use data from the Census of Manufacturing Industries (CMI) of 2005–06,<sup>9</sup> to test for correlations between changes in output tariffs, input tariffs, and upstream FDI in manufacturing and services between 2012 and 2017, and sector-level characteristics in 2005–06. In particular, we consider employment, output, sales, average wages, and the wage-to-capital ratio. In line with the previous analysis, we consider the entire period and the two subperiods 2012–2014 and 2015–2017. The results are presented in Table 3. The top panel

**Table 2.** Tariffs, FDI penetration, and sectoral performance

Dependent variable	Output tariffs			Input tariffs		
	Entire period (1)	2012–2014 (2)	2014–2017 (3)	Entire period (4)	2012–2014 (5)	2014–2017 (6)
Average TFP in t-1	-15.475*** (0.008)	-29.268*** (0.000)	-3.686 (0.466)	-0.353 (0.430)	-2.923*** (0.002)	-0.241 (0.635)
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1213	617	903	1213	617	903
Average change in tariffs	-0.39	0.58	-0.34	0.037	0.008	-0.052

Dependent variable	FDI (log)			Upstream FDI services (log)		
	Entire period	2012–2014	2014–2017	Entire period	2012–2014	2014–2017
Average TFP in t-1	1.370 (0.899)	-34.594 (0.310)	12.254 (0.416)	0.147 (0.938)	0.810 (0.789)	0.076 (0.905)
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1287	657	957	1287	657	957
Average change FDI (million USD)	23.7	39.8	21.3	6.75	4.93	-1.47

*Notes:* The top panel of the table shows the coefficients obtained by regression sector-level output tariffs (columns 1, 2, and 3) and input tariffs (columns 3, 4, and 5) on sector-level productivity in the preceding year. Sector-level productivity is calculated as the weighted average of listed firms' TFP, weighted by sales shares. The bottom panel considers FDI (in logs) in its own sector (columns 1, 2, and 3), and FDI in upstream service sectors in columns 4, 5, and 6. All regressions include sector and year fixed effects and are weighted by the number of firms in each sector for each given year. Standard errors are clustered at the sector level. Significant at \*\*\*1 per cent.

Table 3. Changes in tariffs and sector characteristics

Dep. Var.	Output tariffs				Input tariffs			
	Whole period		2014–2017		Whole period		2012–2014	
	2012–2014	2014–2017	2012–2014	2014–2017	2012–2014	2014–2017	2012–2014	2014–2017
Employees	–0.000 (0.653)	–0.000 (0.427)	–0.000 (0.467)	0.000 (0.217)	0.000 (0.620)	0.000 (0.097)	0.000 (0.620)	0.000 (0.097)
Wages	–0.000 (0.859)	–0.003 (0.530)	0.000 (0.956)	0.001 (0.302)	0.001 (0.422)	0.001 (0.320)	0.001 (0.422)	0.001 (0.320)
Wages/K ratio	0.012 (0.189)	0.017 (0.247)	0.026 (0.308)	–0.001 (0.911)	0.004 (0.326)	–0.001 (0.945)	0.004 (0.326)	–0.001 (0.945)
Output	–0.000 (0.822)	–0.002 (0.281)	0.000 (0.944)	0.001 (0.151)	0.000 (0.270)	0.001 (0.120)	0.000 (0.270)	0.001 (0.120)
Sales	–0.000 (0.326)	–0.004** (0.048)	–0.000 (0.828)	0.001 (0.250)	0.001 (0.264)	0.001 (0.207)	0.001 (0.264)	0.001 (0.207)
Concentration	0.001 (0.785)	–0.010 (0.526)	–0.01 (0.526)	0.001** (0.020)	0.001 (0.785)	0.001** (0.020)	0.001 (0.785)	0.001** (0.020)
Observations	156	78	104	156	78	104	78	104

Dependent variable	FDI in upstream manufacturing sectors				FDI in upstream service sectors			
	Whole period		2014–2017		Whole period		2012–2014	
	2012–2014	2014–2017	2012–2014	2014–2017	2012–2014	2014–2017	2012–2014	2014–2017
Employees	0.002 (0.629)	0.003 (0.146)	–0.005 (0.302)	0.011 (0.147)	0.006 (0.678)	0.021* (0.071)	0.006 (0.678)	0.021* (0.071)
Wages	–0.044 (0.953)	0.049 (0.948)	–0.632 (0.764)	–5.831 (0.463)	–11.494 (0.427)	–5.424 (0.578)	–11.494 (0.427)	–5.424 (0.578)
Wages/K ratio	–19.179 (0.101)	–3.578 (0.715)	–25.750 (0.455)	54.563 (0.428)	132.771 (0.266)	75.164 (0.382)	132.771 (0.266)	75.164 (0.382)
Output	–0.053 (0.857)	0.329 (0.129)	–0.823 (0.112)	–3.234 (0.418)	–6.011 (0.413)	–3.421 (0.483)	–6.011 (0.413)	–3.421 (0.483)
Sales	0.017 (0.952)	0.430** (0.017)	–0.940* (0.066)	–3.673 (0.406)	–6.866 (0.402)	–3.853 (0.474)	–6.866 (0.402)	–3.853 (0.474)
Concentration	–0.034 (0.145)	0.018 (0.160)	–0.085*** (0.000)	–0.404 (0.101)	–0.682 (0.135)	–0.481 (0.116)	–0.682 (0.135)	–0.481 (0.116)
Observations	119	102	34	119	34	102	34	102

Notes: Each cell is a separate regression of the change in the variable on the variable on the header on the variable on the row. All independent variables refer to 2005–2006 and are at the sector level. Wages, output, and sales are in the log. Concentration is measured by the Herfindahl–Hirschman Index. Sector-level characteristics are from the Census of Manufacturing Industries (CMI) of 2005–2006. Significant at \*10 per cent, \*\*5 per cent, \*\*\*1 per cent.

focuses on changes in input and output tariffs. Reassuringly, with only few exceptions, such as in the case of sales and output tariffs in the 2012–2014 period and concentration and input tariffs in the period 2014–2017, we do not find systematic correlations between tariffs and sector-level characteristics. The bottom panel focuses on upstream FDI. Similarly, as far as FDI in services is concerned we only find a mild significant correlation with employment levels in the period 2014–2017. Overall, these results suggest that the differential changes in tariffs and FDI across sectors are unlikely driven by sector-specific characteristics.

For all our specifications, we will show results when restricting the analysis to the 2014–2017 sub-period. As mentioned above, this will allow us to exploit the fact that during this period, the EFF program agreed with the IMF was under implementation, and that brings reasonably exogenous variation in tariff measures (Goldberg & Pavcnik, 2016). Indeed, tariff changes introduced after 2013 were partly driven by the intention to simplify tariff rates as part of the conditions for the EFF agreed with the IMF. The Extended Fund Facility agreed with the IMF was implemented from quarter 4 of 2013 through quarter 3 of 2016. The program required the streamlining of import tariffs in the form of reducing the number of tariff slabs, among other measures related to fiscal consolidation. The streamlining of import tariffs, for example, implied conflating the slabs of 10 and 15 per cent tariffs at a new tariff rate of 11 per cent, and the elimination of the 25 and 65 per cent slabs.

## 5. Results: trade policy, investment integration, and productivity

### 5.1. Baseline results

The results of estimating Equation (1) are reported in Table 4. We find a significant negative association between input tariffs and within-firm productivity. Results persist even when controlling for FDI in upstream manufacturing sectors, to account for possible integration-enhancing reforms that could potentially confound the effects of input tariffs (columns 2–5) and upstream FDI in services (columns 4 and 5). We also find very similar results when focusing only on the period 2014–2017 (columns 3 and 5). As mentioned above changes in tariffs during this period are less likely to be correlated with sector characteristics as changes were driven by the requirement to reduce tariffs dispersion as a condition for the Extended Fund Facility (EFF) agreed with the IMF in August 2013. We obtain similar results when using alternative measures of TFP as shown in Table A3 of the Appendix. In particular, we follow Bloom, Sadun, and Van Reenen (2016) and compute TFP using the non-parametric Solow residual method, where the output elasticity of each of the three input factors (labor, capital, and intermediate inputs) is calculated as the average share of that input in total output. We also obtain similar results when we exclude firms that exit or enter during the period (Table A4 of the Appendix).

Over the period, all sectors experienced ups and downs in input tariffs, although economy-wide there has been a tariff decrease. Because our weighted measure of upstream tariffs uses fixed weights, the change in the indicator is only driven by changes in import tariffs. Based on column 5, our estimates indicate that a one-standard-deviation increase in input tariffs (0.2 percentage points in our sample) is associated with a decrease in productivity of 0.9 per cent. Overall, the decline in input tariffs observed over the period of analysis in our sample (−0.66 percentage points) is associated with a 2.9 per cent increase in productivity. Firm-level productivity over the period increased, on average, by 5 per cent. Thus, the decrease in input tariff can explain more than 50 per cent of the overall increase in productivity. Yet, there are large differences across sectors. Input tariffs fell by 0.8 percentage points for the textile sector, which was associated with an increase in productivity of 3.6 per cent. On the other hand, input tariffs increased by 0.5 percentage points in the metal sector, which is associated with a 2.2 per cent decline in productivity. The positive and significant effect of output tariffs shown in column 1 becomes insignificant once we control for firm fixed effects, that is once we focus on within-

**Table 4.** Productivity and input tariffs—manufacturing firms only

Dep. Var.: TFP (log)	Whole period		2014–2017 (3)	Whole period (4)	2014–2017 (5)
	(1)	(2)			
Output tariffs (lag)	0.002** (0.001)	0.007 (0.009)	–0.002 (0.010)	–0.001 (0.008)	–0.011 (0.007)
Input tariffs (lag)	–0.088** (0.036)	–0.081*** (0.025)	–0.071* (0.033)	–0.055** (0.023)	–0.044* (0.024)
Export share (lag)	0.145*** (0.027)	0.296*** (0.033)	0.277*** (0.039)	0.296*** (0.033)	0.280*** (0.037)
Sector-level FDI (lag)	0.000 0.002**	0.000 (0.000)	–0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Upstream FDI in manufacturing (lag)		0.006 (0.004)	0.001 (0.004)	0.008 (0.006)	0.003 (0.003)
FDI in upstream service sectors (lag)				0.123*** (0.020)	0.102*** (0.010)
Firm FE	No	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Sector time trend	No	Yes	Yes	Yes	Yes
Observations	1477	1477	1170	1477	1170
Firms	322	322	316	322	316

*Notes:* The table reports the estimates of linear regressions. In column 1 we also control for foreign ownership, province, and firm size based on quartiles of the distribution of sales. Standard errors clustered at the sector level are reported in parenthesis. Significant at \*10 per cent, \*\*5 per cent, \*\*\*1 per cent.

**Table 5.** The association between tariffs and imports of intermediate products

	(1)	(2)	(3)
Dep. Var.: import of intermediate imports (value)			
Lagged tariffs (6 digits)	−0.020*** (0.005)	−0.034*** (0.007)	−0.026*** (0.008)
Year FE	Yes	Yes	Yes
Sector (2 digits) FE	No	Yes	No
Sector (6 digits) FE	No	No	Yes
Observations	13833	13833	13833
Sectors (6 digits)	2584	2584	2584

*Notes:* The table reports the estimates of linear regressions. Standard errors clustered at the sector level are reported in parenthesis. Significant at \*\*\*1 per cent. Products are classified as intermediates if they fall within the ‘Industrial supplies’ category of the Broad Economic Categories (BEC) classification.

*Source:* UN Comtrade.

firm variations (columns 2–5).<sup>10</sup> Hence, our estimates suggest that the input channel is a larger force in driving productivity changes, compared to the competitive channel in line with the findings of Topalova and Khandelwal (2011) for India and Amiti and Konings (2007) for Indonesia.

Firms operating downstream also use inputs from the services sector. We focus on those that are traded (supplied) through commercial presence in the country (FDI) and examine how increased FDI penetration in these upstream services affects the productivity of firms downstream. Results are presented in Table 4 (columns 4 and 5). Controlling for input tariffs, our results show that increases in FDI in upstream services sectors are associated with increased productivity of firms operating in downstream sectors. Indeed, a one standard deviation increase in FDI presence in upstream services sectors (1.5%) is associated with a 0.2 per cent increase in productivity (30% of a standard deviation in TFP). This suggests vertical spillovers from FDI in services upstream. The same does not hold for FDI in manufacturing sectors upstream. These results are in line with those presented in Arnold, Javorcik, Lipscomb, & Mattoo, (2016) for India, Fernandes and Paunov (2012) for Chile, and Duggan et al. (2013) for Indonesia.

## 5.2. *Deciphering the mechanisms*

So far, we have established that tariffs on inputs and FDI presence in services sectors upstream affect the productivity of firms operating downstream. In this section, we provide some suggestive evidence to disentangle three possible underlying mechanisms at play that link upstream conditions and downstream productivity.

*5.2.1. Input tariffs and the availability of imported inputs – intensive and extensive margins.* Changes in input tariffs alter the domestic prices of imported inputs and therefore their affordability. When input tariffs fall, the cost of accessing potentially higher quality intermediates also falls – for example, it becomes cheaper to import more of the synthetic fibers that Pakistani producers of dry-fit sportswear were already importing, allowing them to improve their input mix. In addition, the number of varieties of imported intermediates increases. A reduction in the prohibitive tariff on melt-blown fibers, the nanofiber used to produce N95 masks, could make the fibers available in Pakistan and make N95 production in-country feasible. Through both mechanisms, firms’ technological choices improve, and, with that, their productivity (Defever et al., 2020; Grossman & Helpman, 1991; Luong, 2011).

Our results are consistent with an increase in the imports of intermediate inputs following a reduction in tariffs. [Table 5](#) shows the results of regressing imports of intermediate inputs (at the HS six-digit disaggregation, within the BEC classification for industrial supplies) on lagged tariffs.<sup>11</sup> We find that lower input tariffs resulted in an increase in the volume of imported intermediate inputs. To give a sense of the magnitude of these effects, the average decrease in import tariffs experienced over the period 2014–2017 explains about 30 per cent of the observed increase in the total volume of imported intermediates.

[Table A6](#) shows the results of regressing the number of varieties of imported intermediates at the six-digit level of disaggregation (within a two-digit HS chapter) on import tariffs using both a linear and Poisson estimator. We find that a decrease in tariffs is also associated with an increase in the number of intermediate input varieties imported.

*5.2.2. Import duty exemptions.* In principle, import duty exemptions or refunds for duties paid on intermediates used to produce exportable products are available for exporters of any size. In practice, securing them is costly due to administrative burdens, they take time to be processed, and there is uncertainty with respect to the amounts to be refunded, adding financial and economic costs, that, per unit of output, tend to decrease with exporters' size.<sup>12</sup> Unfortunately, there is no systematic data to identify which firms in the dataset secured exemptions and which ones did not. However, a pilot survey conducted online with 80 firms in the textile and apparel sector, complemented with six focus group discussions provide some on the way the two most common exemption schemes work: the Manufacturing Under Bond (MUB) and the Duty Tax Remission for Exporters (DTRE).

For these two schemes survey results revealed that the time it took for Customs to approve applications was <60 days for 40 per cent of respondents, and more than 60 days for 60 per cent of respondents. The time it takes for approvals to be processed, and for refunds to be paid, even after applications had been approved, induces some firms to opt out of the mechanism or rely on domestic intermediates in the first place.<sup>13</sup>

Because the process to secure exemptions is not only lengthy but also complex (for example, the pilot survey revealed that the number of documents required by an application was 12 for MUB and 20 for DTRE), it is likely that these schemes favor larger firms, which can devote resources for this purpose, or in general firms with greater expertise and capacity. The administrative burdens associated with claiming (and receiving) duty exemptions are essentially a fixed cost. This means the average administrative cost of claiming duty exemptions tends to decrease as firm size increases. Indeed, almost 75 per cent of exemptions are claimed by the largest 100 firms (World Bank, 2019b). In addition, to benefit from exemptions, a firm needs to import its inputs directly, which is more likely for large and internationally connected exporters.

Column 1 of [Table 6](#) presents the results of estimating an extension of [Equation \(1\)](#) where we interact input and output tariffs with an indicator of whether a firm is an exporter, which is defined as a firm that exported in at least one year over period of analysis. Evidence suggests that the impact of upstream tariffs on the productivity of firms downstream is entirely driven by non-exporting firms (columns 1). This is in line with the fact that exemptions on intermediate inputs are granted to exporting firms. Hence, non-exporting firms are indeed those that would benefit the most from reductions in tariffs on inputs, confirming that the mechanism at play is increased availability of inputs at cheaper prices and of increased varieties rather than concomitant reforms that would have affected all firms alike.

Our results in columns 2 and 3 of [Table 6](#) are consistent with the anecdotal evidence reported above on the way exemption schemes work. Within the exporters' group, it is smaller and domestic-owned firms that benefit from reduced input tariffs, which is consistent with these types of firms opting out of the exemption schemes. For this specification, we define as foreign a firm that had a foreign shareholder in at least 1 year over the period. As mentioned above, our measure implies a broader definition of foreign ownership than what is more often used in



**Table 6.** The effect of input tariffs by type of firm

Dep. Var.: TFP (log)	(1) All	(2) Exporters only	(3) Exporters only
Output tariffs: exporters	−0.005 (0.006)		
Output tariffs: non-exporters	0.002 (0.008)		
Input tariffs: exporters	−0.009 (0.020)		
Input tariffs: non-exporters	−0.116*** (0.024)		
Output tariffs: foreign		−0.004 (0.004)	
Output tariffs: domestic		0.006 (0.004)	
Input tariffs: foreign		−0.004 (0.033)	
Input tariffs: domestic		−0.061** (0.020)	
Output tariffs: large			−0.013** (0.005)
Output tariffs: small			0.006 (0.004)
Input tariffs: large			0.026 (0.045)
Input tariffs: small			−0.060** (0.025)
FDI upstream manufacturing	0.007 (0.005)	0.007* (0.003)	0.007** (0.003)
FDI upstream services	0.117*** (0.014)	0.001 (0.011)	−0.001 (0.011)
Sector time trend	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	1477	648	648
Firms	322	137	137
<i>t</i> -Test for input tariff coefficients	0.000	0.019	0.091

*Notes:* The table reports the estimates of linear regressions. Columns 2 and 3 focus on the subsample of exporters. Standard errors clustered at the sector level are reported in parenthesis. All independent variables are lagged one period. In columns 5 and 6, large firms are those in the top quartile of the distribution of sales. Significant at \*10 per cent, \*\*5 per cent, \*\*\*1 per cent. Results refer to the entire period. Results for the 2014–2017 period are reported in [Table A5](#) of the [Appendix](#).

the literature.<sup>14</sup> To get a sense of the size of these ‘smaller’ publicly listed exporters, we look at their average sales and compare them to the average sales of firms in Pakistan. In this paper, ‘smaller exporters’ are defined as those in the bottom three quintile of the distribution of sales. These exporters employ about 100 fewer employees than larger exporters.<sup>15</sup> They exported on average about 760 million PKR in 2017, which is close to the annual exports of an export-oriented, non-publicly listed, medium-sized firm in Pakistan. Instead, the larger exporters in this sample exported more than seven times that amount, on average. Overall, these results suggest that failing to account for the way duty exemptions work can lead to the mismeasurement of the productivity effect of tariff reductions.

Besides these policy implications, these specifications also allow us to isolate the effect of upstream tariffs from other potential institutional reforms. If trade policy reforms conducive to reductions in upstream tariffs tend to happen with institutional reforms that reduce costs of doing business, then our baseline estimates of the effect of upstream tariffs on the productivity of firms downstream may be contaminated by an overall improved business environment upstream (and downstream) that also helps productivity. In the presence of exemptions, changes in upstream tariffs should only affect non-exporting firms, or those exporters that cannot access them, while changes in the overall doing business environment should in principle affect all firms. The results shown in [Table 6](#) confirm that our main explanatory variable indeed captures changes in upstream tariffs.

*5.2.3. Characterizing the association between FDI in services upstream and firms’ productivity downstream.* The literature on productivity gains downstream from increased FDI in upstream sectors argues that the distance to the technological frontier matters. Fernandes and Paunov (2012), for example, argue that technologically less advanced firms could experience stronger

**Table 7.** The effect of upstream FDI by type of firm

Dep. Var.: TFP (log)	(1) All	(2) All	Dep. Var.: Intangible assets (log)	(3) Innovators
Output tariffs	0.004 (0.009)	-0.001 (0.006)	Output tariffs	0.005 (0.028)
Upstream tariffs	-0.014 (0.022)	-0.048** (0.021)	Upstream tariffs	-0.189 (0.169)
FDI upstream manufacturing	0.004 (0.008)	0.005 (0.006)	FDI upstream manufacturing	0.034 (0.026)
FDI upstream service	0.117*** (0.022)	0.130*** (0.021)	FDI upstream service	0.271*** (0.048)
FDI upstream service $\times$ distance frontier	0.249*** (0.059)			
FDI upstream service $\times$ top firms		-0.036* (0.017)		
Sector-by-year trend	Yes	Yes	Sector-by-year trend	Yes
Year FE	Yes	Yes	Year FE	Yes
Firm FE	Yes	Yes	Firm FE	Yes
Observations	1477	1477	Observations	707
Firms	322	322	Firms	153

*Notes:* The table reports the estimates of linear regressions. Standard errors clustered at the sector level are reported in parenthesis. Significant at \*10 per cent, \*\*5 per cent, \*\*\*1 per cent. Results refer to the entire period. All independent variables are lagged one period. Distance from the frontier is time-invariant and is measured by the difference between the average productivity of a firm in the first 2 years, and the average productivity of firms in the top quantile of the distribution. Frontier firms are those in the top 2 quintiles of the distribution of average TFP in the first 2 years.

productivity gains from FDI upstream as they have an opportunity to catch up by learning about advanced managerial and organization techniques, optimizing their machinery use, and improving their production as more reliable services are available, and more knowledge is embodied in services brought by FDI. More advanced firms instead may have less to gain since they already use better technologies. Similarly, Blalock and Simon (2009) show, for Indonesia, that firms with better capabilities tend to gain less from supplier-client interactions with multinationals than more sophisticated firms. Note that learning from FDI upstream may require a minimum level of capabilities. Since we focus on publicly listed firms that tend to be larger and more sophisticated than average firms, it is reasonable to assume that these firms display a minimum level of absorptive capacity. In Table 7 we explore whether distance from the technological frontier matters in the extent to which Pakistani firms operating downstream benefit from FDI in upstream services. We do so in two ways. First, we interact upstream FDI in services with the distance from the frontier<sup>16</sup> (column 1) and find that firms that are further away from the frontier benefit more than those closer to it. Second, we estimate our main specification separately for frontier and non-frontier firms, where frontier firms are those in the top 2 quintiles of the distribution of average TFP in the first 2 years of the analysis. In columns 2 and 3 of Table 7 we find that, indeed, the association between FDI in services upstream and productivity of downstream firms is higher for non-frontier firms. Taken together, these results point to larger distance to the technological frontier as an enabling factor for gains from upstream services FDI in Pakistan.

Finally, we consider whether the association with productivity possibly materializes through an increase in innovative activities. For the subsample of firms that have invested in intangible assets, our proxy for innovation, at least once over the period (column 3 of Table 7) we find that FDI in upstream services is positively associated with the innovative investment. Hence, this evidence is suggestive of the link between upstream FDI in services and downstream firms' productivity operating through the mechanism of increased investment in innovation. The existence of knowledge spillovers from FDI in services has been recognized in the literature (Blind & Jungmittag, 2004). Foreign-owned firms tend to enjoy some technological advantages that make their engagement with the domestic market profitable. In the service sectors, these largely involve intangible assets, which, given their only partial excludability, can generate knowledge spillovers to firms that utilize the services. Indeed, evidence suggests the presence of information and knowledge flows from foreign firms to their domestic customers and a consequent learning-from-supplier effect (Crespi, Criscuolo, Haskel, & Slaughter, 2008). There is also evidence that increasingly goods embody some accompanying services, which themselves can be considered a form of innovation in products. Both forms of FDI-induced innovation would result in an increase in investment in intangible assets. Ultimately, investment in intangible assets has been found to increase productivity, not only in relation to its R&D component, but also in the form of organizational capital, ICT, and firm-specific human capital (Syverson, 2011; Battisti, Belloc, & Del Gatto, 2015) and stimulate firm growth (Hosono, Takizawa, & Yamanouchi, 2020).

## 6. Conclusions

This paper examines the extent to which integration in the global marketplace in upstream sectors explains productivity in downstream sectors. We rely on firm-level data on publicly listed firms in non-banking sectors in Pakistan over the period 2012–2017. We adopt a standard approach in the literature to estimate productivity and measure changes in input tariffs, to proxy for integration in goods, and upstream FDI presence in the services sector, to proxy for integration in services. Estimating the effect of integration on productivity is challenging because integration policies are shaped by governments that respond to some extent to private sector interests. We show that in the case of Pakistan this concern is mitigated, over a restricted

period, as tariff changes were driven by the need to simplify the tariff structure and reduce tariffs dispersion following an IMF intervention, yet, because of the lack of valid and relevant instruments to formally address the potential endogeneity challenge, our results should be read as correlations rather than as causal effects.

We present three main findings. First, we find that integration with the global marketplace of upstream sectors – both for goods and services – has been associated with increased productivity in downstream sectors. Second, we find that tariff reductions upstream were associated with increased productivity downstream mainly for non-exporters, and relatively smaller exporters, which is suggestive of import duty exemption schemes that are only imperfectly functional in helping exporters being immune to frictions in upstream goods sectors. Third, we find that FDI in upstream services sectors tends to be associated with productivity gains of those firms downstream that are further away from the technological frontier and that this type of FDI encourages investments in intangible assets, pointing to a potential mechanism through which upstream services FDI increases productivity downstream.

Finally, data constraints prevent us from shedding more light on the causal links between exporting and foreign ownership and productivity in Pakistan, as well as from providing evidence on the links between upstream integration and downstream productivity for a wider set of firms, rather than just the publicly listed ones. Exploring these elements is important both from an analytical and a policy perspective. That should be an important task for future data collection efforts and research.

## Notes

1. Both India and Indonesia have in place systems of import duty exemptions for intermediates used for exporting.
2. Note that Amiti and Konings (2007) find that the effect of import tariffs is stronger for importers than firms using domestic inputs only. In addition, Defever et al. (2020) show that the effect of input tariffs depends on whether inputs are imported directly or through intermediaries. Unfortunately, in our data we are not able to identify whether firms import intermediates and if they do so directly or indirectly. This would have offered another possibility to identify firms that can access duty exemptions as only direct importers in Pakistan can claim duty exemptions.
3. See Pakistan 2013 Article IV Consultation, and August 2013 Letter of Intent (IMF, 2013).
4. Note that observations with zero investment are dropped when computing TFP since the estimation method demands a strictly monotonous relationship between the proxy, which is investment, and output. When looking at the other characteristics of the firms dropped, we observe that they are significantly less likely to be exporters and foreign, while we find no statistically significant difference in terms of the propensity to invest in intangible assets.
5. Using 2017 data, the median publicly listed firm has annual sales of about 4 billion PKR compared to the upper threshold for a medium firm, as indicated by the State Bank of Pakistan, update to 2017 is 600 million PKR.
6. Ali (2015) using administrative data for more than 50,000 firms estimates that only about 34% of firms were exporting in 2012/13. According to the same study, exporting is highly skewed towards large firms, which are responsible for around 82% of total exports, hence our data set is likely to be representative of the average exporting firm in Pakistan.
7. Our methodology to estimate TFPR, as most common estimators of production functions, also assumes Hick neutral technological progress. This assumption has been recently challenged by Doraszelski and Jaumandreu (2018). Unfortunately, we cannot implement the adjustment suggested in the study due to the lack of quantity and price data. On the other hand, to provide further robust checks we propose as an alternative measure of productivity, a Solow-residual based measure of conventional TFP and show the results in the [Appendix](#). In addition, we also show the results when we use an alternative TFP based on the estimation, within the ACF framework, of separate production functions for the textile and non-textile sector.
8. We lag independent variables one period to allow for non-instantaneous adjustments to changes in tariff policy (e.g. tariff changes take place once-a-year with the approval of the Finance Act at the beginning of the fiscal year in July) or to changes in the landscape in terms of multinational presence in upstream markets.
9. A census was also conducted in 2015 but the data have not been made available.
10. We would like to add a note of caution in the interpretation of the effect of output tariffs. While output tariffs are more plausibly exogenous in the period 2014–2017, this is also a period of lower variability in tariffs over time, which could also affect the results.

11. In particular, we estimate the following equation at the product level:  $IN_{IMPt} = \beta_1 T_{pt-1} + v_t + u_p + \varepsilon_{pt}$ , where  $IN_{IMP}$  indicates the value of intermediate inputs or the number of varieties at the product level (6 digit) and  $T$  are tariffs, also at 6 digit level. We include both sector and year fixed effect. This analysis is at the sector level given the last of firm-level data on intermediate imports.
12. The cost per unit of exportable out of running a dedicated administrative unit to claim these refunds and follow up on the process is lower for large than small firms.
13. The survey evidence is only anecdotal. A total of 80 firms in the textile and apparel sector were interviewed in early 2019 through an online platform. Survey results were subsequently validated through structured focus group discussions. See World Bank (2019b) for a discussion of the survey results.
14. By using this broader definition of foreign ownership, we do not find significant effects of changes in upstream tariffs on downstream productivity of foreign firms. Hence, we expect that a more conservative measure of foreign ownership will lead to similar results.
15. Based on available employees' data, smaller exporters employ about 330 employees on average vs. an average of 480 employees for larger exporters. According to the State Bank of Pakistan, SMEs have up to 250 employees.
16. The distance from the frontier is measured by the difference between the average productivity of a firm and the average productivity of firms in the top quantile of the distribution. The measure is time invariant and is computed using data from the first two years a firm participates in the sample.

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No potential conflict of interest was reported by the author(s).

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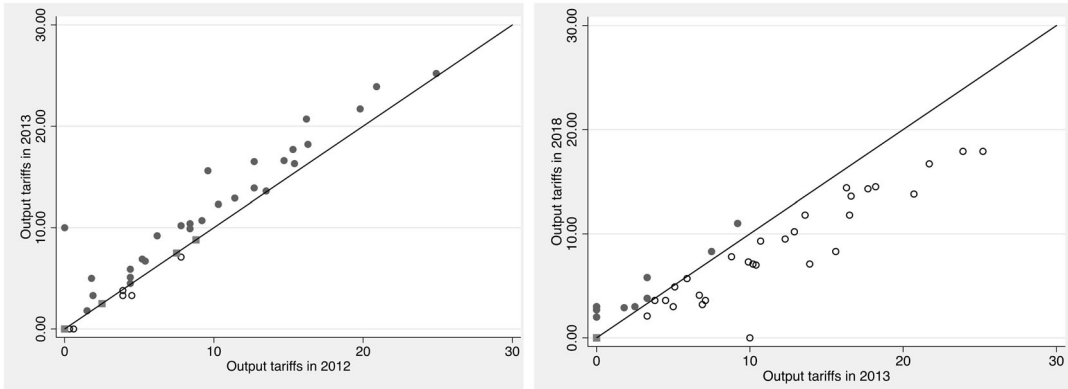
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**Appendix: Additional figures and tables****Figure A1.** Product-level tariffs changes: 2012–2013 and 2013–2018.

*Note:* UN TRAINS. We excluded from the graph the motor vehicles, beverages, and tobacco products sectors that have an average tariff of 38.5 and 60.5, respectively.

**Table A1.** Descriptive statistics

Sector	Average sales	Average wages	Share of exporters	Share of foreign-owned	Share of innovators	Obs	Firms
Beverages and tobacco	13.87	8.86	0.20	0.25	0.40	20	4
Chemicals	11.98	5.93	0.44	0.31	0.61	228	50
Food	16.53	6.18	0.47	0.41	0.54	70	15
Machinery	5.84	3.43	0.47	0.42	0.65	43	9
Metals	12.39	3.62	0.71	0.00	0.68	34	7
Motor	19.78	4.50	0.41	0.17	0.71	90	20
Non-metallic minerals	11.16	4.47	0.76	0.37	0.39	135	29
Paper	9.45	4.73	0.55	0.38	0.88	40	8
Power	38.66	4.85	0.00	0.35	0.53	79	17
Sugar	5.62	1.45	0.69	0.59	0.21	147	31
Textiles	5.62	2.65	0.70	0.73	0.20	591	132
Total	10.63	3.78	0.58	0.51	0.39	1477	322

*Notes:* Authors' calculations are based on Financial Statements Analysis of Companies (Non-Banking) public at Pakistan Stock Exchange and data on foreign ownership from Bureau van Dijk. Sales are in billion PKR while wages are in million PKR.

**Table A2.** Coefficients of the production function

	OLS (1)	ACF (2)	Textile only (ACF) (3)	Non-textile (ACF) (4)	Solow (3)
Capital	0.04	0.047	0.081	0.042	0.45
Wages	0.21	0.033	0.048	0.193	0.08
Material	0.94	0.695	0.936	0.858	0.84

*Notes:* The table reports the coefficients of the production function obtained using different methods. Column 1 shows the coefficients of a simple OLS model, column 2 shows the coefficients obtain by applying the ACF on the entire sample, while columns 3 and 4 show the coefficients when estimating the production function, within the ACF framework) separately for the textile and non-textile sectors. Finally, column 3 shows the shares used in computing the Solow-based TFP measure.

**Table A3.** Estimates obtained using alternative measures of TFP

Dep. Var.:	(1)	(2)	(3)	(4)
	Whole period Solow-based TFP	2014–2017 Solow-based TFP	Whole period ACF TFP by sector	2014–2017 ACF TFP by sector
Output tariffs (lag)	–0.002 (0.009)	–0.014 (0.008)	–0.008 (0.007)	–0.013 (0.008)
Input tariffs (lag)	–0.066*** (0.019)	–0.060** (0.026)	–0.072** (0.024)	–0.063** (0.027)
FDI in upstream manufacturing sectors (lag)	–0.001 (0.005)	0.001 (0.004)	0.005 (0.005)	0.001 (0.004)
FDI in upstream service sectors (lag)	0.090*** (0.019)	0.077*** (0.021)	0.098*** (0.017)	0.076*** (0.015)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Sector-by-year trend	Yes	Yes	Yes	Yes
Observations	1477	1170	1477	1170
Firms	322	316	322	316

*Notes:* The table reports the estimates of linear regressions. Standard errors clustered at the sector level are reported in parenthesis. In columns 1 and 2 TFP is computed using the non-parametric Solow residual method, where the output elasticity of each of the three input factors (labor, capital, and intermediate inputs) is calculated as the average share of that input in total output. TFP is then estimated as the residual of the production function, making use of these calculated elasticities. . In columns 3 and 4, TFP is estimated using the ACF method but estimating the production function coefficients separately for textile and other sectors. Significant at \*\*5 per cent, \*\*\*1 per cent.

**Table A4.** Estimates excluding entry and exit

Dep. Var.: TFP (log)	(1)	(2)
	Whole period	2014–2017
Output tariffs (lag)	–0.000 (0.006)	–0.013 (0.007)
Input tariffs (lag)	–0.054** (0.023)	–0.069** (0.024)
FDI in upstream manufacturing sectors (lag)	0.008* (0.004)	0.006** (0.002)
FDI in upstream service sectors (lag)	0.037* (0.020)	0.040*** (0.012)
Firm FE	Yes	Yes
Year FE	Yes	Yes
Sector-by-year trend	Yes	Yes
Observations	1335	1068
Firms	267	267

*Notes:* The table reports the estimates of linear regressions. These specifications include only firms that are observed for the entire period of analysis, hence they exclude firms that entry or exit during the period. Standard errors clustered at the sector level are reported in parenthesis. Significant at \*10 per cent, \*\*5 per cent, \*\*\*1 per cent.



**Table A5.** Productivity, input tariffs, and FDI by type of firm—period 2014–2017

Dep. Var.: TFP (log)	(1) All	(2) Exporters	(3) Exporters
Output tariffs: exporters	−0.010 (0.007)		
Output tariffs: non-exporters	−0.006 (0.008)		
Input tariffs: exporters	−0.070* (0.035)		
Input tariffs: non-exporters	−0.112** (0.043)		
Output tariffs: foreign		−0.015** (0.006)	
Output tariffs: domestic		−0.007 (0.006)	
Input tariffs: foreign		−0.052 (0.031)	
Input tariffs: domestic		−0.080** (0.031)	
Output tariffs: small			−0.022*** (0.006)
Output tariffs: large			−0.006 (0.006)
Input tariffs: small			−0.028 (0.041)
Input tariffs: large			−0.081** (0.030)
FDI upstream manufacturing	0.003 (0.003)	0.003 (0.005)	0.003 (0.005)
FDI upstream services	0.087*** (0.016)	−0.002 (0.007)	−0.002 (0.008)
Sector time trend	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	1170	515	515
Firms	316	136	136
<i>t</i> -Test for input tariff coefficients	0.049	0.199	0.188

*Notes:* The table reports the estimates of linear regressions. Standard errors clustered at the sector level are reported in parenthesis. All specifications control for FDI in their own sector (lagged). In columns 5 and 6, large firms are those in the top 2 quintile of the distribution of sales. Significant at \*10 per cent, \*\*5 per cent, \*\*\*1 per cent.

**Table A6.** The association between tariffs and the variety of products imported

Dep. Var.: number of products (at 6 digit level within a 2 digit chapter)	OLS (1)	Poisson (2)
Lagged tariffs (2 digits)	−0.262* (0.152)	−0.010* (0.006)
Year FE	Yes	Yes
Sector time trends	Yes	Yes
Observations	502	502
Sectors (2 digits)	84	84

*Notes:* The table reports the estimates of linear regressions (column 1) and a Poisson model (column 2). Standard errors clustered at the sector level are reported in parenthesis. Significant at \*10 per cent.