

The Impact of NAFTA on Prices and Competition: Evidence from Mexican Manufacturing Plants*

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Abstract

This paper assesses the impact of the North American Free Trade Agreement on Mexican manufacturing plants' output prices and markups. We distinguish between Mexican goods that are exported and those sold domestically, and decompose their prices separately into markups and marginal costs. We then analyze how these components were affected by the reductions in Mexican output tariffs, intermediate input tariffs, and U.S. tariffs on Mexican exports. We find that domestically sold products saw a decline in prices as Mexican plants faced more competition and gained access to cheaper inputs. By contrast, exported goods saw a slight increase in prices as plants increased their markups in response to a favorable competitive environment due to declines in U.S. tariffs.

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1 Introduction

The past few decades have seen drastic reductions in tariffs, a large share of which can be attributed to reciprocal multilateral or bilateral trade liberalizations. Reciprocal trade liberalizations have been negotiated through multilateral organizations such as the General Agreement on Tariffs and Trade (GATT) and the World Trade Organization (WTO), a notable example being the Uruguay Round from 1986 to 1994. At the same time, reciprocal trade liberalizations have been pursued through bilateral and regional agreements among groups of countries, exemplified by the North American Free Trade Agreement (NAFTA) in 1994. Given the rising policy debate over globalization in recent years, understanding how domestic firms respond to reciprocal tariff changes is of great policy relevance.

Reciprocal trade liberalization differs from unilateral trade liberalization because it involves reductions in tariffs on both exports to and imports from participating countries. These tariff reductions may affect domestic firms' prices and the competition they face through multiple channels. As tariffs on imports fall, domestic firms face more competition but can simultaneously take advantage of cheaper imported inputs. In addition, as foreign tariffs on exported goods fall, exporters may enjoy greater access to foreign markets. Empirical studies that fail to account for these effects may not fully grasp the implications of trade liberalization for firms' competition.

There are two main challenges in empirically studying the effects of reciprocal tariff reductions on firms' prices. The first challenge is the scarcity of detailed data. Import tariff reductions may primarily affect prices in the domestic market through increased competition with imported goods, while reductions in tariffs on exported goods may primarily affect prices on exported goods. Therefore, it is critical to obtain data that record firms' output prices at a disaggregated product–destination market level for a broad set of industries. The second challenge is that markups and marginal costs are not observable, even when detailed price data are available. Decomposing prices into markups and marginal costs and analyzing how these components are affected by the tariff reductions is informative in assessing both the total gains from reciprocal trade liberalization and the distribution of gains between producers and consumers. Therefore, a structural model is needed to decompose prices into markups and marginal costs.

In this paper, we empirically analyze the impact of reciprocal trade liberalizations by focusing on how Mexican firms responded to NAFTA. We overcome our first challenge by relying on a confidential dataset that includes disaggregated plant–product-level data of Mexican manufacturing plants for the period 1994–2008. The data record quantity and price (unit value) information for both domestic and exported goods produced by plants, covering 85% of total value added in manufacturing. A unique feature of this dataset is the distinction between domestic and foreign markets, which enables us to distinguish between the impact of reciprocal trade liberalization on exporters and the impact on producers serving the domestic market.

Equipped with these data, we overcome the second challenge by following the empirical framework developed by de Loecker, Goldberg, Khandelwal, and Pavcnik (2016) to derive estimates of markups and marginal costs at the plant–product–destination level. This method estimates pro-

duction functions to identify markups from the wedge between the output elasticity of a variable input and its expenditure share out of total revenue, which is now a standard approach in the industrial organization literature.¹ One advantage of this approach is that we do not need to make any assumptions about market structures or consumer preferences to recover markups.² In addition, we are able to estimate the product-level markups and marginal costs of multi-product firms across a broad set of manufacturing industries, which is a novel contribution to existing studies on NAFTA.

Tariff reductions from NAFTA affected the markups and marginal costs, and hence prices, of Mexican manufacturing plants via multiple channels. We illustrate these channels by examining the impact of Mexican output tariffs, tariffs on intermediate inputs, and U.S. tariffs on prices, markups, and marginal costs at the plant–product–destination level. We first focus on the impact of tariff reductions under NAFTA on domestically sold products. We find that Mexican plants reduced the prices of domestically sold products in response to the reductions in Mexican output tariffs—tariffs that the Mexican authorities imposed on the same products from abroad—through increased competition. Meanwhile, reductions in Mexican tariffs on intermediate inputs affected the prices of domestically sold products through two channels. First, they directly reduced marginal costs, thereby reducing prices. Second, the reduction in marginal costs enabled plants to increase markups. Overall, we find that the first channel dominated the second, resulting in a slight reduction in prices. These results so far are consistent with de Loecker et al. (2016), who look at the impact of the unilateral trade liberalization episode in India, although they do not distinguish between domestically sold and exported products.

Unlike domestically sold products, the prices of products that were exported did not respond to the Mexican output tariffs, as these tariffs did not have a direct effect on the competitive environment in the export market. Input tariffs, however, had a similar effect on export prices as on domestic prices: export prices decreased as the direct effect of cost reduction dominated the markup increase. Furthermore, we find significant evidence of the impact of NAFTA on Mexican exporters through reductions in U.S. tariffs imposed on Mexican exports. We find that the markups on exported products increased, leading to an increase in the prices of exported products. This suggests that Mexican exporters took advantage of greater access to the U.S. market, which we consider as evidence for the anti-competitive effect of reciprocal trade liberalizations. This channel has not been studied extensively because it requires plant–product-level data that distinguish between exporters and domestic producers.

Overall, our estimates imply that the observed output and input tariff declines during the 1994–2008 period led to an average reduction in prices of Mexican domestic products by around

¹See Olley and Pakes (1996), Levinsohn and Petrin (2003), de Loecker (2011), de Loecker and Warzynski (2012), and Akerberg, Caves, and Frazer (2015) for production function estimation at the plant level. de Loecker et al. (2016) and Garcia-Marin and Voigtländer (2019) are examples of production function estimation at the product level.

²An alternative approach for markup estimation, exemplified by Berry, Levinsohn, and Pakes (1995), Goldberg (1995), and Goldberg and Hellerstein (2013), assumes specific preferences and market structure to derive estimates of markups. The detailed product–destination-level data required as well as the particular assumption on market structure makes it infeasible to use this approach for a broad set of industries as we do in this work.

6.6%. This was the result of the decline in marginal costs being partly offset by the increase in markups. For products exported to the U.S., the input and U.S. tariff reductions under NAFTA led to a slight increase in prices, by around 1.6%. Marginal costs declined in response to input tariff reductions, but markups increased by a larger magnitude as plants faced more a favorable competitive environment in the export market. These results suggest that Mexican consumers benefited from NAFTA through lower prices. Mexican producers, at the same time, benefited from larger profit margins realized through lower input prices and higher markups.

The main contribution of this paper is to separately estimate the effects of tariff reductions on goods that are exported and goods that are sold domestically. In this regard, we contribute to the existing empirical research on trade liberalizations. In this strand of literature, our work is most closely related to de Loecker et al. (2016), who estimate product-level markups and analyze the unilateral trade liberalization episode in India.³ They find pro-competitive effects from output tariff declines and an incomplete cost pass-through to prices. That is, output tariff declines led to a reduction in the markups of Indian firms, and input tariff declines led to a slight increase in markups, in turn leading to a smaller decline in prices. Focusing on the reciprocal trade liberalization episode of NAFTA, we find similar results for prices and markups of goods sold domestically in Mexico. In addition to these effects, we also find evidence of markup increases in the export market. That is, U.S. tariff declines led to an increase in the markups that Mexican plants charged on their exported goods. This channel, which plausibly comes from improved market access, is unique in reciprocal trade liberalizations and does not exist in unilateral trade liberalizations.⁴

The empirical findings presented in this paper are in line with the theoretical literature that analyzes the competitive effects of trade reforms. Within this literature, our work is closely related to the trade model analyzed by de Blas and Russ (2015) in which the endogenous distribution of markups responds to changes in trade costs.⁵ By lowering trade costs, trade liberalization indirectly reduces the residual demand for domestic goods, leading to a decline in domestic markups (pro-competitive effects) and an increase in welfare. However, in a regional free trade agreement, the increase in welfare is offset by a rise in foreign markups (the anti-competitive effects in de Blas and Russ, 2015), which lowers the overall gains from trade. Our paper contributes to this literature

³Other contributions to this literature are the studies by Levinsohn (1993) on Turkey, Harrison (1994) on the Ivory Coast, Krishna and Mitra (1998) on India, Amity and Konings (2007) on Indonesia, and Brandt, Van Biesebroeck, Wang, and Zhang (2017) on China. Caselli, Chatterjee, and Woodland (2017) also follow the same method as de Loecker et al. (2016) to estimate markups of Mexican plants at product level, but the focus of that paper is on exchange rate pass-through. Relatedly, Blum, Claro, Horstmann, and Rivers (2024) estimate production technologies and markups of Chilean manufacturing firms for each destination market in order to disentangle demand and cost drivers of firm heterogeneity. Dhyne, Petrin, Smeets, and Warzynski (2022b) estimate production functions in a multi-product setting although their focus is not on the effects of trade liberalizations.

⁴Existing studies such as Lileeva and Treffer (2010) and Bustos (2011) mostly focus on the impact of improved market access on productivity instead of markups.

⁵Quantitative trade models, such as the one from Eaton and Kortum (2002) with perfect competition and the monopolistic competition model of Melitz (2003), are unable to capture the competitive effects of trade liberalization, since they assume constant markups. Even in models with variable markups, few predict changes to competition from liberalization. Bernard, Eaton, Jensen, and Kortum (2003) and Arkolakis, Costinot, Donaldson, and Rodríguez-Clare (2019), for example, allow for variable markups and find that the distribution of markups is invariant to changes in trade costs.

by providing the first empirical evidence for both pro-competitive and anti-competitive effects of reciprocal trade liberalizations.

Lastly, our work is also related to the large body of literature that studies the impact of NAFTA. Previous works have found how tariff reductions from NAFTA increased trade volume (Romalis, 2007), enhanced productivity (Lopez-Cordova, 2003; Iacovone, 2012; de Hoyos and Iacovone, 2013), triggered quality-upgrading (Verhoogen, 2008; Iacovone and Javorcik, 2012), and increased income (Easterly, Fiess, and Lederman, 2003), but did not improve wage inequality in Mexico (Esquivel and Rodríguez-López, 2003). Furthermore, viewing free trade agreements from the demand side, Faber (2014) uses microdata from the Mexican Consumer Price Index and finds that the NAFTA tariff cuts reduced consumer prices mostly through improved access to cheaper high-quality products. We complement this literature by illustrating how NAFTA affected the markups and marginal costs of manufacturing plants at the plant-product level, which is informative in inferring the impacts on Mexican producers and consumers.

The rest of the paper is structured as follows. Section 2 discusses the data used in the estimation, before performing a preliminary analysis on the impact of tariff reductions under NAFTA on prices in Section 3. Section 4 introduces the empirical framework used in the estimation of markups and marginal costs, and then establishes the validity of the estimation results. Section 5 analyzes the impact of tariff reductions on prices, markups, and marginal costs, and the last section concludes.

2 Data

We mainly rely on two sets of data to conduct the analysis of this paper. The first is the manufacturing survey datasets available at the Mexican Institute of Statistics and Geography (INEGI). We use these datasets to estimate the markups and marginal costs of Mexican manufacturing plants. The second is the tariff data from the World Bank’s World Integrated Trade Solution (WITS), which enable us to construct tariff shocks to the Mexican manufacturing plants after NAFTA came to effect.

2.1 Manufacturing survey datasets

We use manufacturing plant and product data from two surveys conducted and maintained by INEGI: the Monthly Industrial Survey (EIM) and the Annual Industrial Survey (EIA). The EIM reports monthly data on plants’ employment and wage bill, as well as quantities and sales value in Mexican pesos (MXN) at the product level. Products are disaggregated at the 8-digit level of the CMAP94 classification.⁶ A unique feature of the EIM is that the quantities and sales value of each product are recorded separately for products that are sold domestically and for those that are exported.⁷ While the EIM does not record the export destinations, more than 85% of exports were destined for the U.S. during our sample period of 1994–2008. Motivated by this high concentration

⁶We use the 1994 Mexican Classification of Activities and Products (CMAP94), a precursor to NAICS. See Appendix A.1 for examples of these product lines.

⁷Export sales are free-on-board values in MXN.

of Mexican exports, we implicitly assume in the empirical analyses that the U.S. is the destination country of all exported products.

The EIA records yearly information on plant-level inputs, total production, and other detailed data on plant operations. In our analyses, we use data on material expenditures, total employment, capital, import and export status, and research and development expenditures. To construct a capital series of Mexican plants, we use the perpetual inventory method with investment by type and the initial book value of a capital stock.⁸ All monetary variables are deflated by their appropriate price deflators.

We focus on the plants that are covered by both the EIM and EIA, which are all listed in the 1993 Economic Census. Each plant in the surveys is classified according to a unique 6-digit CMAP94 *clase* (class) code, which is similar to the 6-digit North American Industrial Classification System (NAICS) industry code. The plants in the 1993 Economic Census cover 206 6-digit class codes in the manufacturing sector, and were chosen to ensure that the plants covered at least 85% of the value added in each code and contained all plants with more than 100 employees.⁹ Despite the detailed records at the micro-level and decent coverage, we acknowledge the limitations of the two surveys. First, the sample is skewed toward larger plants. Furthermore, since the plants included in our sample are those that appeared in the 1993 Economic Census, these data are not suitable to track the extensive margin changes of Mexican manufacturing plants.¹⁰

We aggregate monthly values from the EIM as annual data and match the EIM and EIA information using a unique plant identifier provided by INEGI. The resulting panel consists of approximately 180,000 product–plant–year observations from 1994 to 2008.¹¹ Table A3 in Appendix A.3 shows the average number of plant–product–destination observations by sector, as well as the average number of products by a plant in the sample. Table A4 in the same appendix presents the number of plants in the sample, as well as summary statistics of the main variables from the EIA that we use in the estimation by sector. The tables show that while the majority of plants in the sample are multi-product and non-exporter plants, single-product plants account for a significant fraction of plants in each sector. This feature contributes to the empirical strategy discussed in later sections.

2.2 Tariff data

Tariff data for Mexico and the U.S. come from WITS, available at the HS 6-digit level. We manually construct the concordance between this classification and the CMAP94 classification. As

⁸See Appendix A.2 for further details.

⁹For a more detailed description of the sampling methodology, see Appendix A.3.

¹⁰The survey also lacks information on certain dimensions that may be important for Mexican exports. First, it does not cover the so-called Maquiladora plants that mostly engage in processing exports specializing in labor-intensive products (Utar and Ruiz, 2013). Second, it does not record whether the plants are part of multinational enterprises.

¹¹The merged panel includes roughly 3,600 plants per year and 12,000 plant–product observations per year. By comparison, the analysis in Iacovone and Javorcik (2012) includes 5,000 plants and 16,000 plant–product observations per year using the same datasets for 1994–2003. Given the longer sample period and attrition over time, our sample has a smaller number of observations per year on average.

discussed in more detail in Appendix A.4, we match approximately 5,000 products in the CMAP94 classification to one or multiple HS codes using the CMAP94 product description provided by INEGI. When multiple HS 6-digit codes correspond to a single CMAP94 product, we use the simple average tariff across the corresponding HS 6-digit codes. With this concordance, we construct a measure of output tariffs—the tariffs applied by the Mexican government to goods coming from the U.S.—and a measure of U.S. tariffs—the tariffs applied by the U.S. government to goods coming from Mexico.

To capture the tariff changes applied to imported intermediates, we construct class-level intermediate input tariffs using the Mexican input–output (IO) table provided by INEGI for 2003.¹² Because the 2003 IO table uses the NAICS classification, we convert it to the CMAP94 classification using the concordances provided by INEGI. For each product class, we calculate the simple average output tariff and then use the IO coefficients to compute weighted-average input tariffs. Formally, the intermediate input tariffs of plant j in class c at time t is given by:

$$\tau_{c(j)t}^{input} = \sum_k \Phi_{kc(j)} \tau_{kt}^{output},$$

where $\Phi_{kc(j)}$ is class c 's share of intermediate inputs coming from class k , and τ_{kt}^{output} is the simple average output tariff in class k .¹³

Taken together, the output and U.S. tariffs we construct vary at the product level, whereas the intermediate input tariffs vary at the class level. Appendix A.5 presents more details on the construction of these tariff measures. In later sections, we assess the impact of the changes in these tariffs on various outcome variables of Mexican manufacturing plants. One concern in doing so is that the three measures of tariffs are likely to be correlated with each other, so there may not be enough variation in the data to identify the effects of each tariff measure separately. We report in Appendix A.5 the summary statistics for the three tariff measures and their correlation matrix. Although the three tariff measures are indeed correlated with each other, the correlation is far from unity. As a result, there is sufficient variation for us to identify the coefficients separately.

Another concern in regressing Mexican manufacturing plants' outcome variables on the tariff measures is that the tariff changes might be correlated with omitted factors that also affect these outcomes. For example, tariff schedules under NAFTA may have been set to protect specific Mexican products or industries. However, substantial evidence, both empirical and anecdotal, indicates that the potential endogeneity arising from protectionism is not likely to be an issue. If tariffs were set for protectionist purposes, we would expect that products with high initial tariffs would face higher tariffs under NAFTA, or a slower tariff decline schedule. However, Figure A1 in Appendix A.5 shows that products with high initial tariffs faced the largest tariff declines under NAFTA. Moreover, Kowalczyk and Davis (1998) present empirical evidence that the phase-out periods for Mexican tariffs appear to be uncorrelated with their levels prior to NAFTA. Anecdotally,

¹²We use the year 2003 because earlier IO tables are available only at higher levels of aggregation.

¹³We use the CMAP94 class code that each plant is assigned to determine the class c for each plant j . There are 177 unique classes that plants are assigned to.

the circumstances surrounding NAFTA negotiations suggest that Mexican negotiators had little bargaining power in setting tariffs (Cameron and Tomlin, 2002). Therefore, both sets of evidence suggest that we can plausibly consider the tariff reductions under NAFTA to be exogenous from the viewpoint of individual Mexican plants.

3 Motivating facts

In this section, we illustrate how output prices of Mexican manufacturing plants reacted to tariff cuts under NAFTA. Furthermore, we investigate how selected proxies for output markups responded to the tariff changes. The advantage of these approaches is that we can easily produce stylized facts with readily available data on prices and tariffs before decomposing output prices into markups and marginal costs.

3.1 The impact of tariff declines on prices

We begin by illustrating how output prices of Mexican manufacturing plants responded to the tariff cuts under NAFTA. We expect the output tariffs to change the competitive environment of the products sold domestically in Mexico. At the same time, input tariffs may affect prices for both domestic and exported products through changes in input costs. Finally, since most exported products were destined for the U.S., changes in U.S. tariffs may affect export prices.¹⁴ Therefore, we estimate the following specification separately for domestic and exported products:

$$\log P_{ijt} = \alpha + \beta_1 \log \left(1 + \tau_{it}^{output} \right) + \beta_2 \log \left(1 + \tau_{c(j)t}^{input} \right) + \beta_3 \log \left(1 + \tau_{it}^{US} \right) + \xi_{ij} + \psi_{st} + \varepsilon_{ijt}, \quad (1)$$

where P_{ijt} is the price of product i from plant j at time t , τ_{it}^{output} is the Mexican output tariff applied to product i , $\tau_{c(j)t}^{input}$ is the intermediate input tariff for class c which plant j belongs to, and τ_{it}^{US} is the tariff applied by the U.S. on product i from Mexico. ξ_{ij} and ψ_{st} are plant–product and sector–year fixed effects, respectively. With these fixed effects, the coefficients for the tariffs are identified by exploiting variation in prices and tariffs within a plant–product–destination over time, controlling for changes in macroeconomic conditions at the sector level. Because input tariffs vary at the class level, we also cluster standard errors at this level of variation.¹⁵

We present in Table 1 the results of the estimation of specification (1). The results for domestic prices are consistent with those from de Loecker et al. (2016). In particular, the decline in output tariffs pushes down domestic prices, presumably by increasing competitive pressure in

¹⁴One can argue that the changes in U.S. tariffs may have influenced the prices of domestic products as well. Iacovone and Javorcik (2012), for example, find that an increase in market access driven by a decline in U.S. tariffs has stimulated investment by Mexican manufacturing plants as they prepared to introduce new products into the export market. See also Head and Ries (1999), in which they explore the effect of the Canada–U.S. Free Trade Agreement on Canadian firms’ productivity through increases in scale.

¹⁵In Section 5, we decompose these prices into markups and marginal costs and separately analyze how each component was affected by the same tariff changes. The main analysis excludes observations with markups in the top and bottom 1 percentile within each sector. We impose the same sample restriction when running specification (1) to ensure consistency.

the domestic market. At the same time, the effect of U.S. tariffs on domestic prices is small and statistically insignificant.¹⁶ The effect of input tariffs is significant, consistent with our expectation that lower tariffs would be passed on to prices through lower input costs. In Appendix C.1, we further explore this channel by interacting the input tariffs with the plant’s import status. Perhaps surprisingly, we find statistically insignificant coefficients on the interaction term, suggesting that all plants experienced cost reductions through input tariff reductions regardless of their direct exposure to imports.¹⁷ This result may be explained by increased import competition among the input suppliers. A reduction in input tariffs may have induced domestic suppliers of these inputs to cut prices, thereby indirectly benefiting non-importers. This channel is consistent with the positive and significant coefficient of domestic prices on output tariffs discussed earlier. The insignificant coefficient on the interaction term can also be explained by plants being exposed to imported inputs indirectly through their domestic suppliers. Recent evidence from Dhyne, Kikkawa, Mogstad, and Tintelnot (2021) show that in the small open economy of Belgium, a median firm in the economy sources around 40% of its inputs from abroad, while more than 80% of firms do not import directly.

A unique feature of the INEGI data is that we observe export prices separately from goods sold domestically. Column (2) in Table 1 shows that the effect of the declines in output tariffs on the prices of exported goods is not statistically significant. The insignificant result implies that a more competitive domestic market does not have any direct implication for the prices of Mexican goods exported elsewhere. We find the same effect of input tariffs on prices as in domestic products: input tariff reductions led to a decline in export prices as well. In addition, as shown in Appendix C.1, this effect is present for all plants, not just for plants that import directly. Finally, the decline in U.S. tariffs had a statistically significant impact on the prices of exported products. This result suggests that exporters responded to the reductions in U.S. tariffs by raising prices, partially offsetting the decrease in tariffs.

¹⁶This is in contrast to the finding of Almunia, Antràs, Lopez-Rodriguez, and Morales (2021), who find that firms with declining domestic sales increased exports.

¹⁷We find similar results when we interact input tariffs with plants’ domestic expenditure share, a sufficient statistic capturing plants’ exposure to imports (Blaum, Lelarge, and Peters, 2018; Ramanarayanan, 2020).

Table 1: Impact of tariffs on prices

	Domestic	Exported
	(1)	(2)
$\log(1 + \tau_{it}^{output})$	0.04 ^b	0.04
	(.02)	(.03)
$\log(1 + \tau_{c(j)t}^{input})$	0.04 ^a	0.04 ^c
	(.01)	(.02)
$\log(1 + \tau_{it}^{US})$	0.01	-0.04 ^b
	(.02)	(0.02)
Within R^2	0.002	0.002
N	143,717	27,642

Note: The dependent variable is the log of prices. Column (1) uses the sample of domestic products and Column (2) uses the sample of exported products. Regressions include plant–product and sector–year fixed effects. Standard errors are clustered at the class level.

Significance: a (1%), b (5%), and c (10%).

The results in Table 1 treat domestically sold goods and exported goods independently. The differences in how prices reacted to tariffs may be driven by plants serving both markets reacting differently to different tariff changes, or by different sets of plants that specialize in the domestic market or in exporting. In Appendix C.2, we investigate whether the results in Table 1 hold if we focus on domestic products from two groups of plants: plants that never export any of their products, and plants that also sell products to the export market. We find that the coefficients of prices on the tariffs for the two groups of plants are similar to those in Column (1) of Table 1.¹⁸ This implies that the pricing response of domestic products did not depend on whether the plants were exporting at the same time. We then turn our attention to exported products from plants that also sell to the domestic market. We find that the coefficients of prices on the tariffs are similar to those in Column (2). This result is consistent with the fact that most exported products were from plants that also served the domestic market.

Furthermore, in the same appendix, we also focus on plant–product pairs that sell to both markets in the same year. With this sample, we add plant–product–year fixed effects and interact the tariff changes on a dummy variable indicating whether the product was exported. The coefficients on the interaction terms would isolate out the differential responses that plants may have had across destinations for the same product. We find a negative coefficient on the interaction term with the input tariffs, implying that plants decreased prices less for exported goods. As we show in Section 5, this can be rationalized by plants raising markups to a larger extent for exported goods. Meanwhile, coefficients on both output and U.S. tariffs are insignificant. Nevertheless, the point estimate on the U.S. tariff interaction is negative, which is consistent with plants raising prices for

¹⁸In addition to the sample of plants that also sell products to the export market, we consider a narrower set of plants that sell different sets of products to different destinations. We find similar results, implying that the specialization of products to destinations does not matter for the responses to tariffs.

exported goods in response to U.S. tariff reductions.

While the results presented in Table 1 reveal important insights on how changes in tariffs influenced prices, they do not identify the channels through which the prices were affected. Prices may have responded to tariff reductions through markups that were induced by changes in market competitiveness. Alternatively, marginal costs may have also responded through changes in plants' productivity or in input prices. To further explore these mechanisms, we proceed to Section 3.2 to analyze how tariff changes impacted measures that proxy markups at plant level. Then, we formally decompose prices into markups and marginal costs in Section 4 and analyze how the NAFTA tariff reductions affected these components in Section 5.

3.2 The impact of tariff reductions on proxy measures for markups

Before decomposing output prices into markups and marginal costs using the procedure described in Section 4, we also experiment with proxy measures for markups at the plant level. The advantage of this approach is that we can gauge the impact of tariff changes on markups with readily available data on prices and tariffs. The measure we consider is each plant's inverse material share, i.e., the material input expenditure relative to sales. This measure consistently captures plant-level markups as long as the output elasticity with respect to material inputs is constant, material inputs are static inputs to the plant, and the plant minimizes its short-run costs (de Loecker and Warzynski, 2012).

With inverse material expenditure shares measured at the plant level, we consider the following specification:

$$\log Y_{jt} = \alpha + \beta_1 \left(1 + \tau_{jt}^{output}\right) + \beta_2 \left(1 + \tau_{c(j)t}^{input}\right) + \beta_3 \left(1 + \tau_{jt}^{US}\right) + \xi_j + \psi_t + \varepsilon_{jt}. \quad (2)$$

Note that input tariffs are still measured at class level, whereas output tariffs and U.S. tariffs are now constructed at the plant level as the average of product-level tariffs weighted by the sales share of these products. As the level of observation is now at the plant-year level, we include plant fixed effects together with sector-year fixed effects.

In Table 2, we present regression results of specification (2). Column (1) uses the full sample, whereas Columns (2) and (3) analyze domestic and exporting plants separately. Following the results shown in Table 1, we drop U.S. tariffs and output tariffs in the regression for domestic and exporting plants, respectively. We can see that, for all three regressions, input tariffs have negative and significant coefficients. This implies that the reduction in input tariffs increased plant-level markups approximated by inverse input material share for both domestic and exporting plants. At the same time, output tariffs have a positive coefficient in both Columns (1) and (2), but the coefficient is only significant in Column (1) with the full sample. The effect of U.S. tariffs is insignificant in both Columns (1) and (3). These results indicate that while the decline in output tariffs may have reduced markups due to increased competition, there was no clear effect of U.S. tariffs on plant-level markups as measured by the inverse material shares.

Table 2: Impact of tariffs on inverse material shares

Dependent var	log (inverse material share _{jt})		
	All	Domestic	Exported
	(1)	(2)	(3)
$\log(1 + \tau_t^{output})$	0.02 ^b (0.01)	0.01 (0.01)	
$\log(1 + \tau_t^{input})$	-0.69 ^a (0.03)	-0.71 ^a (0.04)	-0.68 ^a (0.05)
$\log(1 + \tau_t^{US})$	0.02 (0.02)		0.01 (0.02)
R^2	0.404	0.409	0.399
N	69,676	37,562	32,020

Note: In Column (2), we consider Mexican plants that only served the domestic market. In Column (3), we consider Mexican plants that exported at least once during the sample period. Regressions include plant and sector–year fixed effects. Standard errors are clustered at the class level.

Significance: a (1%), b (5%), and c (10%).

Taken together, we find that prices of Mexican manufacturing plants responded differently to tariff reductions under NAFTA, depending on whether the goods were exported abroad or sold domestically. Export prices slightly increased with reductions in the U.S. tariffs, while prices of domestic goods decreased with reductions in Mexican output tariffs. Plant-level markups seem to have played a role in these price changes. Markups at the plant level, as proxied by the plants’ inverse material shares, decreased slightly in response to the output tariff reductions, which is consistent with the movements in domestic prices. By contrast, markups increased in response to the input tariff reductions, while prices decreased. This suggests that marginal costs—the other component of prices—declined to a larger magnitude when input tariffs went down.

All these results are suggestive at best, as they come with multiple limitations. First, inverse material shares work as proxies for markups only under the assumption of output elasticity with respect to material inputs that are constant. Second, even if inverse material shares are a good proxy for markups, they are not informative in analyzing how plant–product-level markups responded to tariff declines, as inverse material shares are only measured at the plant level.¹⁹ Lastly, one needs an estimate of markups in order to back out marginal costs, which is another important component of prices. To further investigate the markup responses that may potentially vary across the destination of the good, in the next section, we outline the framework developed by de Loecker et al. (2016),

¹⁹One might argue that market shares may be another candidate that proxy well for markups, and these market shares can in principle be measured at the level of plant-product-destinations. Market shares can be useful measures for markups as there is a positive mapping between market shares and markups in the class of Nash-Bertrand models (Amiti, Itskhoki, and Konings, 2019a). This positive relationship between market shares and markups also arises when one takes a “demand-side” approach to estimate plants’ production functions and markups. In contrast to the “supply-side” approach that this paper and de Loecker et al. (2016) take, the “demand-side” approach typically assumes a demand structure together with a mode of competition to derive the markup for each product. As in Piveteau and Smagghue (2019) and Orr (2022), both following the “demand-side” approach, markups are derived to be positively correlated with plants’ market shares. As our sample of plants is constrained to those that appeared in the 1993 Economics Census and skewed towards larger plants (see Section 2.1), market shares constructed using our sample are susceptible to measurement errors.

which enables us to estimate product-specific markups.

4 Recovering markups and marginal costs

In this section, we set up the empirical framework used to estimate markups and marginal costs at the product level, separately for domestic and exported products. We then discuss the estimates obtained from the framework before moving on to the main analysis in Section 5. The empirical framework we use closely follows the one developed by de Loecker et al. (2016), which relies on the estimation of quantity production functions and exploits plants' cost minimization problem. Inheriting both the advantages and limitations of this framework, we distinguish ourselves from de Loecker et al. (2016) by analyzing the domestic and exported products separately.

In the main analysis of this paper, we assume that domestic and exported varieties of the same disaggregated product category are distinct products, even if they are produced by the same plant. We treat domestic and exported varieties as different products for two reasons. First, products destined for the domestic market may differ in quality from exported products from the same plant. If quality is positively correlated with consumer income, for example, one would expect the products exported to the U.S. to be of higher quality than those sold on the domestic market.²⁰ Second, since domestic and exported products are shipped to two different markets, plants may respond very differently to changes in tariffs even with the exact same physical product. Such differential responses of plants are indeed what we find in Section 5.

4.1 Estimation framework

We illustrate the key steps of the framework developed by de Loecker et al. (2016) and present the remaining details in Appendix B. The starting point of this framework is the approach introduced by Hall (1986), and subsequently refined by de Loecker and Warzynski (2012) and many others. The main idea of this framework is to rely on the first-order conditions from a plant's cost minimization problem to recover the model's implied markups.

Consider the production function of product i from plant j in sector s at time t :

$$Q_{ijt} = F_i(M_{ijt}, L_{ijt}, K_{ijt}; \beta_s) \Omega_{jt}, \quad (3)$$

where Q_{ijt} is the physical output, M_{ijt} is the material input, L_{ijt} denotes the labor input, K_{ijt} is the capital input, β_s is the parameter vector of the production function that we assume to be sector-specific, and Ω_{jt} is the Hicks-neutral productivity at the plant level.

Treating materials as static inputs, one can derive the following expression for the markup plant

²⁰See for example Linder (1961), Hallak (2006), Verhoogen (2008), and Hallak and Sivadasan (2013). In particular, Verhoogen (2008) documents that the same Volkswagen Puebla plant in Mexico produced two varieties of the same product with clear quality differences: the New Beetle for the U.S. market and the Original Beetle for the Mexican market.

j charges on its product i at time t from the plant's cost minimization problem:

$$\mu_{ijt} = \theta_{ijt}^M \times (\Psi_{ijt}^M)^{-1}, \quad (4)$$

where $\theta_{ijt}^M = \frac{\partial Q_{ijt}}{\partial M_{ijt}} \frac{M_{ijt}}{Q_{ijt}}$ is the output elasticity of material inputs, with M_{ijt} representing the quantity of material inputs used by plant j for product i . In addition, $\Psi_{ijt}^M = \frac{W_{ijt}^M M_{ijt}}{P_{ijt} Q_{ijt}}$ is the expenditure share of materials in product i 's revenues, with P_{ijt} being its sales price and W_{ijt}^M being the material input price that the plant takes as given.²¹

Equation (4) reveals that we need estimates of output elasticity, product revenue, and input expenditures per product in order to construct markups at the product level. With estimated markups, we can obtain the estimates of the marginal costs of products, MC_{ijt} , from $MC_{ijt} = \frac{P_{ijt}}{\mu_{ijt}}$.

Since product output quantity is observed (potentially with measurement error), we take the following steps to estimate the output elasticities and input expenditures per product. First, we derive the following equation by taking logs of (3):

$$q_{ijt} = f_i(\mathbf{x}_{ijt}; \beta_s) + \omega_{jt} + \epsilon_{ijt}. \quad (5)$$

The term $\mathbf{x}_{ijt} = (m_{ijt}, l_{ijt}, k_{ijt})$ represents the log of inputs (material, labor, and capital), q_{ijt} is the log of output, ω_{jt} is the log of Hicks-neutral plant-level productivity, and ϵ_{ijt} captures the measurement error on quantity produced. We assume a translog production function, with parameters β_s varying at the sector level.²² In what follows, we highlight some of the key challenges in estimating the translog production function and how the de Loecker et al. (2016) framework deals with these challenges.

Unobserved plant-level productivity A common challenge in estimating production functions is that the productivity term, ω_{jt} in equation (5), is unobserved. This leads to a simultaneity bias that arises from the fact that plants observe their productivity draws before making their choice of inputs. For single-product (and destination) plants, we overcome this challenge by following the proxy methods used by Olley and Pakes (1996) and Levinsohn and Petrin (2003). We assume that demand for materials is increasing with productivity, which enables us to invert the demand function and obtain a control function for the unobserved productivity term. Note that this method requires data on physical units of inputs, but the INEGI data only have material expenditures. We address this challenge of unobserved input prices below.

Importantly, we assume a first-order Markov process for the law of motion of the productivity

²¹Note that equation (4) does not require all material inputs to be static inputs. As long as a fraction of material inputs are used as static inputs, equation (4) follows from the first-order conditions.

²²In particular, the translog production function takes the following form:

$$\begin{aligned} f_i(m_{ijt}, l_{ijt}, k_{ijt}; \beta_s) = & \beta_{sm} m_{ijt} + \beta_{smm} m_{ijt}^2 + \beta_{sl} l_{ijt} + \beta_{sll} l_{ijt}^2 + \beta_{sk} k_{ijt} + \beta_{skk} k_{ijt}^2 \\ & + \beta_{sml} m_{ijt} l_{ijt} + \beta_{smk} m_{ijt} k_{ijt} + \beta_{slk} l_{ijt} k_{ijt} + \beta_{smlk} m_{ijt} l_{ijt} k_{ijt}. \end{aligned}$$

term and allow tariffs at $t - 1$ to influence the level of productivity at t .²³ As we discuss in later sections, tariffs can potentially affect plants’ marginal costs and hence productivity. For this reason, we also include tariffs in the law of motion of productivity. We follow Akerberg et al. (2015) and estimate the production function parameters by GMM. The moment conditions require that the shocks to plants’ productivity are orthogonal to lagged material inputs, current dynamic inputs of capital and labor, and their interaction terms. A key assumption to construct the moment conditions is that capital and labor do not respond contemporaneously to the innovation to productivity shock, but materials do. For multi-product plants, one first needs to recover the unobserved input expenditures for each product. We address this challenge later in this section.

Unobserved product-level input prices An additional obstacle in the production function estimation is the lack of data on physical units of inputs. Instead, we have data on input expenditures deflated by industry-level input price indices. Failure to observe input prices at the plant or product level when estimating quantity production functions might lead to significant biases in the estimation (de Loecker and Goldberg, 2014). To overcome this obstacle, we proxy for unobserved plant–product-level input prices using a function of output prices, market share, and product dummies. This proxy is guided by two key insights from existing works. The first is from Khandelwal (2010), who suggests that if two products in the same category have the same price, then the product with larger market share should be of higher quality. The second is that higher quality products require higher quality inputs that are more expensive (Kugler and Verhoogen, 2012).²⁴ Guided by these two insights, we construct an input price control that is a function of market shares, output prices, and product dummies. As discussed in more detail in Appendix B, the input price control function allows for different products manufactured by the same plant (including the same products sold to different markets) to have different input prices, and for the same products produced by different plants to have different input prices. This framework, however, does not permit separate control functions for each input. We estimate the parameters of the input price control function for each sector jointly with the production function parameters in the GMM estimation.

Unobserved input expenditures by product The procedure described so far is sufficient for the production function estimation for the set of single-product plants. For multi-product plants, we still need to recover their product-specific input expenditure shares. We do so by additionally assuming the following. First, we assume that productivity is plant-specific, not plant–product-

²³For the exact equation of the law of motion, see Appendix B. We allow for lagged tariffs to influence the level of productivity, implying that the shocks to plants’ productivity need to be orthogonal to changes in tariffs for identification. We test this assumption in Appendix C.7 and verify that, controlling for lagged tariffs, the changes in tariffs have an insignificant impact on plants’ estimated productivity.

²⁴Note that this assumption implicitly rules out high-quality goods being produced through a combination of low-quality inputs and a different production process. As a result, a product with a larger market share conditional on its price should be of higher quality and therefore must be produced using more expensive inputs. Acknowledging the limitation of this approach, we nevertheless test this relationship in Appendix C.3, in which we examine the correlation between our measure of quality, the residuals from a regression of market shares on output prices and product dummies, and average wages. We find that there is an overall positive relationship between the residuals and average plant-level wages.

specific. The homogeneity of productivity across products within plants is crucial for identifying the share of inputs spent on each product.²⁵ As highlighted in de Loecker et al. (2016), this assumption does not rule out economy of scope. Assuming that both multi-product and single-product plants use the same production technology indeed rules out physical synergies in production. However, economies of scope that operate through productivity can still be captured by the plant-specific productivity term.

Second, we assume that within plants, a product’s expenditure share is the same across inputs, i.e., the production function is homothetic. Note that the translog production function that we assume does not guarantee homotheticity. However, one can derive relationships between production function parameters that need to be satisfied under homotheticity. We later test whether these relationships hold under the estimated parameters in Section 4.2, and find evidence that they broadly hold.

With these assumptions, for each plant, we can recover the input expenditure shares and its productivity by solving a system of equations consisting of the production function and input price control function parameters.

Selection correction We assume that multi-product plants and single-product plants that manufacture the same product use the same technology parameters β_s . This assumption enables us estimate β_s from single-product plants. However, this approach introduces a sample selection bias. We correct for this bias when estimating the production function for the single-product plants in the spirit of Heckman (1979). In particular, we use the probability of remaining a single-product plant as a control. We assume, as in Mayer, Melitz, and Ottaviano (2014), that the number of products increases with productivity and include the probability of remaining a single-product plant as a control in the law of motion of productivity.

4.2 Validity of the estimates

Having estimated the output elasticities, markups, and marginal costs, we validate these estimates before investigating how markups and marginal costs responded to the tariff reductions under NAFTA. First, we focus on the estimated output elasticities. We report in Table 3 the median estimates of the output elasticities and implied returns to scale (RTS), together with the number of observations used for estimating the production function. As explained in the previous section, only products manufactured by single-product plants are used in the estimation. The estimated elasticities are in line with the results of other studies using product-level data, with the largest elasticities for materials, followed by elasticities for labor, and lastly the smallest elasticities for capital.²⁶

²⁵An alternative approach is to add more structure on the demand side, as in Orr (2022). This approach allows for heterogeneity in productivity across products, but at the same time imposes additional assumptions on markups.

²⁶See, for example, de Loecker et al. (2016) and Garcia-Marin and Voigtländer (2019).

Table 3: Median elasticities by sector, all products

Sector	Materials	Capital	Labor	RTS	Obs. in Estimation
	(1)	(2)	(3)	(4)	(5)
Food and Beverage	0.86	0.06	0.19	1.12	1,781
Textile Manufacturing	0.62	0.02	0.28	0.97	992
Apparel Manufacturing	0.86	0.05	0.11	1.00	1,691
Wood and Furniture Industries	0.73	0.12	0.08	0.91	490
Paper Industries	0.95	0.01	0.30	1.21	1,968
Chemical Industries	0.65	0.09	0.27	1.03	1,995
Non-Metallic Mineral Products	0.58	0.08	0.42	1.05	1,519
Metallic Manufacturing	0.67	0.18	0.23	1.09	1,493
Machinery and Equipment Manufacturing	0.74	0.02	0.10	0.80	1,073
Total	0.76	0.08	0.18	1.05	1,073

Note: Estimates of output elasticities of the production function for all products, domestic and exported, and all years in the sample (1994–2008). Columns (1)–(3) report median elasticities for each sector. Column (4) reports the median returns to scale, which is the sum of labor, capital, and material elasticities. Column (5) reports the total number of observations used during estimation of the production function for each sector. The total corresponds to the median observations across all products and years.

We also examine the correlation between reported input expenditure shares at the plant level and the theoretical expenditure shares implied by the output elasticities under cost minimization. Given production function $F(L, K, M)$, cost minimization yields a material expenditure share equal to $\frac{\theta^M}{\theta^L + \theta^K + \theta^M}$, where θ^L , θ^K , and θ^M are the output elasticities of labor, capital, and materials, respectively. The expressions for labor and capital share can be defined analogously. We present in Appendix C.4 the relationships between the observed and implied expenditure shares for material inputs, labor, and capital. We find that there is a positive and significant relationship between the observed expenditure shares of materials and the expenditure share implied by our estimated elasticities. We also find broadly positive relationships for the share of labor and capital inputs.

To recover the input expenditure shares for multi-product plants, we assumed homotheticity in the production function. Given the translog production function for each sector s , the following conditions have to be satisfied for the translog production function to be homothetic:

$$\begin{aligned}
0 &= 2\beta_{smm} + \beta_{sml} + \beta_{smk}, \\
0 &= 2\beta_{sll} + \beta_{sml} + \beta_{slk}, \\
0 &= 2\beta_{skk} + \beta_{smk} + \beta_{slk}, \\
0 &= \beta_{smlk}.
\end{aligned} \tag{6}$$

In Appendix C.5, we test equation (6) with the estimated parameters. We find that all four conditions are satisfied in the majority of sectors, suggesting that our assumption that product

expenditure shares are the same across inputs is broadly consistent with the estimates.²⁷

We then focus on the estimated markups. Table 4 shows the median estimates of markups by sector and destination.²⁸ The values of the estimated markups are comparable to those found in studies by de Loecker et al. (2016) in India and Garcia-Marin and Voigtländer (2019) in Chile, both of which use product-level data. Our finding that the median markup on exported goods is generally lower than the median markup on domestically sold goods is also consistent with the findings of Blum et al. (2024) using Chilean data.

Table 4: Median markups by destination

Sector	Domestic	Exported
	(1)	(2)
Food and Beverage	1.12	1.11
Textile Manufacturing	1.11	1.32
Apparel Manufacturing	1.27	1.19
Wood and Furniture Industries	1.06	0.90
Paper Industries	1.47	1.93
Chemical Industries	1.29	1.03
Non-Metallic Mineral Products	1.96	1.79
Metallic Manufacturing	1.14	1.03
Machinery and Equipment Manufacturing	1.27	1.45
Total	1.24	1.19

Note: We trim outliers above the 99th and below the 1st percentiles of the markup distribution by sector and destination. The total corresponds to the median markup across all products and years in each sample.

We also compare the estimated markups to accounting measures of revenue over variable costs at the plant level. As reported in Appendix C.6, we find a positive and significant correlation between the estimates of markups and accounting measures of revenue over variable costs, which strengthens the validity of our estimates. Furthermore, our markup estimates concur with theoretical models in the multi-product plant literature, such as Mayer et al. (2014). Consistent with their prediction, in the same appendix, we find that a plant’s most important products (measured by their revenue shares) have lower marginal costs, and plants charge higher markups on such products.

We then turn to the estimated marginal costs and ask whether marginal costs differ between domestic and exported varieties within plant–product pairs. If marginal costs are the same, then the observed price differences across destinations directly reveal the differences in markups. In this case, one would be able to infer how markups responded to tariff changes within plant–product pairs across destinations by simply regressing output prices that are directly observable. However,

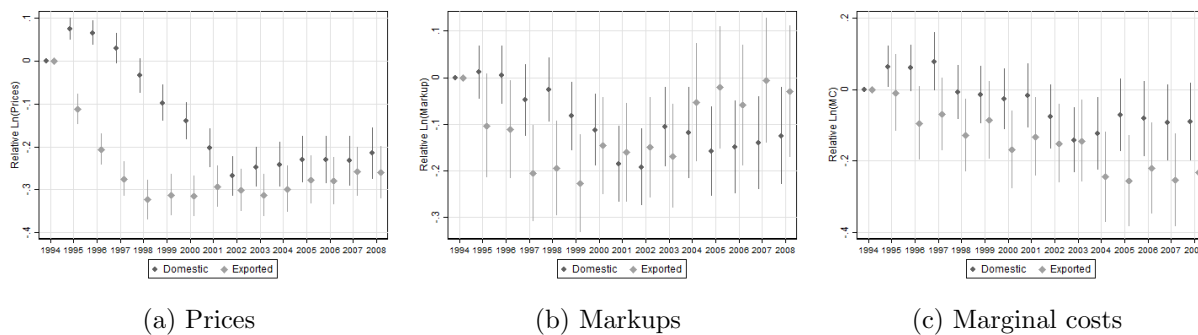
²⁷The results presented in Section 5 remain qualitatively unchanged when we restrict the sample of analysis to plants in sectors where all four conditions are satisfied.

²⁸In Table 4 and all of the results that follow, we have trimmed outliers above the 99th and below the 1st percentiles of the markup distribution by sector and destination to make sure that outliers are not driving the main results.

in Appendix C.8, we find that the estimated marginal costs are larger for exported varieties on average, compared to the same set of products produced by the same plant but sold domestically. Because we assume a common productivity term for all products within each plant, these marginal cost differences within plant–product pairs must reflect the differences in input expenditures used for production. While we do not directly observe input prices and expenditures, we verify this by regressing the plants’ expenditures for each plant–product pair on its share of exported output or its export status dummy, controlling for output quantities, input price indices, and plant–product fixed effects. We find a positive coefficient on the export share or on the export status dummy, implying that varieties that are exported require larger input expenditures compared to the same products sold domestically.

Finally, before exploring how the tariff changes under NAFTA impacted prices, markups, and marginal costs in the next section, we end this section by plotting the within-plant–product trajectories of the three variables. We focus on plant–product pairs that both were sold domestically and exported throughout the sample period following a specification akin to that in Garcia-Marin and Voigtländer (2019). We regress the three variables on plant–product fixed effects including two sets of plant–product–year-specific dummy variables: one for domestically sold varieties and the other for exported varieties. The results presented in Figure 1 reveal that prices and their components declined generally throughout the sample period. While it is tempting to interpret these declining prices as a consequence of NAFTA, we note that during this period, both the U.S. and Mexico experienced increases in imports from the rest of the world (see Appendix C.9 for details). The increased competition with the rest of the world in the two markets could have contributed to the general declines in prices, markups, and marginal costs of Mexican plants. Therefore, in the next section, we regress prices and their components on the tariff reductions to formally identify the effect of NAFTA.

Figure 1: Within-plant–product trajectories of prices, markups, and marginal costs



Note: The figures show the trajectories of prices, markups, and marginal costs separately for domestically sold and exported goods during the sample period. Plant–product fixed effects are controlled for, and the 99% confidence intervals for each estimate are computed using standard errors clustered at the plant–product level.

5 The impacts of NAFTA

In this section, we use the estimated markups and marginal costs at the plant–product–destination-level to analyze the impact of tariff declines from NAFTA on prices and their components. In particular, we consider the following regression equation:

$$\log Y_{ijt} = \alpha + \beta_1 \log \left(1 + \tau_{it}^{output} \right) + \beta_2 \log \left(1 + \tau_{c(j)t}^{input} \right) + \beta_3 \log \left(1 + \tau_{it}^{US} \right) + \xi_{ij} + \psi_{st} + \varepsilon_{ijt}, \quad (7)$$

where Y_{ijt} is either the price, markup, or the marginal cost of product i from plant j at time t . The terms ξ_{ij} and ψ_{st} are plant–product and sector–year fixed effects, respectively. We estimate equation (7) separately for domestic and exported products and identify the coefficients on tariffs from variation in time of the dependent variables and tariffs within a plant–product pair. Motivated by the results in Section 3.1, we consider output and input tariffs as independent variables in regressions for domestic products. Similarly, for regressions of exported products, we consider input and U.S. tariffs as the independent variables.

We present our main results in Table 5. The first three columns show results for the domestic products, and the last three columns show results for the exports. We first focus on the first three columns and explore how domestic prices and their components were affected by the tariff reductions. The results for prices in Column (1) are consistent with the motivating facts presented in Table 1: prices of domestic goods fell in response to reductions in output tariffs and input tariffs. Compared to Column (1) of Table 1, these coefficients and their statistical significance remain unchanged after removing the U.S. tariffs from the independent variables.

The coefficients on output tariffs in Columns (2) and (3) suggest that, although statistically insignificant, the decline in output tariffs lowered domestic prices by decreasing both marginal costs and markups. The reduction in marginal costs can be explained by increasing competition in the Mexican market. Previous studies have documented that increasing foreign competition, measured by cuts in output tariffs, can increase plant-level productivity (Pavcnik, 2002; Lopez-Cordova, 2003; Khandelwal and Topalova, 2011). In Appendix C.7, we estimate the impact of tariff declines on quantity total factor productivity (TFPQ). Consistent with existing works, we do find that the decline in output tariffs under NAFTA led to an increase in future TFPQ.²⁹

²⁹TFPQ is a measure of physical productivity and does not confound changes in productivity with movements in prices or markups, in contrast to revenue TFP (TFPR) (Foster, Haltiwanger, and Syverson, 2008). This difference between TFPQ and TFPR becomes particularly important when one tries to estimate the impact of trade policies on plants’ productivity (Pierce, 2011; Garcia-Marin and Voigtländer, 2019). In the appendix, we demonstrate how predictions on TFP responses can differ when one estimates the impact of tariff reductions on TFPR.

Table 5: Impact of tariffs on prices, marginal costs, and markups

	Domestic			Exported		
	$\log P_{ijt}$	$\log MC_{ijt}$	$\log \mu_{ijt}$	$\log P_{ijt}$	$\log MC_{ijt}$	$\log \mu_{ijt}$
	(1)	(2)	(3)	(4)	(5)	(6)
$\log(1 + \tau_{it}^{output})$	0.04 ^b (0.02)	0.03 (0.02)	0.02 (0.03)			
$\log(1 + \tau_{c(j)t}^{input})$	0.04 ^a (0.01)	0.09 ^c (0.05)	-0.05 (0.05)	0.04 ^c (0.02)	0.26 ^a (0.07)	-0.22 ^a (0.07)
$\log(1 + \tau_{it}^{US})$				-0.04 ^b (0.02)	0.06 (0.04)	-0.10 ^b (0.04)
Within R^2	0.002	0.001	0.000	0.002	0.005	0.004
N	143,717	143,717	143,717	27,642	27,642	27,642

Note: Dependent variables are the logs of prices, marginal costs, and markups. The regressions exclude outliers in the top and bottom 1% of the markup distribution within each sector. Regressions include plant–product and sector–year fixed effects. Standard errors are clustered at the class level.

Significance: a (1%), b (5%), and c (10%).

The statistically insignificant coefficient of output tariffs on markups in Column (3) may be driven by two opposing effects. Markups can respond to changes in the competitive environment or to changes in marginal cost. First, to isolate out the effect of the change in the competitive environment, we follow de Loecker et al. (2016) and regress the estimated markups on output tariffs while controlling for the marginal costs. As shown in Appendix C.10, we indeed find evidence of pro-competitive effects on markups: after controlling for marginal costs, the decline in output tariffs indeed reduced the markups of domestic products. Second, to illustrate how markups responded to changes in marginal costs, in Appendix C.11, we run a pass-through regression where we regress prices on marginal costs. We find that the pass-through of marginal costs on prices was incomplete, indicating that markups increased in response to the marginal cost reduction.³⁰

The coefficients of input tariffs for on domestic marginal costs and markups in Columns (2) and (3) are also consistent with our results of incomplete pass-through of cost to prices. In response to the decline in input tariffs, prices decreased but not as much as the marginal costs. The differences can be attributed to the increases in markups, although this is statistically insignificant. These results again point to plants behaving in an oligopolistic manner whereby they respond to input price cuts by increasing their output markups, as in Amiti et al. (2019a).

We then move on to exported products, and discuss the responses of prices and their components shown in the last three columns. Similar to domestic products, removing the output tariffs from the independent variables in Column (2) of Table 1 does not change the coefficients of input tariffs and U.S. tariffs on prices: the reduction in input tariffs decreased exported prices whereas the reduction in U.S. tariffs increased prices of exported products. For input tariff reductions, marginal costs and

³⁰Existing works that estimate the price pass-through of tariff changes find mixed evidence. For example, focusing on the Indian trade liberalization episode, de Loecker et al. (2016) find incomplete pass-through, which is in line with our estimates. By comparison, Amiti, Redding, and Weinstein (2019b) and Fajgelbaum, Goldberg, Kennedy, and Khandelwal (2020) document almost complete pass-through of tariff shocks on import prices in the recent U.S. trade war episodes.

markups of exported products responded in a similar manner as those of domestic products, albeit with larger magnitudes.

Finally, we analyze how the cuts in the U.S. tariffs affected export prices and their components. Columns (5) and (6) show that the increase in export prices was due to the increase in markups, which more than offset the potential fall in marginal costs. Improved access to the U.S. market enabled exporting plants to raise markups without increasing the after-tariff prices paid by U.S. consumers.³¹ As in domestic products, in Appendix C.10, we investigate this hypothesis by regressing the estimated markups on U.S. tariffs, controlling for marginal costs. We find that the decline in U.S. tariffs led to an increase in markups of exported products. Note that the above result is the opposite of the pro-competitive effect of output tariff reductions on domestic products, suggesting an anti-competitive effect of trade liberalization predicted by de Blas and Russ (2015).

The results presented in Table 5 are broadly consistent with those from de Loecker et al. (2016): they find that declines in Indian output tariffs led to lower prices of Indian plants, and declines in Indian input tariffs reduced plants' marginal costs but increased their markups. de Loecker et al. (2016) focus on outcome variables at the plant-product level and only consider output and input tariffs. By contrast, we consider outcome variables at the plant-product-destination level and additionally explore the effects of U.S. tariffs.

One natural question that follows immediately is whether the responses of Mexican firms are similar to those of Indian firms in de Loecker et al. (2016) when we aggregate the outcome variables in our analysis at the plant-product level. In Appendix C.12 we answer this question by first taking the quantity-weighted averages of the outcome variables to aggregate our estimates at the plant-product level, and then regressing them on output and input tariffs. The results reported in the appendix confirm the findings shown in Table IX of de Loecker et al. (2016): lower output and input tariffs lead to a decline in output prices mainly through marginal cost reductions.

Our findings so far suggest that domestic and exported goods of Mexican plants responded differently to different types of tariff reductions. While plants reduced their prices of domestic goods in response to the fall in output and input tariffs, they responded to lower U.S. tariffs by increasing markups on exported goods. As discussed in Section 3.1, these differences may be driven by plants serving both markets reacting differently to different tariff changes, or by different sets of plants specializing in the domestic market or in exporting. We investigate in Appendix C.2 whether these differential responses are coming from plants that produce the same products for different markets. In the appendix, we focus on plant-product pairs that sell to both markets in the same year, and add plant-product-year fixed effects with tariff changes interacted with a dummy variable indicating whether the product was exported.³² As previously discussed in Section 3.1, we find that

³¹An additional channel through which markups of exports can go up is through the incomplete pass-through of costs to prices. While statistically insignificant, the lower U.S. tariffs reduced the marginal costs of exported goods, and this could induce plants to raise markups. We illustrate this further in Appendix C.11 by regressing prices on marginal costs for the set of exported products. We find low correlation between the two, suggesting that plants also charge variable markups on their exports.

³²Relatedly, we also investigate in Appendix C.2 how much of the effects on domestic goods' outcome variables are coming from plants that never export anything throughout, from plants that both sell domestically and export, or from plants that may produce other products that are only exported. We find that these sets of plants also reacted

the prices of exported goods decreased less in response to input tariff reductions. Decomposing the movements of prices into markups and marginal costs reveals that this was driven by plants raising markups to a greater extent for the exported goods. Although statistically insignificant, the point estimates of the U.S. tariff interaction terms suggest that plants raised markups on exported goods when U.S. tariffs declined. This implies that the differential responses documented in Table 5 also apply to plants producing the same products for both markets.³³

Taken together, the results presented in this section suggest that the tariff declines from NAFTA led to more competition in the domestic market, forcing domestic producers to lower their markups and consequently their prices. In addition, lower tariffs also reduced the marginal costs of domestic products that were not completely passed through to prices. Our estimates suggest that while Mexican consumers benefited from a decrease in prices, producers also profited, as the lower marginal costs allowed them to increase their profit margins despite the increased competitive pressure. The estimated coefficients and the observed average declines in tariffs from 1994 to 2008 imply that the output and input tariff declines under NAFTA led to an average 6.6% decline in domestic prices, with a 10.8% average decline in marginal costs partly offset by a 4.3% average increase in markups.

While the results presented above are qualitatively consistent with those from de Loecker et al. (2016), we find contrasting effects for exported products. Our estimates suggest that both input and U.S. tariff reductions under NAFTA led to a decrease in marginal costs but an increase in markups on exported products, suggesting that these tariff cuts benefited Mexican exporters with larger profit margins.³⁴ The estimated coefficients and the observed average declines in tariffs from 1994 to 2008 imply that the input and U.S. tariff declines under NAFTA led to an average 37.9% decrease in marginal costs and an average 39.5% increase in markups. As a result, the prices of exports slightly increased by an average of 1.6%.

6 Conclusion

This paper analyzed the impact of NAFTA on prices and competition in Mexico using detailed disaggregated information on Mexican manufacturing plants. Employing the methodology developed by de Loecker et al. (2016), we estimated markups and marginal costs at the plant–product–destination level by exploiting quantity and price data on domestic and exported products. Our results suggest that tariff declines from NAFTA affected the prices of domestic and exported products through different channels. For domestic products, input tariff reductions led to a decline in marginal costs and thus prices, but changes in markups were insignificant on average. Meanwhile, exporters raised markups in response to input and U.S. tariff reductions. As a result, the average export prices slightly increased.

to the tariff changes in the same way as found in Table 5.

³³This finding is consistent with Dhyne, Kikkawa, and Magerman (2022a), in which they model firms charging different markups depending on the destination market.

³⁴In general, higher markups do not necessarily benefit producers, as they may simply reflect high overhead fixed costs. Because we mainly focus on the intensive margins of trade wherein plants in our analysis have already paid the overhead costs, higher markups translate to larger profit margins for these incumbent firms.

Overall, our empirical analysis suggests that Mexican consumers benefited from NAFTA through lower prices in the domestic market. In addition, Mexican manufacturers also benefited from NAFTA's tariff reductions through lower input prices despite increasing foreign competition. It appears that exporters disproportionately benefited, as the reductions in U.S. tariffs on Mexican products permitted an additional expansion in their profit margins.

Our analysis sheds light on how reciprocal trade liberalizations affect firms' prices and the competition firms face. The NAFTA episode and the detailed plant–product-level data from Mexican manufacturing plants provide us with an opportunity to study this question empirically. Our work complements existing literature by differentiating firms' adjustment in domestic and foreign markets. We believe that understanding firms' responses under such circumstances is very important, since a large proportion of past tariff reductions have been reciprocal.

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