Trade Liberalization and Carbon Emissions: Firm Level Evidence from Pakistan

Nida Jamil[1], Theresa Chaudhry[2] and Azam Chaudhry[2]

Abstract

Trade liberalization offers economic benefits through increased access to international markets. However, given global climate change, it is important to consider the potential negative impact on the environment. If the advantages of trade liberalization come at the expense of the environment, the economic losses will offset some of the gains. This study investigates the effects of two instances of trade policy changes on firm-level carbon emissions by Pakistani firms. In 2005, Pakistan and China signed a free trade agreement (FTA), which expanded the access of Pakistani firms to Chinese markets. Simultaneously, the Multifibre Agreement (MFA), which imposed quotas on textile exports from developing countries to the United States and the European Union, was abolished. These exogenous events resulted in foreign demand shocks for the Pakistani textile sector. By focusing on textile manufacturers in Punjab, Pakistan, we analyze the impact of the FTA and the end of the MFA on firm-level emissions resulting from changes in access to the Chinese and US markets. We find that the Pakistan-China FTA resulted in a rise in Pakistani exports to China, with firms moving up the quality ladder. There was also an overall increase in emissions, but no significant increase in emissions per unit of output. However, the end of the MFA resulted in a decrease in Pakistani exports to the US due to increased competition from other countries or the strong "third-party" effects. As a result, firms moved away from their core product towards dirtier, low quality and high-emission intensity products.

JEL: F10, F14, F18, Q37, Q53

Key words: Carbon Emissions, Trade, Multifibre Agreement, Free Trade Agreement, Pakistan.

[1] *School Of Economics, The University of Edinburgh. 31, Buccleuch Place, Edinburgh, EH8 9JT, United Kingdom.*

[2]*Economics Department, Lahore School of Economics. Intersection Main Boulevard Phase VI DHA and Burki Road, Lahore, 53200, Pakistan.*

I. Introduction

Climate change is a critical global issue and international trade - incorporating the production and transport of manufactured goods - is responsible for 20 to 30 percent of greenhouse gas (GHG) emissions worldwide (WTO, 2021). In recent years, there has been an increasing concern about energy usage and carbon emissions during the manufacturing processes as there is a worldwide shift towards sustainable manufacturing. Resources and energy are utilized at every step of the manufacturing process (Govindan et al., 2013) and the use of fossil fuels leads to a notable rise in carbon dioxide (CO_2), a major greenhouse gas (GHG) (Tseng et al., 2013). This can be seen when, in 2010, due to rising demand and consumption of manufactured goods, China's emissions accounted for around 25% of world CO_2 emissions, with the manufacturing sector accounting for roughly 60% of total consumption (Cao et al. 2012). Therefore, the reduction of resource utilization and carbon emissions from manufacturing processes, particularly enhancing efficiency, has become a growing concern as the world moves towards environmentally friendly manufacturing practices. Understanding how demand (or consumption) shocks to the manufacturing sector impact carbon emission intensity is extremely important as incomes rise around the world. This becomes even more important in the context of developing countries where the environmental protection laws are relatively weak.

This study contributes to the literature by analyzing the impact of demand shocks due to changes in trade policy on emission intensity in the context of a developing country. While much of the literature on the environment and emissions is at the level of the macroeconomy, we provide micro-level evidence at the firm level.

The impact of trade on carbon emissions through exporting firms can be grouped into three main categories. The first, known as the scale effect, increases emissions when production of output increases to meet foreign demand. The technological or technique effect, on the other hand, tends to lower emissions per unit by promoting the use of cleaner and more energy-efficient technologies. The composition effect refers to changes in a firm's product mix, which can either increase or decrease emissions intensity depending on whether trade pushes production toward dirtier or cleaner products. Concentration of a firm on its core varieties tends to reduce emissions intensity, since firms are usually more efficient in their production (Barrows & Ollivier, 2018).

In developing countries, exporting firms are known to be larger, more capital-intensive and productive, pay higher wages, and generally produce higher-quality output (Jamil et al., 2022; Brambilla, et al., 2015; Verhoogen, 2008; Wagner, 2007). Firm-level evidence on environmental performance exists but high-quality studies are still relatively scarce. Rodrigue et al. (2022) found that in China, during its WTO accession in the early 2000s, exporters were less emissions-intensive and continued to reduce their emissions intensity over time. Exporting activities reduced SO_2 intensity by more than one-third, mainly attributable to energy sourcing, product scope, and capital-vintage. Dirty producers initially expanded rapidly but then reduced their emissions intensity. Pei et al. (2020) also find that the export intensity of Chinese firms is associated with lower Sulfur Dioxide (SO_2) emissions intensity and that exporters abate more pollution.[1] Lin & He (2022) explored the same question using matching and DiD techniques, but their results were decidedly mixed; export intensity improved a firm's environmental performance only for certain kinds of firms (private,

[1] They hypothesize (but do not test) that a combination of government regulations, VAT export subsidies (which vary inversely with emissions), and pressure from foreign buyers are the mechanisms.

foreign-funded) and in particular locations (coastal areas). Nonetheless, because exports expanded so rapidly in China, the pollution intensity increased, leading to higher infant mortality (Bombardini & Li, 2020). The technique effect, whereby higher incomes lead to the adoption of pollution-reducing technologies, was not enough to offset the scale of the massive export expansion, leading to detrimental health impacts on the young.

In India, increases in exports were associated with a fall in emissions intensity, but that decrease was mainly due to product mix and price effects rather than technological improvement (Barrows & Ollivier, 2014a). Considering the sales in both home and export markets, however, foreign demand caused the emissions growth rate of Indian exporters to rise due to the scale effect, although technological improvements slowed the increase (Barrows & Ollivier, 2021). In contrast, the end of the Multi Fibre Agreement (MFA) led to quality downgrading and an increase in emissions intensity as Indian firms lost market access (Barrows & Ollivier, 2014b). Overall, between 1990 and 2010 in India, two factors reduced emissions intensity: production was re-allocated across firms to cleaner firms and technological change reduced emissions intensity for individual products over time. On the other hand, a third, stronger factor superseded them both, leading firms to be slightly dirtier on average: the elimination of export taxes *reduced* competition for Indian firms, giving them space to produce varieties outside their core competencies (Barrows & Ollivier, 2018).

Institutions can also be a source of cross-country differences in emissions, according to Shapiro (2023): Strong institutions favor clean industries (and their export), shifting the production of dirty industries to countries with weaker institutions. In addition, trade policy in most countries enables the import of "dirty" inputs at lower tariff rates and indirectly subsidizes carbon emissions (Shapiro, 2021). However, multinational production can help somewhat when multinational corporations headquartered in environmentally "clean" countries invest in production in "dirty" countries because they bring along their more efficient energy blueprint with them, thus lowering industry emissions in the host country (Garcia-Lembergman et al., 2024). This is true even though affiliates of multinationals in developing countries tend to be less clean in their production than at home. Even in the U.S., exporting's role in reducing firm-level emissions intensity is industry-specific (Cui & Qian, 2017).[2]

Given the exigencies of the climate crisis (in addition to trade protection considerations), the European Union is moving to implement carbon taxes through the Carbon Border Adjustment Mechanism (CBAM). During the transitional period 2023-26, importers are required to report the greenhouse gas content of goods entering the EU. Beginning in 2026, importers will be required to purchase certificates for the import of goods with embedded emissions. Currently, the industries covered include cement, iron and steel, aluminum, fertilizers, electricity, and hydrogen.

The EU is also in the process of implementing another new initiative, called the Corporate Sustainability Due Diligence Directive ("CS3D"), to mitigate climate change. In it, large companies (both EU and non-EU) will need to "adopt and implement effective (and extensive) due diligence policies for identifying, preventing, mitigating, and bringing to an end actual and potential human rights and environmental harms in their own operations, those of subsidiaries, and of their business partners relating to their 'chain of activities' (i.e., specific

[2] In decreasing order, the largest gaps between exporters and non-exporters were found in petroleum and coal, furniture and fixtures, rubber, transport equipment, fabricated metals, and chemicals. Exporters were not more environmentally friendly in the paper, printing, stone/clay/glass, and metals sectors.

parts of the value chain)" (Baker McKenzie, 2024). The initial CS3D proposal included leather and textiles, but at the last minute, these sectors were excluded.

The CBAM or CS3D could eventually apply to textiles, a sector that is a key component of exports for many developing countries. As of 2021, Pakistan was the seventh-largest exporter of textiles in the world. Cotton-based textiles account for approximately 60% of total exports and 46% of overall manufacturing. For this reason, it is important to understand the relationship between demand for Pakistan's textile exports and firm-level emissions.

Using firm-level data for Punjab, we look at the impact of two major trade policy changes on emissions from Pakistan's textile sector: the end of the Multi-fibre Arrangement (MFA) in 2005 and the Pakistan-China Free Trade Agreement (FTA) in 2006.

With the end of the MFA agreement in 2005, quota restrictions by the USA and Europe on the import of textiles and apparels from developing countries were removed. It was anticipated that the removal of quotas would lead to shifts in trade patterns, with Pakistan benefiting from increased access to major markets such as the US and EU. However, in Pakistan, the benefits of the removal of the MFA restrictions were partially offset by other factors, including fierce competition from other countries ("third party" effects), and overall, Pakistan's market share in the US and EU fell (Whalley, 2006).

At about the same time, Pakistan and China entered into a Free Trade Agreement (FTA) where both countries lowered their tariff rates. While the trade balance was in favor of China, Pakistan's exports to China grew at a rate of 13.6% per year between 2003-2018 (World Bank, 2020).

Therefore, Pakistan's textile industry experienced two major exogenous demand shocks in 2005-06, both of which had the opposite outcomes. These two demand shocks differ in nature due to their degree of exposure to foreign market competition or third-party effects in the international market. While the Pakistan-China FTA impacted access of Pakistani firms to the Chinese market alone, firms exporting to the United States simultaneously faced an increase in foreign market competition along with greater access to the US market. Thus, given the different nature of these demand shocks, we empirically analyze the effects of these policy changes on the carbon emissions of textile manufacturers in Pakistan.

We start by providing some more details about the Pakistan-China FTA and the end of the MFA in section II and III. Section IV describes the data sets used. Section V presents some preliminary correlations and results. Section VI presents the results from the end of the MFA and the Pak-China FTA. Section VII presents some discussion of the results and section VIII concludes.

II. Pakistan-China FTA

China and Pakistan began lowering tariffs on each other's exports in the early 2000s, culminating in the signing of the Pakistan-China Free Trade Agreement (FTA) in 2006, which outlined significant tariff reductions to be implemented over five years. The FTA aimed to strengthen mutual friendship, grow and diversify trade, remove barriers, offer fair competition conditions, and establish a platform for future bilateral economic cooperation. As a result of this decade-long process, total trade between the two nations more than tripled, with China becoming Pakistan's second-largest import partner (Xin et al., 2014). In March

2011, China and Pakistan began discussions for the second phase of the FTA to further liberalize and facilitate trade. These discussions were completed in April 2019 with the signing of an Amending Protocol, which came into effect on December 1, 2019 (Ministry of Commerce, 2019). The diplomatic relations between the two nations have further strengthened following the implementation of the China-Pakistan Economic Corridor (CPEC) project, which is part of China's One Belt One Road plan.

Though the FTA appeared to be an opportunity for both countries, the trade imbalance benefited China rather than Pakistan. Figure 1 depicts that, despite an increase in Pakistani exports to China, imports from China have expanded at a higher rate, indicating that China has benefited more from the FTA. China has taken advantage of 57% of the FTA's privileges, whereas Pakistan has only used 5% of them (Mukhtar, 2019).

Figure 1: Trade Flows between Pakistan and China ($US Billions)

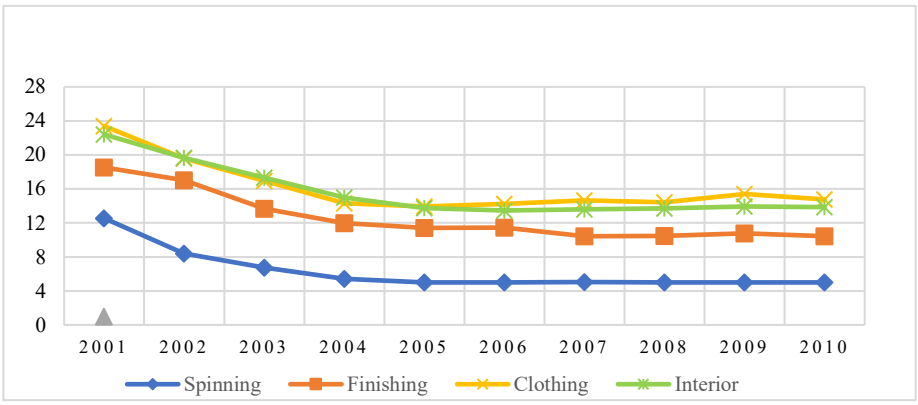


Source: UN Comtrade Data

Figure 2 delves deeper into the Chinese tariffs imposed on Pakistani exports under the FTA by focusing on Pakistan's largest export sector, the textile sector. Dividing the textile sector into four sectors (spinning, clothing, interior and finishing)[3], we see that the most substantial decrease in Chinese tariffs on Pakistani textile exports occurred between 2001 and 2005, with little change between 2005 and 2010. Furthermore, while tariffs fell across every segment, China's concessions to Pakistan were more significant in low-value added sectors such as spinning and less generous in higher-value added clothing and garments. As a result, only the spinning segment experienced a significant increase in exports to China (Figure 3).

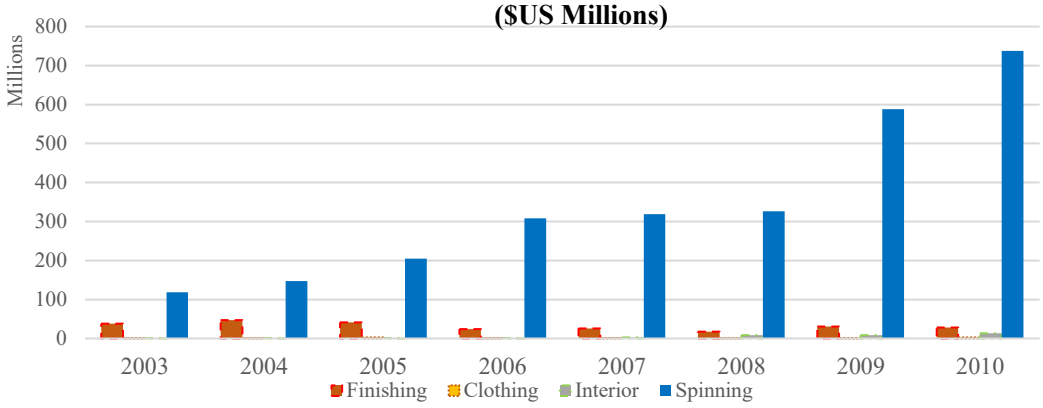
[3] The products are classified into spinning, interior, clothing and finishing segments as done by De Leocker (2011).

Figure 2: Tariff Rates imposed by China on Pakistani Textiles Segments



Data Source: World Trade Organization (WTO) Tariff Analysis

Figure 3: Pakistan's Segment Wise Exports to China ($US Millions)



Source: UN Comtrade Data

III. End of the Multifibre Arrangement (MFA)

The end of the Multifibre Arrangement (MFA) marked a significant shift in global trade of textiles and clothing. Adopted in 1974, the MFA set quotas on the quantity of textiles and clothing that developing nations could export to developed countries, with the aim of safeguarding developed countries' domestic industries which were being severely harmed through rapidly expanding imports. Although the MFA was officially signed in 1974, its origins date back to the 1930s. During a period of global economic turmoil, Japan emerged as the top exporter of cotton textiles, pushing the United States and Europe to limit imports from Japan in order to protect their local textile industry. The restrictions never truly went away. By the 1960s, they were extended to Hong Kong, Pakistan, and India. Initially, the agreements covered only cotton, but they gradually evolved into "multifiber" arrangements incorporating clothes and textiles made from all fibers (MacDonald, 2006)[4].

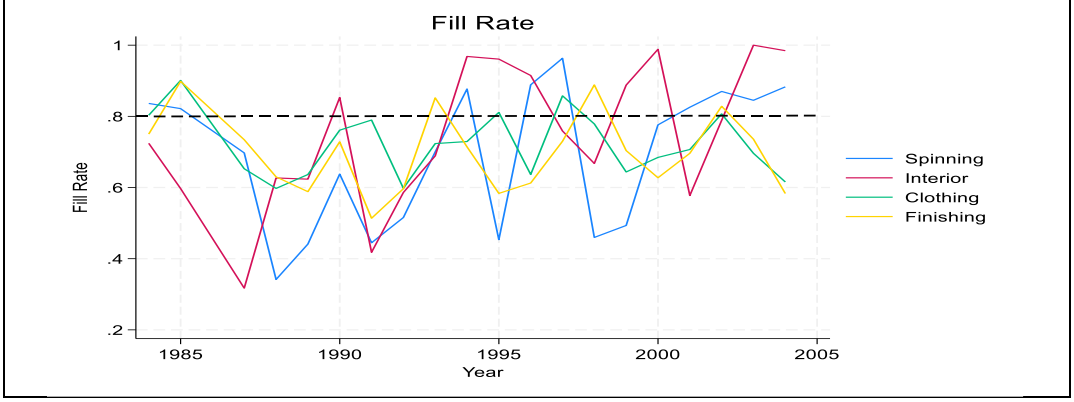
[4] By restricting imports under the MFA, the United States and the European Union hiked domestic clothing prices. Domestic production increased, while domestic consumption decreased. Outside of these two markets, the impacts were more complex, since restrictions on one group of countries provided opportunities for others, resulting in changes in global textile markets. Export restrictions imposed on Japan and Hong Kong expanded Taiwan and South Korea's export potential. Restrictions imposed on Taiwan and South Korea widened prospects for Thailand and Indonesia. In this way, the MFA expanded, but investment in textile manufacturing also increased. Entrepreneurs from

A significant milestone of the Uruguay Round (1994) was the signing of the Agreement on Textile and Clothing (ATC), which ended the MFA. The process of incorporating textile and clothing products into General Agreement on Tariffs and Trade (GATT) and World Trade Organization (WTO) was initiated by the ATC. The ATC attempted to phase out these quotas over a ten-year period in four phases, with complete elimination of quotas by January 1, 2005 (WTO, 2024).

The restrictiveness of quotas under the MFA is typically determined by "fill rates," which are a critical measure used to understand the extent to which countries utilize their allocated export quotas for textiles and clothing. The fill rate is defined as the percentage of a quota allowance that is actually used by an exporting country[5]. Higher fill rates indicate a higher utilization of the quota, suggesting that the quota is restrictive and binding. According to fill rate estimations by Khandelwal et al., (2010), countries including Bangladesh, China, Indonesia, Pakistan, India, and Sri Lanka had fill rates above 80% under U.S. textile and clothing quotas, while countries with low fill rates include Jamaica, Guatemala, Colombia, and Honduras.

Figure 4 below shows the segment wise fill rates for Pakistan under U.S. textile and clothing quotas during the period of 1985-2005. The black dashed line shows the 80% fill rate threshold to indicate that the quota was binding. While the fill rates fluctuated over years, the spinning and interior segment are the most restrictive and binding segments under the MFA. Post 2005, the quotas were removed for Pakistan and for the rest of the world.

Figure 4: Segment Wise Fill Rates for Pakistan under U.S. Textile and Clothing Quotas



Data Source: US Commerce Department's Office of Textile and Apparel (OTEXA)

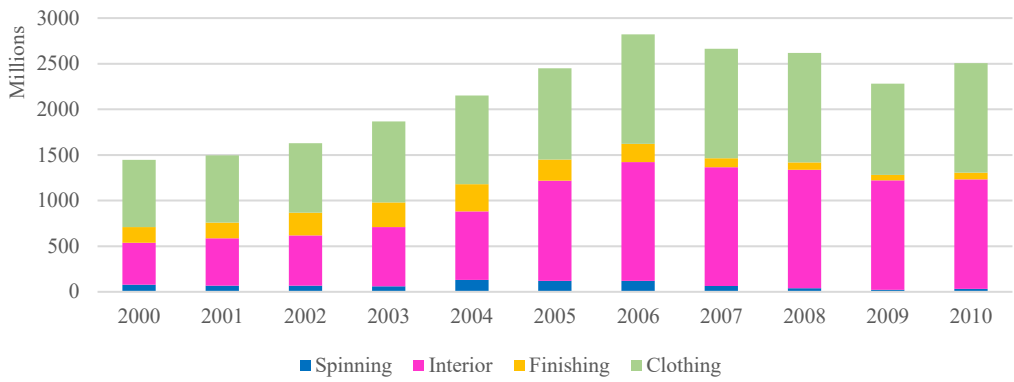
Figure 5 below shows that pre-2005, Pakistan's main exports to the US were concentrated in high-value-added segments like clothing and interior while their shares fell after the Multifibre Agreement ended. Post-2006, Pakistan saw some loss in its market share to the US. Appendix D shows a selected list of high value-added products HS code 61 (articles of apparel and clothing accessories, knitted or crocheted) and 62 (articles of apparel and

countries restricted by the MFA transferred capital and knowledge to countries that would otherwise be unable to export considerable amounts of textiles. Thus, for some countries, the attempt to curb global exports actually boosted exports (MacDonald, 2006).

[5] Fill rates are defined as exports as a percentage of adjustable base quota. The base quota is the original quota level agreed upon at the start of the contract term, whereas the adjusted level is the ex-post quota that exporting countries can apply to a product category in place of the base quota by using flexibility adjustments in the MFA.

clothing accessories, not knitted or crocheted) in which Pakistan's export value (US $) growth to the US declined post 2005.

Figure 5: Pakistan's Segment Wise Exports to USA ($US Millions)



Source: UN Comtrade Data

IV. Data

In this section, we briefly describe the data sources used in this analysis.

Census of Manufacturing Industries (CMI) Punjab, Pakistan

The Punjab Bureau of Statistics in Pakistan conducts the Census of Manufacturing Industries (CMI), a firm-level survey, every five years. This comprehensive survey provides data on the firm's income as well as its input usage, including materials and labor costs, and various capital stock measures. We create an unbalanced panel data set for the firms in Punjab, Pakistan, using the three waves of the CMI that were conducted in 2000, 2005, and 2010. Our research focuses on Pakistan's largest export sector, textiles. The primary feature of our data set is that, unlike most microdata sets, it includes disaggregated pricing and quantity details for each firm f at the product level j for the period t. Therefore, our data set has three dimensions of variation: time, firm, and product level. By utilizing the firm's actual output instead of depending on sectoral deflators, we can reduce the impact of the omitted output price bias in our estimation.

The products in the CMI data were coded using Pakistan Standard Industrial Classification (PSIC) codes, which are based on International Standard Industrial Classification (ISIC) codes. We first convert these PSIC codes into relatable ISIC codes, then we link them into convertible Harmonized System (HS) codes using the conversion codes made available by the United Nations International Trade Statistics to make them compatible with the international databases that primarily rely on HS product coding[6].

[6] We also convert them into relatable HS codes since we have to link these products with their respectable tariff rates which are available by the World Trade Organization (WTO) and quota/fill rates made available by US Commerce Department's Office of Textile and Apparel (OTEXA), both classified in accordance with the HS code.

Table 1: Firm level summary stats for Textile Manufacturers according to the CMI			
CMI Year	*2000*	*2005*	*2010*
Number of firms	491	479	435
Multi-Segment firms	2.1%	6.70%	17.80%
Multi-Product firms	6%	20%	18%
Average number of product varieties	8	4	3
Exporters	95	106	151
Capital (PKR[7])	387,230	545,247	686,950
Labor	478	504	540
Materials (PKR)	381,521	465,356	1,545,092
Energy (PKR)	62,535	78,598	132,348
% of exporters selling to China	25%	21%	14%
% of exporters selling to USA	32%	27%	26%
Non-Exporters	396	373	284
Capital (PKR)	203,000	341,519	383,622
Labor	191	279	309
Materials (PKR)	151,205	220,420	258,225
Energy (PKR)	48,727	55,582	69,384

Table 1 shows us the size of the firms (as measured by their inputs) for exporters and non-exporters. We can see that the exporters, to begin with, are much bigger in terms of inputs than the non-exporters. Furthermore, CMI provides detailed data on energy usage, which enables us to calculate CO_2 intensities at the firm level. This multi-product dimension of CMI together with the energy data have not been explored previously, thus we go into further detail about it here. In the CMI, firms report their annual energy use in value and physical quantity (kilowatts of electricity)[8]. We convert energy usage into CO_2 emissions, which serve as an emission measure. We calculate CO_2 intensity using emission factors from the International Energy Agency (IEA)[9]. The IEA has the most reliable available factors for converting electricity into CO_2 emissions (kg CO_2 per kWh) for most countries, which also serve as the foundation for most of the grid electricity factors in the World Resources Institute (WRI) tool for emissions from purchased electricity (WRI, 2024), as well as UK Department for Environment, Food and Rural Affairs (DEFRA) factors for UK and non-UK countries (DEFRA, 2024).

Textile Export Custom Transactions Database

We use the textile export customs transaction data set to identify firms that export specifically to China and the United States. This data contains detailed information on each textile firm's export shipments from Pakistan to the world from 2000 to 2011. It contains information about each export transaction, including the export destination, shipment

[7] 1 PKR equals to approximately $0.006. The values reported in the table are at the current PKR value.

[8] Firms also use other forms of energy, including gas and diesel, but electricity remains the major source of energy used in production. Imran, et al., (2023) examine various sources of carbon emissions in the textile industry of Pakistan including electricity, water, gas, heavy fuel oil, diesel, coal, furnace oil, wood and biomass. They conclude that electricity consumption is the main contributor of carbon footprints in the textile industry of Pakistan. Moreover, even natural gas, diesel, and coal used in the textile firms in Pakistan is mainly to fuel generators, ultimately to produce electricity for textile mills especially for large and medium units (Naqvi, Sayed, & Dar, 2014).

[9] The IEA composite electricity factor (kgCO2/kWh) for Pakistan is 0.4511194. Detailed list for conversion factories for other countries can be found at https://www.iea.org/data-and-statistics/data-product/emissions-factors-2 and in Table 1 by Brander et al., (2011).

product code, and shipment value. We match this data set to the firms in the CMI to determine each firm's export status and destination. Combining this data with the CMI allows us to break down table 1 into exporters and non-exporters, as well as identify the percentage of exporters that report China and the United States as their export destinations.

World Trade Organization (WTO) Tariff Data

As the Pak-China FTA was based on lowering tariffs, we use the World Trade Organization (WTO) Tariff Analysis Online Database[10] to get the Chinese tariff rates imposed on Pakistani textile products. This database contains general information about applicable tariffs and imports, as well as the Consolidated Tariff Schedules (CTS), which include members' binding commitments to maximum tariffs. The database contains information on annual country and product-specific tariff rates[11]. The WTO tariff data uses Harmonized System (HS) codes to identify products. These tariff rates are available at the product level, which we then aggregate at the firm level using revenue shares as weights.

US Commerce Department's Office of Textile and Apparel (OTEXA)

The Commerce Department's Office of Textiles and Apparel (OTEXA) was in charge of managing quotas for the imports into the US under MFA. Quota limitations were product-country-year specific and remained consistent throughout time. OTEXA has maintained annual "progress reports" on each quota since 1984, including the exporting country, year, quota limit, and fill rate (how much of the quota was used). While OTEXA utilizes an idiosyncratic classification scheme, we combine OTEXA codes using HS code mapping available on the OTEXA website. This helps us link the OTEXA data to the CMI.

The OTEXA reports "base" quotas and "adjusted base" quotas, as well as total exports for each country and year. The base quota is the level agreed upon at the commencement of a term agreement. Adjusted base quotas use "flexibilities," allowing countries to borrow unused base quotas up to a certain percentage of the receiving category within a year or across years within a category. The restrictiveness of quotas under the MFA is commonly determined by analysing "fill rates", which represent the proportion of exports in relation to the adjusted base quota[12]. A higher fill rate indicates a higher utilization of the quota and indicates that the quota is restrictive and binding[13].

United Nations Comtrade Trade Data

We use the Comtrade database of the United Nations (UN) to get trade volumes. Since 1962, this International Trade Statistics Database has collected about 3 billion data records from around 170 different nations. It contains extensive trade statistics categorized by product type and trading partner. We use the Comtrade data for the estimation of product quality based on the methodology developed by Khandelwal (2010)[14].

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[10] Retrieved from the link: http://tariffanalysis.wto.org

[11] For each product, it reports the tariff line duties, average tariffs, principal suppliers, duty comparison, tariff concessions, and quotas.

[12] For instance, if a country has an adjustable quota to export 100,000 units of a certain textile product and it exports 90,000 units, the fill rate would be: $(\frac{90,000}{100,000}) * 100 = 90\%$. This means that 90% of the quota was utilized, indicating a high fill rate and suggesting that the quota was nearly fully used.

[13] Adjusted base quotas can exceed base quotas, but fill rates cannot exceed 100.

[14] Refer to Appendix B for a detailed discussion of the estimation of product quality based on Khandelwal (2010).

V. Preliminary Correlations and Results

We start the analysis by examining the impact of the export value on firm-level outcomes by estimating the following equation:

$$Y_{it} = \beta_0 + \beta_1 LogExportValue_{it} + \beta_2 X_{it} + \alpha_j + \alpha_t + \alpha_s + \alpha_{st} + \varepsilon_{it} \quad (1)$$

where Y_{it} includes firm-level outcomes like emissions, emissions per unit, firm output, product quality, quantity of its core product, number of products and capital usage for firm *i* at time *t*. $LogExportValue_{it}$ is the log of export value exported by firm *i* at time *t*. X_{it} includes firm-level controls including firm-level total factor productivity (TFPQ) and firm inputs. α_j are the product fixed effects and α_t are the time fixed effects. Based on De Loecker (2011), we divide the textile sector into four segments *s* which include spinning, clothing, interior, and finishing. We control for the segment fixed effects and segment-time effects as represented by α_s and α_{st} respectively. We estimate firm-level total factor productivity (TFPQ) based on De Loecker et al., (2016) and product quality based on Khandelwal (2010). Appendix A and B describe these methodologies in detail.

Table 2 presents the results of the preliminary specification from equation (1). The results show that as the value of Pakistan's textile exports increased, the total emissions also increased since higher exports translate into higher output, i.e., the scale effect. But an interesting result is that as exports increased, firms increased the output of their core products, and the quality of these products increased and at the same time, the emissions per unit of output decreased i.e., we find evidence of composition effect with firms moving towards their core products rather than a technological effect (insignificant result in column 6).

Table 2: Log Firm Level Outcomes

	Emissions	Emissions Per Unit	Log Output	Log Core Product Quantity	Log Quality	Log Capital	Log number of products
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Log Export Value	0.038**	-0.046***	0.084***	0.037**	0.004***	0.019	0.004
	(0.018)	(0.007)	(0.018)	(0.016)	(0.001)	(0.026)	(0.005)

Controls include firm average productivity, quality (excluded in column 5), number of products produced (excluded in column 7), firm inputs (capital excluded in column 6), product, segment, time and segment-time fixed effects.
N=1405, *p<0.10, ** p<0.05, *** p<0.01, Robust Standard Errors in parentheses.

The primary concern regarding endogeneity in equation (1) is the potential impact of time-varying omitted variables that can influence both the firm-level outcomes and the export value of the firm. (A secondary issue arises from instances where the export value is zero. Since export values cannot be negative, the distribution is left-censored.) To solve the endogeneity problem, many studies make use of exogenous determinants of exports such as foreign demand shocks or changes in trade policy to predict firm-level exports.

Bernard et al., (2014) show that the demand shocks faced by exporters are correlated with the firm-level exports of the country under investigation. El-Sahli et al. (2023) find similar results for firms in Sweden and Finland while Barrows and Ollivier (2014a) find a positive correlation between demand shocks and export value for firms in India. Similarly, a negative

demand shock due to the global financial crisis in 2009 dropped world trade by 12%, whereas China's export value dropped by 15% in 2009 as compared to 2008 (Chen et al., 2020), reaffirming the positive relationship between demand shocks and exports.

While we do not have the same measures of firm-level foreign demand for our sample, we can estimate shocks to *total* firm-level demand, using the methods of Haltiwanger et al. (2018), explained in more detail in Appendix C. Figure 6 presents the distribution of total demand shocks for the years 2000, 2005, and 2010. We can see that the mean of the demand shock distribution has moved towards the left over the span of 10 years, indicating that there has been an overall reduction in the magnitude of demand shocks enjoyed by the textile sector in Pakistan.

Figure 6: Demand Shocks Distribution: Year Wise

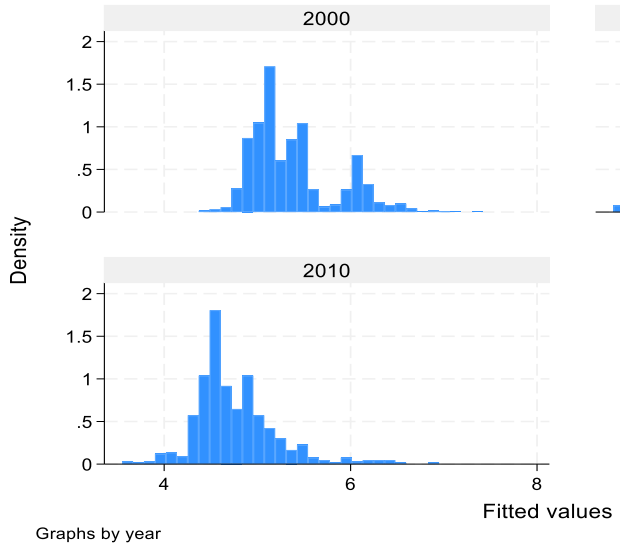


Table 3 below shows the overall positive correlation between export values and total demand shocks for Pakistan. Recall, however, that the Haltiwanger et al. (2018) demand shocks embodied both domestic and foreign demand. In addition, the major trade liberalization episodes occurring during this period incorporated both export-enhancing and export-reducing developments. The Pak-China FTA reduced tariffs on goods from Pakistan, increasing opportunities for exporters. The end of the Multibre Agreement was more complex on the other hand. Reductions in quotas on goods from Pakistan were welcomed by exporters, but it was accompanied by exposure to increased competition from the rest of the world, especially China, which was now also unhindered by quantitative restrictions on its exports. Barrows & Ollivier (2014b) already found that for India this increased competition effect from China (hurting exporters) overpowered the elimination of quotas on Indian goods. After we describe the trade policy measures in the next section, we will see how each of these changes - reductions in tariffs on Pakistani exports, $Tariff_{it}$, reductions in quotas on Pakistani exports, QR_Pak_{it}, and reductions in quotas on exports from the rest of the world, ROW_{it} - impacted the demand and the export values of Pakistani textile firms.

Table 3: Log Firm Level Outcomes	
	Log Export Value
Demand Shocks	0.273**
	(0.119)
Controls include firm average productivity, quality, number of products produced, firm inputs, product, segment, time and segment-time fixed effects. N=1405, *p<0.10, ** p<0.05, *** p<0.01, Robust Standard Errors in Parentheses.	

VI. A deeper dig into the Pak-China FTA and the end of the MFA

For the Pak-China FTA, we use the $Tariff_{it}$ imposed by China on firm *i* at time *t.* As mentioned in the data section, the tariff rates available by the World Trade Organization (WTO) are at the product level. We use product revenue shares as weights to aggregate these tariff rates to the firm level for firm *i* at time *t.*

For the end of the MFA, we use two measures: Pakistan's quantity restrictions or constraints QR_Pak_{it} and the quantity restrictions or constraints for the rest of the world ROW_{it}. Unlike the Pak-China FTA, which was specific to Pakistan and China, the end of the MFA did not only abolish the quotas for Pakistani exporters but simultaneously for the exporters from the rest of the world. Incorporating the ROW_{it} restrictions will allow us to fully incorporate the effect of the end of the MFA for Pakistan i.e., the simultaneous gain of more access into the US markets and the increase in competition as other countries gained increased access at the same time. The US Commerce Department's Office of Textile and Apparel (OTEXA) reports the fill rates for each product *i* at time *t* faced by Pakistan. Using product revenue shares as weights, we aggregate these as the firm level to get firm level quota restriction QR_Pak_{it} for firm *i* at time *t*.

We estimate the constraints on the rest of the world ROW_{it} based on the work by Barrows and Ollivier (2014b). To calculate Pakistani competitor constraints by product category under the MFA, we consider a weighted average of imports into the US under quotas from countries other than Pakistan each year. Let *i* represent a quota-group product category, *t* the year, and *k* the exporting country to the US. We create a competitive constraints index for the rest of the world (ROW), which includes countries other than Pakistan as:

$$ROW_{jt} = \frac{\sum_{i \in \Lambda} V_{jk0} * R_{jkt}}{\sum_{i \in \Lambda} V_{jk0}} \qquad (2)$$

V_{jk0} is the value of exports of product *j* from country *k* to the USA in some pre-liberalization base period 0. R_{jkt} is the quota indicator fill rate for product *j* from country *k* in year *t*, and Λ is a set of all countries other than Pakistan that export to the US. It is essential that the import shares V_{jk0} are evaluated before the end of the MFA, since the value of exports may change year to year as a result of the liberalization and therefore, may respond endogenously. Following Barrows and Ollivier (2014b) we take 1994 (the final year before the first phase out of the MFA) as the base year.

The ROW_{jt} index ranges from 0 to 1, with ROW_{jt}= 0 indicating that no exports from Pakistan's competitors to the US were subject to a quota in year *t* (based on pre-period

weights) and ROW_{jt}=1 indicating that all exports to the US (excluding Pakistan) for product category *j* were subject to a quota in *t*. As ROW_{jt} increases, the rest of the world is constrained, which means Pakistan has less competition in the US market, and hence Pakistani firms in product group *j* have better access to the US, regardless of US-Pakistan quota rates. Finally, the ROW_{jt} indicator at the product level is then aggregated at the firm level using product revenue shares as weights to get a measure of ROW_{it} competition faced by firm *i* at time *t* from the rest of the world. This measures the "third party" effects of the presence of other countries (excluding Pakistan) in the US market.

We use these measures of the Pak-China FTA and the end of the MFA to estimate the following equation on firms' total demand and export values (Y_{it}):

$$Y_{it} = \beta_0 + \beta_1 Tariff_{it} + \beta_2 QR_Pak_{it} + \beta_3 ROW_{it} + \alpha_j + \alpha_t + \alpha_s + \alpha_{st} + \varepsilon_{it} \quad (3)$$

We see the impacts on firms' total demand and export values of the changes brought about by these two major trade policy changes in Table 4. Tariff reductions $Tariff_{it}$ obtained through the FTA with China increased both demand and export values. Reducing the quota restrictions on Pakistani exporters (QR_Pak_{it}) had a large impact quantitatively on exporters but it was only marginally significant. On the other hand, reductions in quantitative restrictions on the rest of the world (ROW_{it}), by increasing the competition faced by Pakistan in external markets (smaller values of ROW_{it}), had large and highly significant impacts on firms, reducing both demand and export values. Therefore, Pakistan's exports to the US following the end of the MFA greatly affected by the competitive environment inside the US market, rather than by the specific restrictions imposed on Pakistan by the US.

Table 4: Impacts of the end of the MFA and the Pak-China FTA on Textile Demand and Export Values

	Exporters		All Firms	
	Demand Shocks	Log Export Value	Demand Shocks	Log Export Value
	(1)	(2)	(3)	(4)
$Tariff_{it}$	-0.344***	-0.955***	-0.208***	-0.277***
	(0.069)	(0.178)	(0.029)	(0.064)
QR_Pak_{it}	-1.158*	-1.560*	-0.542*	-0.689
	(0.590)	(0.915)	(0.278)	(0.693)
ROW_{it}	0.623***	4.090***	0.698***	0.871**
	(0.181)	(0.722)	(0.118)	(0.434)

Controls include firm average productivity, quality, number of products produced, firm inputs, product, segment, time and segment-time fixed effects.
N=1405, *p<0.10, ** p<0.05, *** p<0.01, Robust Standard Errors in Parentheses.

Instrumental Variable Approach: Pak-China FTA and end of the MFA specific instruments

In order to estimate the impact of the Pak-China FTA and the end of the MFA more precisely, we re-estimate equation (1) and present two sets of results for each exogenous shock on export values. We use tariff rates ($Tariff_{it}$) and quantity restrictions (QR_Pak_{it} and ROW_{it}), to pick up the impact of the Pak-China FTA and the end of the MFA respectively.

Pak-China FTA

For the Pak-China FTA, we use the firm-specific tariffs applied by China as instruments for the export value as shown in equation (4). We use tariff rates as an instrument for export value, the main exogeneity argument being that tariffs can impact a firm's export mainly due to global competition and price effect but a single firm on its own cannot influence the tariff rates. We then estimate the second stage as shown in equation (5).

$$LogExportValue_{it} = \delta_0 + \delta_1 Tariff_{it} + \delta_2 X_{it} + \alpha_j + \alpha_t + \alpha_s + \alpha_{st} + \varepsilon_{it} \quad (4)$$

$$Y_{it} = \beta_0 + \beta_1 \widehat{LogExportValue}_{it} + \beta_2 X_{it} + \alpha_j + \alpha_t + \alpha_s + \alpha_{st} + \varepsilon_{it} \quad (5)$$

Table 5: Panel A: Second Stage Results: Firm Level Outcomes

	Emissions	Emissions Per Unit	Log Output	Log Core Product Quantity	Log Quality	Log Capital	Log number of products
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Log Export Value	0.646**	-0.129	0.775**	0.898**	0.057**	0.360	-0.309**
	(0.306)	(0.092)	(0.346)	(0.324)	(0.021)	(0.190)	(0.154)
Panel B: First Stage:							
	Log Export Value						
$Tariff_{it}$	-0.149**						
	(0.056)						

Controls include firm average productivity, quality (excluded in column 5), number of products produced (excluded in column 7), firm inputs (capital excluded in column 6), product, segment, time and segment-time fixed effects.
N=1405, *p<0.10, ** p<0.05, *** p<0.01, Robust Standard Errors in parentheses.

Table 5 shows the results. The first stage shows that a reduction in tariff increases exports. For the second stage, we see that a rise in exports led to higher output, higher concentration on core products and higher product quality. But even though exports increased which led to higher emissions, the emissions per unit did not change significantly. Therefore, for firms exporting to China, we do find evidence of the scale effect i.e., more output increases emissions. We also find evidence of composition effect with firms focusing more on their core products which increases the overall product quality. We do not find any evidence of firms investing more in capital as shown in column (6) i.e., no evidence of technological or technique effect. Therefore, changes in product mix and shift towards core products is not enough for firms exporting to China to significantly reduce emissions per unit.

End of the MFA

To estimate the impact of the end of the MFA on firm-level outcomes Y_{it}, we use the restrictions imposed on Pakistani firms as measured through QR_Pak_{it} and the restrictions imposed on the rest of the world as measured through ROW_{it} as instrument as shown in equation (6). The argument for the exogeneity of the instrument is similar to the specifications for Pak-China FTA above. While restrictions on Pakistan and competition in the US market can impact firm level exports, the impact cannot be vice versa i.e., firm-level exports cannot impact quantity restrictions imposed by USA on Pakistan or the rest of the

world. We then estimate the second stage as shown in (7) to estimate the impact of the end of the MFA.

$$LogExportValue_{it} = \delta_0 + \delta_1 QR_Pak_{it} + \delta_2 ROW_{it} + \delta_3 X_{it} + \alpha_j + \alpha_t + \alpha_s + \alpha_{st} + \varepsilon_{it} \quad (6)$$

$$Y_{it} = \beta_0 + \beta_1 \widehat{LogExportValue}_{\iota t} + \beta_2 X_{it} + \alpha_j + \alpha_t + \alpha_s + \alpha_{st} + \varepsilon_{it} \quad (7)$$

Table 6: Panel A Second Stage Results: Firm Level Outcomes

	Emissions	Emissions Per Unit	Log Output	Log Core Product Quantity	Log Quality	Log Capital	Log number of products
Log Export Value	0.132**	-0.123***	0.256***	0.646**	0.024**	0.666	-0.214
	(0.064)	(0.032)	(0.066)	(0.250)	(0.011)	(1.086)	(0.302)
Panel B: First Stage							
	Log Export Value						
QR_Pak_{it}	-1.777						
	(1.156)						
ROW_{it}	3.093***						
	(0.461)						

Controls include firm average productivity, quality (excluded in column 5), number of products produced (excluded in column 7), firm inputs (capital excluded in column 6), product, segment, time and segment-time fixed effects
N=1405, *p<0.10, ** p<0.05, *** p<0.01, Robust Standard Errors in parentheses.

Table 6 shows the impact of the end of the MFA on firm-level outcomes when one uses increased access to the US market for Pakistani firms and increased access to the US market for other country firms, "third party" effects, as an instrument for export values. Here the first-stage results reinforce the idea that the impact of increased access for Pakistani firms was far less important than the impact of increased competition from other firms as they also gained greater access to the US markets. The "third party" effects via the indirect channel ROW_{it} far exceed the direct effects QR_Pak_{it}. Increased access of the third party (lower value of ROW_{it}) indicates an increase in competition for Pakistani firms which reduces the export value.

The output, focus on core products, and product quality all decrease as Pakistani firms compete with other countries in the US market (lower value of ROW_{it} translates into a fall in export value) while overall emissions decrease and emissions per unit increase. Therefore, for firms exporting to the US, the third-party effects dominate, where firms lose out on their export value. Scale effect (more output, more emissions) works in the direction of less output and less emissions. Composition effect leads to firms moving away from their core products while we do not find any changes in capital investment (technological effect) for firms exporting to the US.

Therefore, like in the case of firms exporting to China, firms exporting to the US have significant impact of the scale and compositions effects but not technological effects. Unlike in the case for firms exporting to China, for firms exporting to the US, the changes in firm's product mix are enough to significantly impact the emissions per unit. In this case, as firms

lose out on their market share and move away from their core products, emissions per unit increase (negative demand shock).

Reduced Form Effects of the Pak-China FTA and end of the MFA

Table 7 presents the results for the first specification in which the effect of the Pakistan-China FTA is represented by changes in tariffs ($Tariff_{it}$) and the effect of the MFA is divided into the (i) direct impact on Pakistani exporters, through the reduction in quantity restrictions on Pakistan exports ($QR_{Pak_{it}}$), and (ii) the indirect impact of increased access to US markets for other countries, "third party" effects, given by the reduction in restrictions on other country exports to the US (ROW_{it}). Panel A shows the results for the entire sample while Panel B focuses on the exporters only. Our results remain the same as we move from Panel A to Panel B, but with an increase in magnitude for results in panel B.

Table 7: Log Firm Level Outcomes

Panel A: All Firms

	Demand Shocks	Log Export Value	Emissions	Emissions Per Unit	Log Output	Log Core Product Quantity	Log Quality	Log Capital	Log number of products
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$Tariff_{it}$	-0.208***	-0.277***	-0.082**	0.035	-0.117***	-0.094*	-0.015***	0.168	0.023*
	(0.029)	(0.064)	(0.034)	(0.019)	(0.032)	(0.038)	(0.003)	(0.116)	(0.013)
QR_Pak_{it}	-0.542*	-0.689	-0.658	-0.090	-0.568	-0.851	0.006	-0.357	0.289
	(0.278)	(0.693)	(0.554)	(0.205)	(0.490)	(0.627)	(0.034)	(0.673)	(0.214)
ROW_{it}	0.698***	0.871**	0.548**	-0.266**	0.814***	0.831***	0.092***	-1.709***	-0.044
	(0.118)	(0.434)	(0.172)	(0.094)	(0.164)	(0.216)	(0.015)	(0.329)	(0.081)

Panel B: Exporters Only

	Demand Shocks	Log Export Value	Emissions	Emissions Per Unit	Log Output	Log Core Product Quantity	Log Quality	Log Capital	Log number of products
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$Tariff_{it}$	-0.344***	-0.955***	-0.950***	0.079	-1.029***	-0.496***	-0.038***	-0.005	0.055
	(0.069)	(0.178)	(0.178)	(0.072)	(0.195)	(0.128)	(0.008)	(0.140)	(0.033)
QR_Pak_{it}	-1.158*	-1.560*	0.537	0.330	0.207	0.416	0.063	0.182	0.550
	(0.590)	(0.915)	(1.164)	(0.527)	(1.033)	(0.999)	(0.046)	(1.224)	(0.389)
ROW_{it}	0.623***	4.090***	2.787***	-0.410**	3.196***	2.292***	0.114***	-1.974***	-0.336*
	(0.181)	(0.722)	(0.667)	(0.183)	(0.739)	(0.542)	(0.033)	(0.459)	(0.191)

Controls include firm average productivity, quality (excluded in column 5), number of products produced (excluded in column 9), firm inputs (capital excluded in column 8), product, segment, time and segment-time fixed effects.
N=1405 (Panel A); 353 (Panel B), *p<0.10, ** p<0.05, *** p<0.01, Robust Standard Errors in parentheses.

Reduction in tariffs from the Pak-China FTA led to a positive demand shock and an increase in output and exports of textile manufacturers, accompanied by an increase in the quality of the products but also an increase in overall emissions (scale effect). But this was not accompanied by decreases in emissions per unit. Therefore, changes in product mix (composition effect) are not alone sufficient to reduce emissions per unit. There is no evidence of firms investing in capital (technological effect). Jamil et al. (2022) report similar results for textile firms in Pakistan, where the FTA increases firm productivity, but by less than what has been reported for other countries. They also show that firms exporting to China do not invest more in capital as a result of the FTA.

At the same time, the direct impact of increased access for Pakistani textile exporters to the US had no significant impact on output and emissions. But the increased competition faced by Pakistani manufacturers (lower ROW_{it}) from other countries that gained access to the US market had a significantly negative impact on demand for Pakistani goods; a decrease in output and export value, less concentration on the core products produced by firms, a fall in the quality of their output and a decrease in emissions while the emissions per unit of output increased. Our results are similar to Barrows and Ollivier (2014b) who show that with the end of the MFA for India, the impact was felt mainly due to the "third-party" effects. If access to export markets encourages firms to reduce emission intensity, firms that are crowded out by foreign market competition may increase their emissions indirectly. Interestingly, we find no evidence (no statistically significant influence of QR_Pak_{it}) that US-Pakistan quotas restricted Pakistani exports. Therefore, we see that the reduction in quota restrictions imposed on Pakistan QR_Pak_{it} (direct effect) did not significantly impact firm-level outcomes but rather it is the effect of greater competition ROW_{it} (indirect effect) that impacts them.

When competitors faced restrictions on exporting to the US (higher values of ROW_{it}), Pakistani firms saw an increase in their share of total exports and output. After the MFA ended, Pakistani firms formerly restricted by third-party quotas lost their advantage in accessing the US market (negative scale effect). This is consistent with the assumption that multilateral resistance affects exports. Overall, the estimates suggest that Pakistani firms experienced a competitive shock as a result of the MFA's termination.

The positive aspect of this increased competition from other countries in the US market faced by Pakistani exporters was that there was an increase in capital stock as firms tried to regain their competitiveness, i.e., lower values of ROW_{it} lead to capital accumulation. This result supports the literature that firms increase capital in response to competition and productivity improvements, rather than demand shocks. As Pakistani firms face more competition in the US market, they invest more in capital. Kang (2022) suggests that export competition tends to increase innovation among high-productivity firms. For example, South Korean firms facing competition from Chinese exports have increased their innovation efforts, particularly high-productivity firms, which suggests that export competition can drive firms to invest more in R&D to maintain their competitive edge. Similarly, Goodwin & Pierola (2015) suggest that firms become more productive as a result of exporting to other markets due to knowledge spillovers and exposure to foreign competition. This increased productivity can lead to more capital being allocated towards enhancing export capabilities.

The potential reason for the increase in emission intensity is that as firms face more competition in the US market, output quality falls (column 7) as firms move towards the production of low-quality products (away from their core products). While high-quality

products generate low emissions, low-quality products are emissions-intensive. Therefore, our results suggest that emissions intensity is decreasing in quality.

VII. Discussion

While both the end of the MFA and the Pak-China FTA were anticipated to give more access to Pakistan in the US and Chinese markets respectively, the end of the MFA failed to do so due to intense competition faced by Pakistani exporters in the US markets. Therefore, overall, in terms of emission intensity, the Pak-China FTA turned out to be a better deal for Pakistan (positive demand shock), where emissions per unit did not change significantly (if not fall) as compared to the end of the MFA which resulted in the manufacture of low quality, high emission intensity products (negative demand shock).

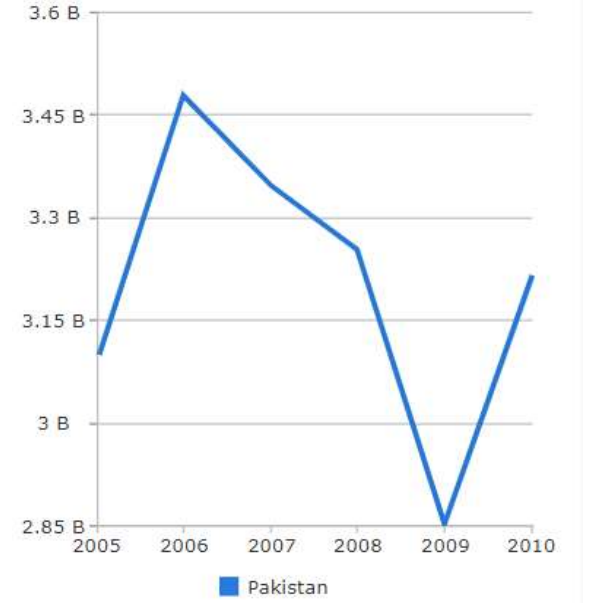
Besides the concern of emission intensity, however, the gain in Chinese markets for Pakistani firms was primarily in the low value-added segments of spinning and finishing (Figure 3) as these were the least protected segments by China (Figure 2). On the other hand, Pakistan lost its market share of high value-added segments in the US, interior and clothing (Figure 5 and Appendix D). Therefore, the loss for Pakistan at the end of the MFA was more than an increase in emission intensity and quality down-gradation but rather in the high value-added segments.

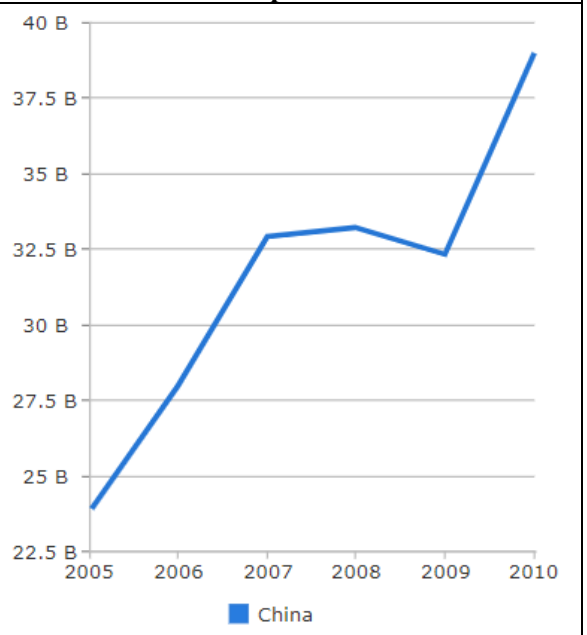
Pakistan, like many other countries, including the Philippines, Nepal, Korea, Taiwan, and Bangladesh, lost its market share in the US market due to competition, especially after China entered the WTO in 2001 (Whalley, 2006). Figure 7 below shows the aggregate export of textiles and clothing from China and Pakistan to the US from the year 2005-2010, soon after the end of the MFA. Pakistan’s market share declined while it increased rapidly for China.

The data from ILO (2005) indicates that India, on the other hand, experienced a rise in textile exports from January to March 2005, but there was a decline in exports of clothes and ready-made garments during the same period. Khandelwal et al. (2010) suggest that China's benefits from the end of the MFA came almost exclusively at the expense of other American trading partners rather than domestic firms. China's significant export growth in the US market in 2005, was anticipated given the relative restrictions of its quotas in comparison to other nations and its track record in previous rounds of quota liberalization. Since China was not a WTO member, it was not eligible for the first two rounds of quota elimination under the ATC, which took place in 1995 and 1998. Upon entering the WTO, China's average export quantity of the items covered by the first two stages increased by 111 and 151 percent in the first year, respectively, and its quotas were promptly lifted. China was also able to take part in the third round of quota removals in 2002 after joining the WTO where its exports to the US markets increased by 145 percent (Khandelwal et al., 2010) with some product categories seeing increases of over 1,000% (Rivoli, 2005).

Figure 7: Pakistan and China's Export of Textile and Clothing to USA (US $ Thousand)

Pakistan's Export to USA	China's Export to USA





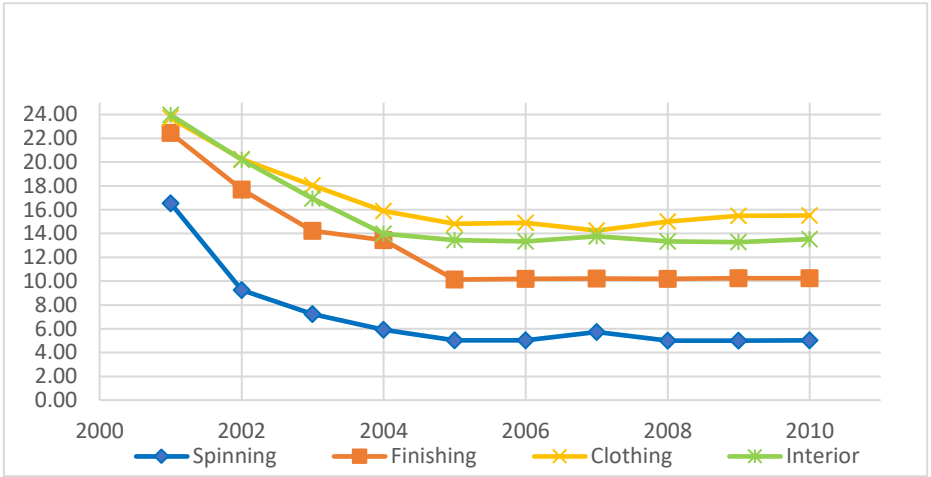
Data Source: World Integrated Trade Solution by the World Bank

Therefore, while China gave access to Pakistani firms in its own market by the import of low-value-added raw materials or intermediate inputs (spinning and finishing), it captured its market share of high-value-added products (interior and clothing) in the US market. Besides Pakistan, China entered into multiple Free Trade Agreements with many countries, including ASEAN countries. Figure 8 shows that China followed a similar strategy with these countries: low tariff rates and high imports of intermediate inputs (spinning and finishing) which were needed to produce high value-added output (interior and clothing) in the textile supply chain.

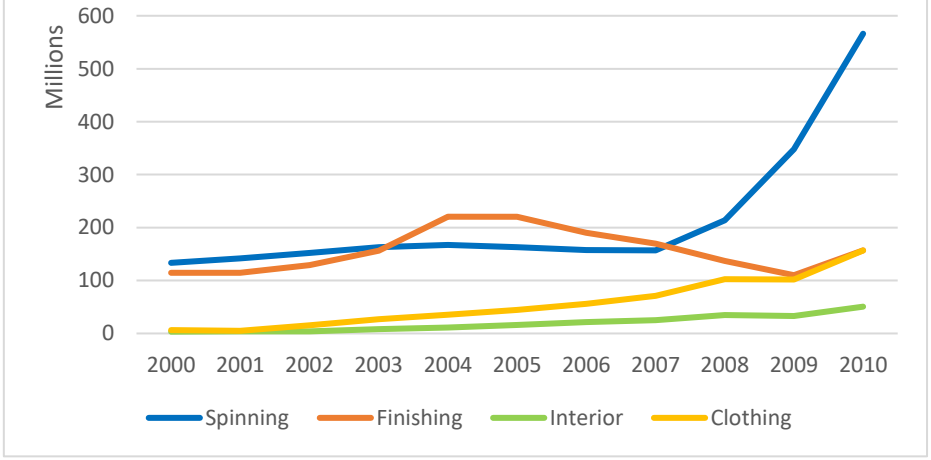
This suggests that China, in its attempt to become a major player in world trade and emerge as a global trader, focused on buying low value-added intermediate inputs from developing countries with an aim of capturing the high value-added segments in developed countries like the US. While various factors including China's comparative advantage in cheap labor-intensive products (Khandelwal et al., 2010), low prices (Rivoli, 2005; Whalley, 2006), and development of science parks for high-tech products (Berger & Martin, 2011) contributed towards its gain in the US market share, ensuring consistent supply of raw materials and intermediate inputs at the upstream end can also be a potential contributing factor.
Liua and Qiu (2016) suggest that just between 2000 and 2006, China's intermediate input imports surged by 256%. This significant increase reflects China's rapidly rising position in global supply networks over this period. A proportion of China's imports, including intermediate inputs, were directly related to export demand. This demonstrates China's inclusion in global and regional manufacturing networks (Godbout & Langcake, 2013).

Figure 8: China's Tariffs and Imports from ASEAN countries

Panel A: Tariff Rates imposed by China on ASEAN Textile Segments



Panel B: China's import from the ASEAN countries



Data Source: World Trade Organization (WTO) Tariff Analysis (Panel A) and UN Comtrade Data (Panel B)

VIII. Conclusion

Trade is an important driver of economic growth in both developing and developed countries, but trade-related emissions are a global concern. However, the influence of trade on emissions is complex; some firms may go down the quality ladder as they export more, resulting in higher emissions per unit of output, whilst others may move up the quality ladder and lower their emissions per unit. It is therefore important to understand how different types of demand shocks affect emissions as firms have the ability to respond to these shocks by modifying their output (scale effect), product mix (composition effect), and capital investment (technological effect)

In this paper, we examine the impact of two exogenous demand shocks on Pakistan's textile exports: the signing of the Pakistan-China Free Trade Agreement (FTA), which reduced tariffs on Pakistani exports to China, and the end of the Multifibre Agreement (MFA), which increased market access for Pakistani textile manufacturers to the United States. The key difference between these two shocks is that the first only affected Pakistan, whereas the second increased access for Pakistani firms to the US while also increasing competitiveness

in this market because other countries acquired access at the same time. So, it's interesting to examine how these demand shocks with varying degree of foreign market competition or “third party” effects influenced Pakistan's textile exports, overall firm-level emissions, and emissions per unit.

We find that the Pakistan-China FTA led to an increase in exports, a focus on core products, and an increase in the quality of the exported goods to China. This was accompanied by an increase in overall emissions, but no significant increase in emissions per unit of output. However, the end of the MFA resulted in a decrease in Pakistan's exports, firms moving away from their core products, and a reduction in emissions due to the increased competition from other countries. This had a far greater negative impact than the positive impact of gaining access to the US market. Additionally, it resulted in a significant increase in emissions per unit of output, with Pakistani firms producing low-quality, dirty products and losing market share of high-value added products. Therefore, our results indicate that different types of demand shocks have different impacts on emissions, and that any analyses of the impacts of increased access to markets must also include analyses of the impacts of increased competition.

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Appendix A

Firm Level Productivity based on De Loecker et al. (2016)

We begin by estimating firm level productivity based on the methodology developed by De Loecker et al. (2016). This methodology works well when price and physical quantity information is available at the product level for multi-product firms, as it is with our data. One of the major contributions of this methodology is that, unlike traditional production function estimation approaches, it estimates the production function at the product level rather than the firm level. Additionally, this methodology has the advantage of estimating productivity without considering any parametric assumptions about consumer demand, market structure, or the nature of competition. As a result, this methodology enables the analysis to be conducted using product-level data without the requirement to explicitly assume a market demand function to aggregate output and prices at the firm level.

Using disaggregated price and physical output data at the product level, the estimation of the quantity-based production function helps control for any omitted output price bias that typically arises when the analysis relies on sectoral deflators. In this methodology, since disaggregated price and physical output data is used (as is available in our data set), there is no need for sectoral deflators. Additionally, this methodology addresses a number of other biases, typically ignored in literature. These biases include the omitted input price bias (mainly arising due to different variety/quality of inputs used by firms) and the unobserved allocation of inputs across multi-product firms (mainly arising due to data limitations where typically input expenditures are available at firm level rather than at the product level). Based on De Loecker et al. (2016), we start by writing the production function for firm *f* producing product *j* at time t as:

$$Q_{fjt} = F_{jt}\left(V_{fjt}, K_{fjt}\right)\Omega_{ft} \qquad \text{(A.1)}$$

where Q is the physical output, V is a vector of variables inputs which adjust freely and K is a vector of fixed inputs facing some adjustment cost. Ω_{ft} is the firm specific productivity. Taking logs of the production function as in equation (A.1) gives:

$$q_{fjt} = f_j\left(\chi_{fjt};\, \beta\right) + \omega_{ft} + \varepsilon_{fjt} \qquad \text{(A.2)}$$

where $q_{fjt}$is the log of output which is a function of the vector χ_{fjt} which includes the log of physical inputs $\{V_{fjt}, K_{fjt}\}$. β represents the respective coefficients while ω_{ft} is the log of productivity. ε_{fjt} is the with idiosyncratic error. Denoting $\widetilde{\chi_{ft}}$ as the observed vector of price index-deflated input expenditures, the product-level input quantities $\chi_{fjt}$for each input are then given as:

$$\chi_{fjt} = \rho_{fjt} + \widetilde{\chi_{ft}} - w^{x}_{fjt} \qquad \text{(A.3)}$$

where ρ_{fjt} is the share of firm input expenditures (in logs) allocated to product j at time t. w^{x}_{fjt} is the deviation of the unobserved firm-specific input prices from the industry-wide input price index (in logs). Substituting this expression of physical inputs (A.3) into equation (A.2) and denoting w_{fjt} as a vector of log firm product specific input price gives:

$$q_{fjt} = f_j(\widetilde{\chi_{ft}};\ \beta) + A(\rho_{fjt}, \widetilde{\chi_{ft}}, \beta) + B\left(w_{fjt}, \rho_{fjt}, \widetilde{\chi_{ft}}, \beta\right) + \omega_{ft} + \varepsilon_{fjt} \quad (A.4)$$

Comparing equation (2) to equation (4), there are now two additional unobserved terms: A(.) represents the input allocation bias which is due to the presence of the unobserved product-level input allocation ρ_{fjt}, while B(.) represents the input price bias which arises from unobserved firm-specific input prices w_{fjt} .

De Loecker et al. (2016) relies on the data from the single product firms to estimate the product-level production function. Using single product firms means that the term A(.)= 0 as ρ_{fjt}=1 by definition. The model by De Loecker et al. (2016) assumes that if the physical relation between input-output is the same for both the single and multi-product firms which produce the same product, and that the technology used in the manufacturing of product j is independent of other products produced by the firm, in that case the input-output relationship from single-product firms can help in approximating the input allocations for multi-product firms.[15] Using single-product firms only (with A(.)=0), equation (A.4) then can be re-written as:

$$q_{fjt} = f_j(\widetilde{\chi_{ft}};\ \beta) + B\left(w_{fjt}, \rho_{fjt}, \widetilde{\chi_{ft}}, \beta\right) + \omega_{ft} + \varepsilon_{fjt} \quad (A.5)$$

In order to solve the problem from the omitted input price bias in B(.) as in equation (A.5), this methodology uses information from the product level output data as proxy for input prices. The main idea is that high quality inputs are needed to manufacture high quality output. Therefore, output prices reflect the quality of inputs and thus, contain information regarding input prices. Assuming that input prices increasing monotonically in input quality, this methodology uses output prices, market share and product dummies to proxy for input prices. Therefore, input prices w^x_{fjt} are written as a function of output quality v_{ft} and firm location G_f as:

$$w^x_{fjt} = w_t(v_{ft}, G_f) \quad (A.6)$$

where output quality v_{ft} is estimated based on output price of the firm p_{ft}, vector of market share ms_{ft}, vector of product dummies $D_{f,}$ and export status of the firm EXP_{ft}. Hence equation (A.6) can be written as:

$$w^x_{fjt} = w_t(p_{ft}, ms_{ft}, D_{f,} EXP_{ft}, G_f) \quad (A.7)$$

As a next step, the GMM estimation procedure is applied to solve for the production function estimates. Once these estimates are obtained, they are used to solve for the input allocation across multi-product firms by simultaneously solving a system of $J_{ft} + 1$ equations for each multi-product firm (where J_{ft} is the number of products produced by firm f in time t). This then helps to back out firm level productivity.

Additionally, this methodology also applies a selection-correction procedure, since firms self-select into being a multi-product firms based on their productivity and input set. This introduces a self-selection bias in the sample, which is corrected by a correction procedure. The correction procedure is based on a probability estimation of the firm being a multi-product firm, based its own productivity threshold and information set.

[15] To illustrate this with an example, this methodology assumes that a firm which only produces motorcycles will use the same technology as a firm which produces both motorcycles and cars.

Appendix B

Output Quality based on Khandelwal (2010)

We use the methodology by Khandelwal (2010) to estimate output quality. This methodology is based on nested logit demand system which allows for both preferences of both horizontal and vertical attributes. The methodology assumes that the quality is a vertical component of the model which represent the mean value a typical consumer attaches to the product. Therefore, it is essential to incorporate product differences at the horizontal level, as expensive imported products may co-exist in the market at the same time with cheap rivals, where price might not be an appropriate proxy for quality.

In the model, a typical consumer n's preferences are based on assuming that she purchases that variety of the product ci within product i at time t to maximize her utility. Therefore, the demand curve of a typical consumer can be represented as:

$$ln\ (s_{cit}) - ln\ (s_{ot}) = \lambda_{1,ci} + \lambda_{2,t} + \alpha p_{cit} + \sigma ln\ (ns_{cit}) + \lambda_{3,cit} \qquad (B.1)$$

where ln (s_{cit}) is the log of variety ci's overall market share and $ns_{cit}$is its market share within product i (nest share). ln (s_{ot}) is the log of the outside option's market share. p_{cit} is the price of the variety *ci* at time *t*.

Quality is defined as $\lambda_{1,ci} + \lambda_{2,t} + \lambda_{3,cit}$ which reflects a valuation of variety ci common across all consumers[16]. Thus, the quality term is decomposed into three main elements: $\lambda_{1,ci}$ the time invariant valuations that the consumer attaches to variety ci reflecting variety fixed-effects; $\lambda_{2,t}$ captures time trends across all varieties represented by the time fixed-effects; and $\lambda_{3,cit}$ a variety-time deviation observed by the consumer (and not by the econometrician) that plays the role of the estimation error. The quality of variety ci is then computed as[17]:

$$\lambda_{cit} = \hat{\lambda}_{1,ci} + \hat{\lambda}_{2,t} + \hat{\lambda}_{3,cit} \qquad (B.2)$$

[16] There is no subscript *n* in these terms since it represents common valuation across all consumers.
[17] For our study, we aggregate the quality at the firm level by using product revenue shares as weights.

Appendix C

Estimating Demand Shocks based on Haltiwanger et al. (2018)

We estimate the demand shocks based on the methodology by Haltiwanger et al. (2018) as shown in equation (C.1).

$$p_{ijt} = b_0 + b_1 q_{ijt} + b_2 \frac{1}{Q_{ijt}} + d_{ijt} \quad \text{(C.1)}$$

Where p_{ijt} is the log of price and q_{ijt} is the log quantity of product *j* produced by firm *f* at time *t*. $\frac{1}{Q_{ijt}}$ is the inverse of the quantity of product *j* produced by firm *f* at time *t* in levels. To obtain consistent estimates, based on the reasoning of Foster et al. (2008, 2016), firm-level total factor productivity (TFPQ) is used as a cost-sharing instrument. The specification includes three instruments: TFPQ, log (TFPQ), and (1/TFPQ), with the last term interacting with product fixed effects. We estimate firm-level TFPQ based on De Loecker et al. (2016).[18] The residual from this specification, d_{ijt}, is the product level demand shock. Using product revenue shares as weights, we then aggregate the product-specific demand shocks at the firm level to get the estimate of demand shock for firm *i* at time *t* as $DemandShock_{it}$.

[18] Refer to Appendix A for a detailed discussion of the estimation of TFPQ based on De Loecker et al., (2016).

Appendix D

Percentage change in Pakistan's Export Value to the US (US $)				
Product Code	**Product Description**	**% Change between the years 2000-2005**	**%Change between the years 2005-2010**	**% Change between the years 2000-2010**
6101302020	BOYS' OVERCOATS ETC	46.71	-58.46	-39.05
6103431520	MEN'S TROUSERS & BREECHES	-64.25	-79.30	-92.60
6103431540	BOYS' TROUSERS & BREECHES	-46.33	-90.19	-94.73
6103431570	BOY'S SHORTS KNITTED OR CROCHETED	19.34	-66.28	-59.76
6104332000	W/G SUIT-TYPE JACKET	669.27	-88.61	-12.39
6104420010	WOMEN'S DRESSES OF COTTON	6.44	-80.16	-78.88
6104432020	GIRLS' DRESSES KNITTED OR CROCHETED	66.46	-72.10	-53.55
6104520010	WOMEN'S SKIRTS AND DIVIDED SKIRTS	-62.59	-96.77	-98.79
6104621020	WOMEN'S OVERALLS OF BIB AND BRACE	86.66	-87.13	-75.97
6104622050	GIRLS' SHORTS COTTON	-44.29	-83.42	-90.76
6104632028	KNITTED GIRLS' SYNTHETIC TROUSERS	-58.36	-99.08	-99.62
6104632030	WOMEN'S SHIRTS OF SYNTHETIC FIBERS	-55.87	-77.55	-90.09
6105202030	BOYS' SHIRTS OF MANMADE FIBERS	23.53	-94.29	-92.94
6106100010	WOMEN'S BLOUSES AND SKIRTS	8.52	-23.92	-17.44
6108320010	WOMEN'S NIGHTDRESSES	649.57	-96.18	-71.33
6108910015	WOMEN'S UNDERWEAR	-63.86	-87.64	-95.53
6109901013	MEN'S TANK TOPS & SINGLETS	-48.77	-93.07	-96.45
6109901025	BOYS' TANK TOPS & SINGLETS	232.24	-96.74	-89.17
6109901049	MEN'S/BOY'S ARTICLES OF MMF	127.25	-70.73	-33.48
6109901065	WOMEN'S TANK TOPS & SINGLETS	-5.07	-62.06	-63.99
6110202020	WOMEN'S SWEATERS OF COTTON	21.60	-20.25	-3.02
6110303035	W/G VESTS	159.57	-85.51	-62.39
6111305030	BABIES' GRMNT & CLTH	-70.11	-90.62	-97.20
6112120010	MEN'S/BOY'S JACKETS FOR TRACK SUITS	1114.74	-95.00	-39.24
6112120050	MEN'S/BOY'S TROUSERS FOR TRACK SUITS	60.71	-91.77	-86.77
6112120060	WOMEN'S/GIRL'S TROUSERS FOR TRACK SUITS	60.30	-77.44	-63.84
6114200005	MEN'S OR BOYS' TOPS	560.79	-91.07	-40.99
6114200015	JUMPERS OF COTTON	-59.50	-92.56	-96.99
6201110010	MEN'S OVERCOATS CARCOATS	-44.40	-79.06	-88.36
6201122060	BOYS' OVERCOAT	203.45	-98.14	-94.34
6201134030	MEN'S OVERCOAT	-43.04	-84.88	-91.39
6202134020	WOMEN'S OVERCOATS & CARCOATS	-90.74	-91.44	-99.21
6203332010	MEN'S SUIT JACKET/BLAZER	101.53	-70.09	-39.72
6203411810	MN TRSRS/BRCHS OF WL	479.07	-84.25	-8.80
6203422010	MEN'S BIB AND BRACE	-78.25	-84.89	-96.71
6203434010	MEN'S TROUSERS	-68.27	-74.12	-91.79
6203492045	MEN'S SHORTS OF ARTI	189.49	-75.15	-28.07

6204194000	WOMEN’S/GIRL’S SUITS OF SILK COTTON	53.56	-38.75	-5.94
6204335010	WOMEN’S SUIT TYPE JACKET SYNTHETIC FIBERS	122.88	-96.64	-92.51
6204423050	WOMEN’S DRESS OF COT CON	-53.34	-71.03	-86.48
6204423060	GIRL’S DRESS OF COTTON	-49.94	-77.16	-88.57
6204444010	WOMEN’S DRESSES OF ARTIFICAL FIBERS	-78.33	-98.56	-99.69
6204522030	WOMEN'S SKIRT & DIVIDED SKIRTS OF COTTON	31.41	-41.84	-23.58
6204522040	GIRLS' SKIRT & DIVIDIDED SKITRS OF COTTON	56.18	-56.89	-32.67
6204533010	WOMEN’S SKIRTS OF SYNTHETIC FIBERS	-9.98	-73.10	-75.78
6204533020	GIRL’S SKIRT OF SYNTHETIC FIBERS	-76.91	-93.61	-98.53
6204593010	WOMEN’S SKIRTS ARTIFICAL FIBERS	-71.08	-86.76	-96.17
6204633530	GIRL’S TROUSERS SYNTHETIC FIBERS	-57.42	-69.44	-86.99
6204692510	WOMEN'S TROUSERS ARTIFICAL FIBERS	-61.58	-99.06	-99.64
6205302050	MEN'S SHIRT OF MAN MADE FIBERS	-6.23	-6.54	-12.36
6205302070	MEN SHIRTS MAN MADE FIBERS	-21.60	-67.06	-74.18
6205302080	BOYS' SHIRT MAN MADE FIBERS	112.51	-96.85	-93.31
6206302000	WOMEN’S/GIRL’S BLOUSES COTTON	238.37	-98.67	-95.50
6206403010	WOMEN’S BLOUSES, SKIRTS AND SKIRT BLOUSES	-30.77	-63.98	-75.06
6206403040	GIRL’S BLOUSES, SKIRTS AND SKIRT BLOUSES	125.47	-87.33	-71.43
6207110000	MEN’S/BOY’S UNDERPANTS	124.53	-59.59	-9.27
6207210010	MEN'S NIGHTSHIRTS	186.48	-85.50	-58.47
6207210040	BOYS' NIGHTSHIRTS	-90.04	-94.53	-99.46
6207220000	MEN’S/BOY’S NIGHTSHIRTS & PAJAMA	-41.67	-96.92	-98.20
6207911000	MEN’S/BOY’S BATHROBES, DRESS	48.61	-93.84	-90.84
6207913020	MEN’S/BOY’S SINGLETS, OTHER	-5.08	-42.50	-45.41
6208110000	WOMEN’S/GIRL’S SLIPS AND PETTIC	-15.54	-24.62	-36.33
6208210020	WOMEN'S NIGHTDRESS	50.84	-59.72	-39.25
6208220000	WOMEN’S/GIRL’S NIGHTDRESSES & PAJAMAS	-32.50	-86.58	-90.94
6208913020	GIRLS' BRIEFS AND SINGLETS	-62.35	-97.97	-99.23
6208920010	WOMEN'S NEGLIGEE	-68.75	-69.54	-90.48
6208920030	WOMEN'S BRIEFS AND SINGLETS	434.90	-95.83	-77.67
6209205050	BABIES' OT GARMENTS	11.18	-41.25	-34.69
6211111010	MEN'S SWIMWEAR	-11.79	-95.59	-96.11
6211320015	B CVRALS & SIM APPRL	-74.68	-84.87	-96.17
6211430050	WOMEN’S/GIRL’S TRACK SUITS	-76.45	-90.71	-97.81
6211430076	WOMEN’S/GIRL’S MMF VESTS N KT C	-49.98	-78.93	-89.46
6214101000	SHAWLS SCARVES, MUFFLERS SILK	-12.06	-78.40	-81.01
6214900090	SHAWLS SCARVES, MUFFLERS OTHER MATERIALS	24.16	-65.25	-56.86
6216000800	SKI/SNOWMOBILE GLOVE	15.39	-33.77	-23.58
6216004100	GLOVES EX SKI COTTON	16.07	-89.26	-87.53
6217101090	CLOTHING ACCESSORIES	494.18	-83.53	-2.12
6301300020	BLANKET N/ELEC & TRA	115.10	-64.80	-24.27
6302100015	BED LINEN, KNITTED O	-27.99	-64.45	-74.40
6302215020	SHEETS OF PRINTED COTTON	257.89	-87.55	-55.45

6302217040	PILLOWCOVERS OF PRINTED COTTON	1290.76	-96.91	-57.08
6302222010	PILLOWCASES OF PRINTTED	24.61	-66.32	-58.03
6302222020	SHEETS OF PRINT MANM	-7.59	-86.57	-87.59
6302321040	SHEETS OF MANMADE FIBER	467.22	-98.95	-94.05
6302321060	BED LINEN: OTHER THAN PRINTED	-9.38	-93.38	-94.00
6302322010	PILLOWCASES OF MANMA	544.38	-99.86	-99.09
6302390010	BED LINEN OF WOOL	204.14	-94.81	-84.22
6302512000	TABLECLOTHS AND NAPK	42.84	-43.57	-19.39
6302530030	TABLE LINEN EX TABLE	1445.44	-94.44	-14.12
6302910005	COTTON DISH TOWELS	-12.56	-69.09	-72.97
6302910035	COTTON TOWELS JACQUA	183.94	-72.10	-20.78
6302932000	BED, TABLE, TOILET,	1.66	-50.51	-49.69
6303921000	CURT & INTER BLINDS/	711.60	-99.50	-95.93
6304192000	OTHER FURNISH ART NT	-54.41	-72.76	-87.58
6304930000	FURNISHISHING ARTICLES	33.32	-93.92	-91.89
6304996030	OTHER FURNISHISHING ARTICLES	447.54	-90.44	-47.67
6307908945	PILLOW SHELLS, OF COTTON	-1.94	-26.03	-27.47
6307908985	SHELLS FOR QUILTS, EIDERDOWNS	-15.95	-68.04	-73.14
6310102030	USED/NEW RAGS, SCRAP TWINE	623.81	-96.84	-77.11

Source: International Trade Administration, The Office of Textiles and Apparel (OTEXA)