Rules of Origin and the Use of NAFTA

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Abstract

We study how Rules of Origin (RoO) affect the use of NAFTA. Firms exporting using NAFTA have to comply with RoO to enjoy preferential tariff treatment. We document: (i) Smallest and largest firms use NAFTA less intensively than medium-sized firms, and (ii) The distortion RoO have on input sourcing choices is increasing in firm size. We rationalize these empirical findings by including fixed costs of using NAFTA and of sourcing from foreign countries in a model of global input sourcing, where the opportunity cost of RoO increases with firm size. We quantify our model using data on Mexican firms, RoO, and tariffs. We conduct counterfactuals that suggest a 25% increase in the strictness of RoO or a 5% tariff on all Mexican imports would result in 0.72% and 13.65% lower US exports of intermediates to Mexico, respectively. On the contrary, we quantify that removing RoO would increase these exports by 2.98%.

Keywords: *NAFTA, Rules of Origin, MFN tariffs, Trade Policy, Input Sourcing*

JEL Codes: F12, F13, F15, F23, O19

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1 Introduction

Since the creation of the World Trade Organization (WTO) in 1995, there has been a proliferation of Free Trade Agreements (FTAs) around the World. Bhagwati (1995) terms this as the *Spaghetti Bowl Effect*, describing how international trade is nowadays dominated by regional agreements instead of relying on multilateral organizations such as the WTO.[1] One of the regulations included in FTAs are Rules of Origin (RoO), defined as *"the criteria needed to determine the national source of a product."*[2] RoO are highly pervasive, being included in at least 62% of existing FTAs according to Kniahin and De Melo (2022).

RoO are implemented to protect local industries, and to increase the amount of regional content in bilateral exports by requiring domestic firms to source some of their intermediate inputs from suppliers in member countries. By doing so, they introduce a key tradeoff between a potential loss of efficiency and lower barriers to trade. On the one hand, firms complying with RoO cannot source their inputs from the most efficient suppliers around the World, increasing their cost of production. On the other hand, RoO allow firms to enjoy preferential tariff treatment, decreasing their cost of exporting to a member country.

This paper studies the effect of RoO on the use of NAFTA to export. We assemble a unique dataset for the universe of Mexican exporters in which we observe whether they used NAFTA or WTO MFN tariffs for their exports to the US, as well as the inputs these firms source from foreign countries. We complement this dataset with: (i) The Most Favored Nation (MFN) tariffs the US applies to Mexican exporters if they use WTO MFN to export, (ii) The RoO firms had to comply with if using NAFTA, and (iii) The exact input composition of every product being exported to the US.

We use our data to compute a product-level measure of RoO strictness, defined as the share of a product's input value restricted to be sourced from suppliers within NAFTA countries. For this, we leverage on the fact that in the NAFTA agreement, most RoO are written in terms of *Classification Changes*, as documented by Conconi et al. (2018). This type of RoO specifies for each product which inputs must be sourced from suppliers within NAFTA countries, according to the Harmonized System (HS) codes of both the final product and its intermediate inputs.[3]

We begin by documenting three empirical facts that inform our modeling choices. First, there is a positive correlation between RoO strictness and MFN tariffs. Second, there is an

[1] According to the WTO, as of 2023 there are 360 active FTAs around the World. Source: WTO's RTA-IS.
[2] Source: WTO's Technical Information on Rules of Origin.
[3] For example, under this type of RoO, a firm exporting a product with HS code 85 has to source all inputs belonging to the same HS code 85 from NAFTA countries, while any input of a different HS code can be freely sourced from around the World.

inverse U-shaped relationship between the use of NAFTA and firm size. Third, using NAFTA to export decreases the probability that a firm sources inputs from non-NAFTA countries, as it has to comply with RoO, and the magnitude of this effect is increasing in firm size. These findings are robust to controlling for industry fixed effects, which should capture any common sectoral unobservables affecting the use of NAFTA and foreign sourcing. The first empirical fact implies firms do face a tradeoff when choosing whether to use NAFTA or WTO membership to export, that is, if a firm wants to avoid paying a high tariff, it has to source a large share of its inputs exclusively from suppliers within NAFTA countries. The second and third empirical facts are suggestive that Mexican exporters face fixed costs of using NAFTA and sourcing from foreign countries. The former should include costs such as complying with labor regulations and learning to use the FTA. The latter should capture costs such as finding a foreign supplier and dealing with foreign bureaucracy.

We include these fixed costs in a workhorse model of global input sourcing, extending it to include distinct sectors and industries within them. In our model, Mexican firms export to the US and choose: (i) Whether they use NAFTA or WTO to export, and (ii) The set of countries from which they can source their inputs. Using NAFTA requires them to comply with RoO and pay the associated fixed cost, while using WTO implies they have to pay MFN tariffs. Exporters in Mexico are monopolistically competitive and require a continuum of intermediate inputs that they can source from heterogeneous suppliers around the World. We introduce RoO by assuming that a share of a firm's inputs can only be sourced from NAFTA countries, while the rest of its inputs can be freely sourced from the best suppliers among the set of countries for which firms have paid fixed costs of sourcing. Mexican exporters are heterogeneous in terms of the RoO and MFN tariffs they face, their fixed costs of using NAFTA and sourcing from foreign countries, how attractive is for them to source inputs from foreign countries, and their export-specific productivity.

The model yields natural predictions on how the use of NAFTA is affected by RoO, tariffs, foreign countries' sourcing efficiency, and fixed costs. (i) The use of NAFTA to export is decreasing in RoO, as these increase marginal cost by requiring firms to source a share of their inputs from possibly inefficient suppliers. (ii) Higher tariffs increase the use of NAFTA, as these increase the cost of exporting using WTO. (iii) The use of NAFTA is increasing in how efficient NAFTA countries are in supplying intermediate inputs, as this decreases the opportunity cost of RoO. (iv) Conversely, the use of NAFTA is decreasing in how efficient non-NAFTA countries are in supplying inputs. (v) The use of NAFTA is decreasing in its fixed cost, and increasing in fixed costs of sourcing from foreign countries. The latter follows since the larger fixed costs of sourcing are, the lower the likelihood a firm will be able to source from these countries, thereby decreasing the cost of complying with RoO.

In our model, an increase in RoO decreases bilateral trade in final goods, as sourcing from inefficient suppliers results in lower demand, and has ambiguous effects on bilateral trade in intermediate goods. On the one hand, stricter RoO will increase the share of inputs being sourced from suppliers in member countries. On the other, since firms sourcing from possibly less efficient suppliers results in lower trade in final goods, purchases of intermediates decrease as well. The magnitude of these two opposing effects depends on the relative efficiency of NAFTA countries in supplying intermediate inputs, and on the extent to which firms can source their inputs from suppliers in non-NAFTA countries.

To quantitatively evaluate these tradeoffs and the impact of RoO, we take the model to the data. We estimate, at the sectoral level, the fixed costs of using NAFTA and sourcing from foreign countries. The moments we target are: (i) The share of firms using NAFTA to export, which pins down its fixed cost, (ii) The share of firms sourcing from each foreign country, which helps us identify fixed costs of sourcing, and (iii) Average exports at the firm level, which pins down US market demand for each sector. We do this by feeding into our model data on the RoO and tariffs that each firm within an industry would either have to comply with or pay. We also estimate how attractive it is for Mexican industries to source their intermediate inputs from foreign countries.

Having quantified our model, we conduct counterfactuals where we study whether the US and Mexico would benefit from a set of policy changes. We explore: (i) An increase in RoO because of the transition from NAFTA to USMCA, (ii) An increase in tariffs on Mexican imports, and (iii) A removal of RoO from the NAFTA agreement. The first two counterfactuals are of interest as they represent the most prominent changes in trade policy that have been either implemented or proposed in recent years between these two countries. The third counterfactual allows us to quantify the inefficiency resulting from restricting firms from sourcing their inputs from the most efficient suppliers. In these counterfactuals, we focus our attention on three key variables policymakers care about: US exports of intermediate goods to Mexico, US prices for Mexican imports, and Mexican firm profits.

Two key factors determine the sectoral heterogeneity in the responses to these counterfactual scenarios. First, the distribution of firm size in a sector. Fixed costs of sourcing from foreign countries imply the opportunity cost of complying with RoO is increasing in size. Therefore, a protectionist policy will be costlier in sectors with relatively larger firms. Second, the efficiency of NAFTA and non-NAFTA countries in supplying intermediate inputs. Sectors sourcing from industries in which NAFTA countries are relatively better suppliers of inputs will be the ones less affected by either an increase or a removal of RoO.

The first counterfactual that we explore is the transition in July 2020 from NAFTA to the United States-Mexico-Canada Agreement (USMCA), which we implement as an increase of 25% in the RoO strictness faced by all Mexican firms.[4] We do this because: (i) Assuming a common increase across all industries allows us to study how sectoral heterogeneity leads to different outcomes through the lens of our key mechanisms, (ii) Detailed sectoral data on the new RoO in USMCA are not yet available. We evaluate the responses to the increase in RoO in terms of three distinct effects. First, stricter RoO require Mexican exporters to source a larger share of their inputs from suppliers in NAFTA countries, this increases US exports of intermediates to Mexico. Second, having to source a larger share of inputs from NAFTA suppliers increases the cost of production, which decreases bilateral trade. Third, some firms will no longer use NAFTA to export. On the one hand, this implies firms can now source from efficient suppliers, potentially decreasing the price of Mexican exports. On the other, not having to comply with RoO decreases the share of inputs sourced from NAFTA countries. Results suggest that bilateral trade would decrease across all sectors. On average, US exports of intermediates to Mexico would decrease by 0.72%, together with a 0.16% increase in US prices for Mexican imports and 0.67% lower Mexican firm profits.

The second counterfactual that we conduct is one in which all Mexican imports pay at least a 5% tariff, following a US proposal in 2019. We assume firms using NAFTA now pay a 5% tariff, while firms using WTO see their tariff increase to at least 5%. This would result in 47% of the firms originally using NAFTA switching to WTO, as having to pay tariffs even if using NAFTA decreases its benefit. This decreases US exports of intermediates as firms would no longer comply with RoO. Moreover, this would not translate into higher foreign sourcing because paying higher tariffs decreases firms' ability to pay fixed costs of sourcing. In this situation, our model predicts US exports would have decreased by 13.65%, US prices would have increased by 4.95%, and Mexican profits would have decreased by 11.68%.

The third counterfactual that we study is what would have happened if NAFTA had removed RoO on all products. This decreases the cost of using the FTA, increasing its use. For firms that were already using NAFTA, the share of inputs they source from member countries would decrease as RoO are no longer in place, but this effect is dominated by the cost reductions coming from being able to source from more efficient suppliers. Firms that switch from WTO to NAFTA, 9.00% of the firms originally using WTO, also increase their foreign sourcing as these firms no longer pay MFN tariffs, which increases their export revenue. Results suggest that US exports would have increased by 2.98%, US prices would have decreased by 1.15%, and Mexican firm profits would have been 5.52% higher.

This paper is related to several branches of the literature. First, we contribute to the literature on the impact of trade liberalization and Free Trade Agreements. Seminal papers

[4]For example, if a product had a 10% RoO strictness under NAFTA, in USMCA the same product would have a RoO strictness of 12.5%.

on this topic are those by Trefler (2004), Romalis (2007), Arkolakis et al. (2008), Bustos (2011), Ossa (2011), Antràs and Staiger (2012), Kehoe and Ruhl (2013), Caliendo and Parro (2015), De Loecker et al. (2016), among others. To the best of our knowledge, this is the first paper to provide evidence on which firms are using NAFTA to export, and how this depends on firm characteristics such as their size and industry.

Second, our paper builds on the literature on global sourcing decisions, including Antras and Helpman (2004), Goldberg et al. (2010), Rodríguez-Clare (2010), Garetto (2013), Kee and Tang (2016), Tintelnot (2017), Bernard et al. (2018), and Head and Mayer (2019). Our model builds on Antras et al. (2017), which develops a model of global sourcing in which firms choose the set of countries from which they can import their inputs. We introduce a new margin of decision for firms: their choice of using either NAFTA or WTO to export, which captures the tradeoff between lower tariffs and inefficiencies in production.

Third, our paper speaks directly to the literature on content protection and the effects RoO have on firm behavior, starting with the work by Dixit and Grossman (1982), Grossman and Helpman (1992), Krishna and Krueger (1995), and Estevadeordal (1999). More recent papers are Carrère and De Melo (2004), Anson et al. (2005), Augier et al. (2005), Ju and Krishna (2005), Cadot et al. (2006), Deardorff (2018), Krishna et al. (2021), Acosta and Leal (2022), and Ornelas and Turner (2023). Our work is closely related to Conconi et al. (2018) which finds that the more restricted an input became under RoO, the larger the extent to which Mexico substituted sourcing it from non-NAFTA countries towards NAFTA ones. Head et al. (2022) also builds a model of input sourcing and RoO, which they calibrate to the automotive industry in North America, allowing them to characterize a Laffer Curve between RoO and the amount of regional content in exports. We contribute to their work using data on the universe of the Mexican export transactions, which allows us to document novel stylized facts on the use of NAFTA and structurally estimate a model of NAFTA and compliance RoO with based on these data.

The rest of the paper is organized as follows. Section 2 describes the data sources we use and how we combine them to construct a dataset capturing firm behavior and the costs and benefits of using NAFTA. In Section 3, we show three empirical facts that we highlight throughout the paper and inform our modeling strategy, as well as provide evidence of Mexican exporters facing fixed costs of using NAFTA and of sourcing from foreign countries. Section 4 develops our model for the use of NAFTA and RoO. Section 5 details the quantification of our model, while Section 6 presents the counterfactual scenarios we explore. Section 7 summarizes our main findings and discusses their policy implications.

2 Data

This section describes the distinct data sources we use to create a unique dataset on the use of NAFTA and firms' sourcing choices, including the RoO and tariffs exporters to the US face. We study Mexican firms exporting final products to the US using either NAFTA or WTO, and importing intermediate inputs from all over the World. The data sources we use are the following:

Mexican Customs Data: This data is accessed through the Econlab at Banco de México, the country's Central Bank. It contains the universe of exports and imports at the transaction level. For every transaction, we observe the following: Firm ID, product at the HS 6-digit level, trade value, origin/destination of the transaction, and whether the transaction was for an intermediate or final good. Crucially for this paper, we also observe whether an export used NAFTA or WTO membership.

US 2022 Harmonized Tariff Schedule: This data set details, at the HS 6-digit level, the MFN tariffs Mexican exporters would have to pay at the border if they choose to export their products using WTO membership.

NAFTA's RoO: This data comes from Annex 401 of the NAFTA agreement, assembled and made available to the public by Conconi et al. (2018). It describes the exact RoO applied to each product at the HS 6-digit level, which Mexican firms have to comply with if they want to use NAFTA to export. As Conconi et al. (2018) points out, most of NAFTA's RoO are defined in terms of *Classification Changes*, which implies that for each final product, we observe which of its inputs have to be sourced from NAFTA countries.

Input-Output Tables: We use the Direct Requirement Coefficients (DRC) Tables published in 1997 by the BEA. These tables provide us with the exact input composition of each final product, defined following the 1997 NAICS classification system.

We combine these two last data sources to compute a product-level measure of RoO strictness. Since we know the input intensity of every product, and we know exactly which of their inputs are restricted to be sourced exclusively from suppliers in NAFTA countries, our measure of RoO strictness is defined as the share of a product's inputs that have to be sourced from NAFTA countries if a firm chooses to use NAFTA to export.[5]

We study exports between September 2014 and June 2020. The former is the first month for which the NAFTA usage information is available, and the latter is the last month before

[5]This requires translating the DRC tables from NAICS to HS; details of this are in Appendix A.

the transition from NAFTA to USMCA. In these periods, there are 25,572 different firms exporting 1,050 unique products to the US, using either NAFTA or WTO to do so. This results in 1,019,408 unique firm-time-product combinations, which we define as our unit of observation. We restrict our sample in two distinct ways.

First, at the firm level, we drop exporters for which their total exports to all destinations are lower than their total imports, which drops 29.27% of firms. We do this as in our data, we cannot identify firms that are either trade intermediaries or mostly sell their products in the domestic market.[6] These firms are not the object of study in our paper.

Second, at the product level, we drop HS 6-digit codes for which: (i) Tariffs are not positive, as there would be no benefit of using NAFTA, nor defined in ad-valorem terms.[7] (ii) Exporters can choose to comply with an alternative Value-Added rule instead of RoO. The data in Conconi et al. (2018) includes information on the HS 6-digit codes for which this is the case. Products with positive ad-valorem tariffs represent 63.27% of the total number of products, while for 86.76% of the products exporters have to comply with RoO.

After restricting the data according to these criteria, our final sample includes 410 HS 6-digit products within 48 different HS 2-digit industries, and 9,918 unique firms exporting final goods to the US, using either NAFTA or WTO to do so.

An illustrative example of an observation in our dataset is the following: In our customs data we observe that *Firm A* exported *Product 1* to the US, imported *Input 1* from the US, and imported *Input 2* from China; we also observe that *Firm A* used NAFTA to export. From the DRC Tables we know *Product 1* is made 40 % of *Input 1*, 40 % of *Input 2*, and 20 % of *Input 3*. From RoO data, we know that if a firm uses NAFTA to export *Product 1*, then it has to source *Input 1* and *Input 3* from NAFTA countries. This implies the RoO strictness of *Product A* is 60%. Lastly, MFN tariff data tells us that whenever a firm exports *Product A* to the US using WTO, it has to pay a 10% ad-valorem tariff.

3 Three Empirical Facts

This section documents three empirical facts on how RoO affect firm behavior, and discusses how they are rationalized in our model. First, RoO strictness and MFN tariffs are positively correlated. Second, small and large firms use NAFTA less intensively than medium-sized firms. Third, the distortion RoO have on firms' input sourcing is increasing with size.

Empirical Fact 1. *There is a positive correlation between RoO strictness and MFN tariffs.*

[6]These firms have disproportionally large imports, as the median of their imports-to-exports ratio is 254.84.

[7]An example of a non-ad-valorem tariff is *US dollars per pound*, for which it is hard to compare across different products.

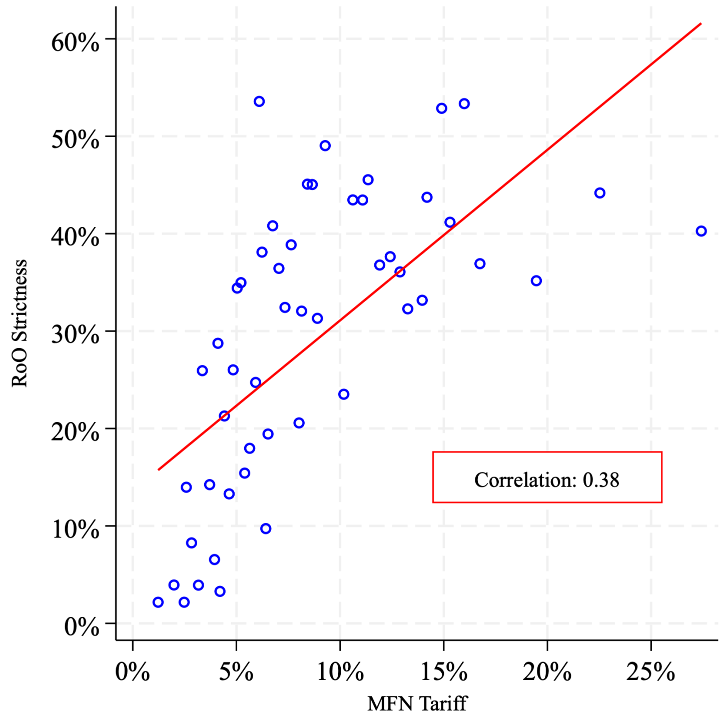


Figure 1: Correlation between RoO strictness and MFN tariffs.

Figure 1 shows this correlation at the product level.[8] The fact that it is positive implies that firms are facing a tradeoff when using NAFTA or WTO to export. For example, if a firm has a high benefit of using NAFTA, because it implies not paying a high tariff, it also faces a high cost of using it, as the RoO on its product will be high as well. In our model, firms will evaluate whether it is worth complying with RoO to avoid paying MFN tariffs.

Empirical Fact 2. *The relationship between the use of NAFTA and firm size follows an inverse U-shape.*

Figure 2 shows how the use of NAFTA depends on firm size. We proxy firm size by computing average monthly total exports to all destinations. We divide firms into percentiles of size and for each one of these, compute the share of firms that export using NAFTA. Results show that small and large firms use NAFTA less intensively compared to medium-sized firms. This relationship could be driven by selection into industries, e.g. it is not that firm size matters *per se*, but rather that small and large firms are in sectors with relatively lower incentives of using NAFTA. To check for this, we estimate Equation (1) using OLS:

[8]The figure is for a binscatter, grouping our sample of 410 HS 6-digit products across 50 distinct bins.

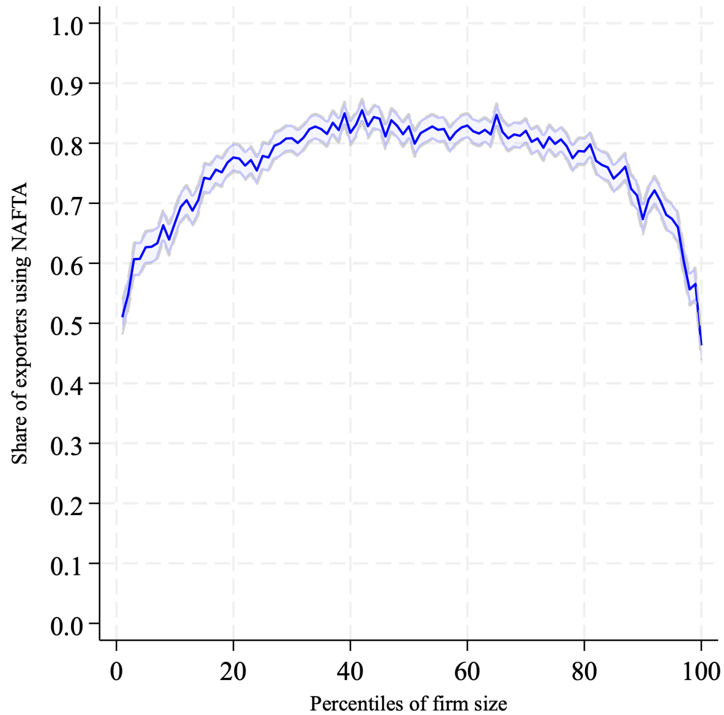


Figure 2: Share of exporters using NAFTA by size percentile.

$$\mathbb{N}_{ikjt} = \beta_0 + \sum_{k=2}^{10} \beta_k \mathbb{I}_{ikt} + \alpha_1 \text{RoO}_j + \alpha_2 \text{MFN}_j + \iota_t + \epsilon_{ikjt} \tag{1}$$

where $\mathbb{N}_{ikjt} = 1$ if firm i of size decile k exporting product j at time t is using NAFTA to export, and $\mathbb{I}_{ikt} = 1$ if the firm belongs to size decile k. To account for the role that RoO and MFN tariffs have in shaping the firm-level decision to use NAFTA, we control for RoO_j, the share of restricted inputs for product j if using NAFTA, and MFN_j, product j's ad-valorem tariff if using WTO. We include time fixed effects ι_t to control for any shocks common to all firms. We do not include industry fixed effects as we are also interested in the *ceteris paribus* effect of RoO and MFN tariffs, and there is little industry-level variation in these.[9]

Figure 3 shows how the estimated coefficients for intercepts $\hat{\beta}_0 + \hat{\beta}_k$ change across size deciles k. In the figure, the x-axis shows the deciles of firm size, while the y-axis shows the predicted share of firms using NAFTA. We assume $\text{RoO}_j = 0$ and $\text{MFN}_j = 0$ for simplicity, as we are interested in the direct effect that firm size has on the use of NAFTA. Results suggest firm size does partly explain the inverse U-shape relationship. Estimated coefficients $\hat{\alpha}_1$ and $\hat{\alpha}_2$ imply that if RoO strictness or MFN tariffs were to increase by 1 s.d., the probability

[9]The average coefficient of variation in RoO strictness and MFN tariffs across products within an industry, defined as $CV = \sigma/\mu$, is equal to 0.63 and 0.19, respectively.

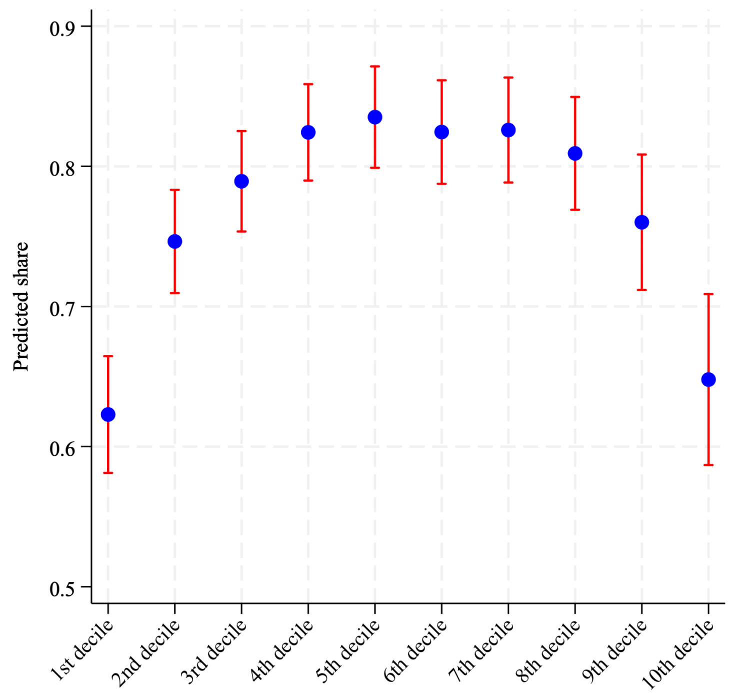


Figure 3: Predicted share of exporters using NAFTA by size decile.

that a firm uses NAFTA would change on average by -9.03 and 3.66 p.p., respectively.

The estimation output is included in Appendix B, where we also conduct the following robustness checks: (i) Include industry fixed effects, (ii) Use different specifications and proxies for firm size, and (iii) Show a particular industry does not drive our results.

Empirical Fact 3. *The decrease in the probability of sourcing inputs from non-NAFTA countries when using NAFTA to export is increasing in firm size.*

To study the impact RoO have on firms' input sourcing choices, we use OLS to estimate Equation (2) separately for firms using either NAFTA or WTO membership to export:

$$\mathbb{S}_{ikst} = \beta_0 + \sum_{k=2}^{10} \beta_k \mathbb{I}_{ikt} + \iota_{s,t} + \epsilon_{ijt} \tag{2}$$

where $\mathbb{S}_{ikst} = 1$ if firm i of size k from industry s at time t sources inputs outside of NAFTA countries, and $\mathbb{I}_{ikt} = 1$ if the firm belongs to size decile k. An exporter sources outside of NAFTA countries if we observe imports of intermediates coming from countries other than the US or Canada. We control for unobservables by including industry-year fixed-effects ι_{st}. For example, for a particular industry it might be more attractive to source from China whenever this country is a good supplier of its inputs.

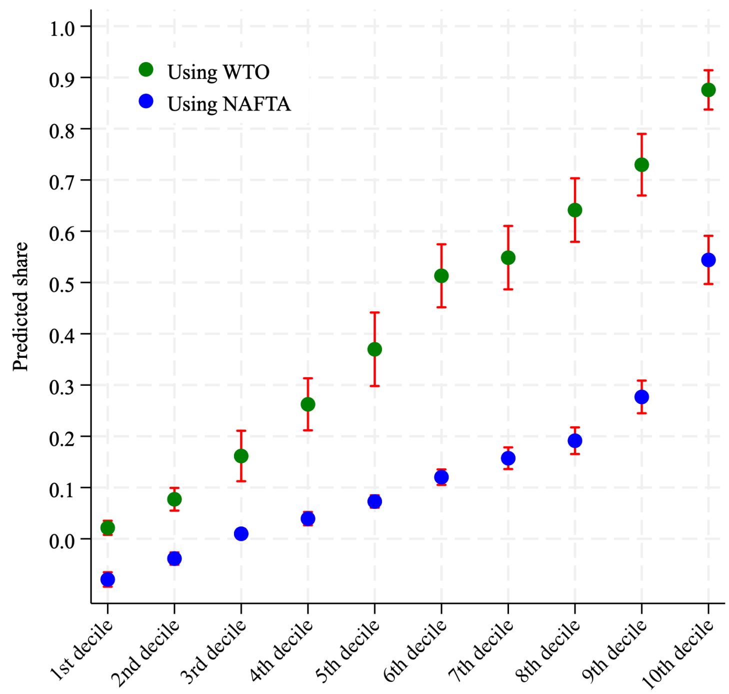


Figure 4: Predicted share of exporters sourcing outside of NAFTA by size decile.

Figure 4 shows how the estimated coefficients $\hat{\beta}_0 + \hat{\beta}_k$ change across size deciles, for exporters either using NAFTA or WTO. We are interested in the gap between the NAFTA and WTO coefficients, which we interpret as the distortion in sourcing choices induced by RoO. While it is mechanically true that a firm using NAFTA should be less likely to source from non-NAFTA countries, as it has to comply with RoO, results show the distortion RoO have on sourcing choices is increasing with size, suggesting that other mechanisms are present. The estimation output for Equation (2) is also included in Appendix B, and we conduct the same robustness checks as those for Equation (1).

We rationalize Empirical Facts 2 and 3 as consequences of Mexican exporters facing fixed costs of using NAFTA and sourcing from foreign countries. Fixed costs of using an FTA to export are well documented in the literature; see Demidova et al. (2012), Cherkashin et al. (2015), and Krishna et al. (2021). Using NAFTA to export not only requires complying with RoO, but also with labor, environmental, and health regulations. Exporters also need to learn to use the FTA, and keep track of the sourcing of their inputs by presenting a *Certificate of Origin* at the border.[10] We consider these factors part of the fixed cost of using NAFTA to export. A firm should also find it costly to be able to source inputs from a

[10] A document required under NAFTA to certify that a good being exported qualifies as an originating good, and thus qualifies for preferential tariff treatment.

foreign country, as it needs to find an appropriate supplier, deal with domestic and foreign bureaucracy, agree on product characteristics, etc. We consider these factors part of the fixed costs of sourcing, as discussed in Antras et al. (2017).

When studying the use of NAFTA and the effect RoO have on it, firm size matters. On the one hand, the larger a firm is, the more able it is to pay the fixed cost of using NAFTA; this by itself generates a positive relationship between firm size and the use of NAFTA. On the other, larger firms should find it more profitable to source from foreign countries; suggesting the opportunity cost of complying with RoO is increasing in a firm's ability to pay these fixed costs. This implies by itself a negative relationship between firm size and the use of NAFTA.

These two fixed costs together explain Figures 3 and 4. For the former, small firms are less able to pay the fixed cost of using NAFTA, while large firms who can source their inputs from all over the World find it too costly to have their input sourcing restricted by RoO. For the latter, small firms are less able to source inputs from foreign countries, thus being restricted by RoO when using NAFTA does not significantly affect their sourcing choices. The larger a firm is, the more it can source inputs from foreign countries, and therefore the larger the distortion RoO have on its probability of sourcing from non-NAFTA countries.[11] This is our key mechanism: the opportunity cost of RoO is increasing in firm size. Our model accounts for this by including fixed costs of using NAFTA and of sourcing from foreign countries.

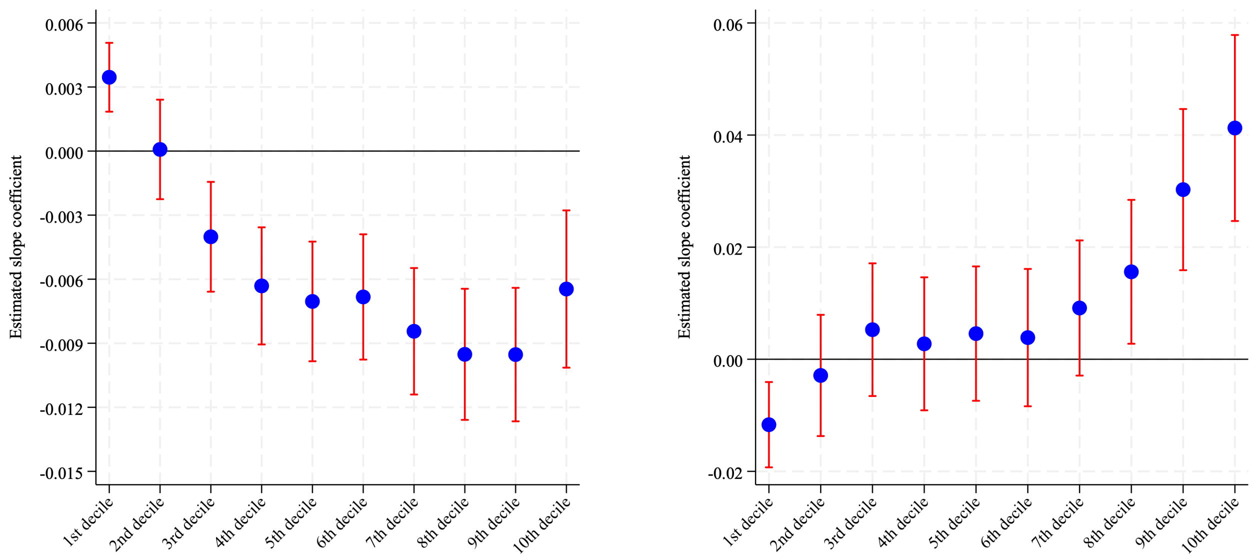
In order to provide evidence on these fixed costs, we exploit cross-product variation in RoO strictness and MFN tariffs across the firm size distribution. In the absence of fixed costs, both the benefit and cost of using NAFTA scale up with firm size. The benefit is not paying the MFN tariff, which is defined in ad-valorem terms. The cost is complying with RoO, which increase a firm's marginal cost. This implies that, without fixed costs, the effects of RoO and MFN tariffs on the use of NAFTA should be homogeneous across the firm size distribution.

To test this, we estimate Equation (3), which allows the marginal effect of RoO and MFN tariffs on the use of NAFTA to vary across firm sizes:

$$\mathbb{N}_{ikjt} = \beta_1 + \sum_{k=2}^{10} \beta_k \mathbb{I}_{ikt} + \alpha_1 \mathrm{RoO}_j + \sum_{k=2}^{10} \alpha_k \mathbb{I}_{ikt} \times \mathrm{RoO}_j + \gamma_1 \mathrm{MFN}_j + \sum_{k=2}^{10} \gamma_k \mathbb{I}_{ikt} \times \mathrm{MFN}_j + \iota_t + \epsilon_{ikjt} \quad (3)$$

where $\mathbb{N}_{ikjt} = 1$ if firm i of size decile k exporting product j at time t is using NAFTA to export, $\mathbb{I}_{ikt} = 1$ if the firm belongs to size decile k, and RoO_j and MFN_j are product j's

[11] The gap in the estimated coefficients decreases for the 10th decile. This could be the result of the import volume the largest firms have, i.e. the largest firms purchase such a large quantity of inputs that even if restricted by RoO, they still find it profitable to pay fixed costs of sourcing.



(a) RoO strictness

(b) MFN tariffs

Figure 5: Marginal effects on the probability of using NAFTA to export.

RoO strictness and MFN tariff, respectively.

Figure 5 shows the absolute value of estimated slope coefficients $\hat{\alpha}_0 + \hat{\alpha}_k$ and $\hat{\gamma}_0 + \hat{\gamma}_k$ weakly increases with size, which we treat as evidence that Mexican firms do face fixed costs of using NAFTA and sourcing from foreign countries. The estimation output for Equation (3) is included in Appendix B.

For smaller firms, RoO and MFN tariffs have a lower effect on their probability of using NAFTA to export, as these firms are less able to pay fixed costs. For example, even if a small firm has high incentives of using NAFTA because it faces a high MFN tariff, it is unable to do so as it cannot pay the fixed cost of it. Likewise, a small firm will not decrease its use of NAFTA even if facing high RoO because the firm was not able to source from foreign countries in the first place. The larger firms are, the less these fixed costs constrain them, and thus the greater the effect RoO and MFN tariffs will have on their probability of using NAFTA, i.e. higher MFN tariffs increase firms' incentives of using NAFTA, while stricter RoO do the opposite.

4 A Model of Rules of Origin and NAFTA Usage

We extend Antras et al. (2017) to include RoO and the choice of using NAFTA to export. The key elements of their model are CES preferences over varieties and monopolistically competitive final good producers, as developed in Melitz (2003). Each variety uses a continuum of intermediate inputs $\nu \in [0,1]$ with competitive global suppliers, as in Eaton and Kortum (2002). Final good producers only sell domestically, and choose from which countries they can source their inputs, their *sourcing strategy*, by paying fixed costs of sourcing.

Our contribution to their model is two-fold: (i) We assume Mexican firms are exporting their final goods to the US, and (ii) We allow firms to also choose whether they export using NAFTA or WTO membership. By choosing the former, firms must comply with RoO, which restrict their sourcing strategies by imposing that a given share of their inputs must come from NAFTA countries. To exploit our product-level data on RoO strictness and MFN tariffs, we include in the model different sectors and industries within them.

4.1 US Consumers

Let N be the set of NAFTA countries. We assume that consumers in the US value consumption of domestic good D and Mexican varieties ω across distinct industries and sectors.

$$U = D^{1-\eta} \prod_{s=1}^{S} \Big[\sum_{i=1}^{I_s} \Big(\int_{\omega \in \Omega_{si}} q_{si}(\omega)^{\frac{\sigma-1}{\sigma}} d\omega \Big)^{\frac{\sigma(\epsilon-1)}{\epsilon(\sigma-1)}} \Big]^{\frac{\alpha_s \eta \epsilon}{(\epsilon-1)}} \tag{4}$$

Domestic good D is meant to capture all non-Mexican products. There is a total of S sectors, and an I_s number of industries within each sector. Ω_{si} represents the set of varieties of sector s and industry i being exported to the US. Parameter $\sigma > 1$ is the elasticity of substitution across varieties of a given industry, while $\epsilon > 1$ is the elasticity across industries within a given sector. We assume that $\sigma > \epsilon$, as demand should be more elastic within an industry than across them. Consumers in the US spend a share $\eta \in [0,1]$ of their income in Mexican imports, and a share $1-\eta$ in domestic good D. Finally, we assume consumers spend a share α_s of their total expenditure on Mexican imports on goods from sector s:

$$\sum_s \alpha_s = 1$$

Consumers maximize their utility in Equation (4) subject to their budget constraint:

$$D + \sum_{s=1}^{S} \sum_{i=1}^{I_s} \Big(\int_{\omega \in \Omega_{si}} q_{si}(\omega) p_{si}(\omega) d\omega \Big) = E \tag{5}$$

where E represents the total income/expenditure of the US, and $p_{si}(\omega)$ stands for the price of variety ω of industry i from sector s. We assume domestic good D acts as a numeraire, and thus the price of a Mexican variety $p_{si}(\omega)$ is expressed relative to it.

Solving the consumer's optimization problem, the demand in the US for variety ω is:

$$q_{si}(\omega) = \frac{\alpha_s \eta E P_{si}^{\sigma-\epsilon}}{\sum\limits_{k} P_{sk}^{1-\epsilon}} p_{si}(\omega)^{-\sigma} \tag{6}$$

where $P_{si} \equiv (\int_0^1 p_{si}(\omega)^{1-\sigma} d\omega)^{1/(1-\sigma)}$ is the Dixit-Stiglitz ideal price index for industry i of sector s. Demand for variety ω is increasing in the expenditure level in the US, and increasing in both the share of expenditure spent in Mexican imports η and the share α_i of total expenditure on Mexican imports spent on industry i. Lastly, demand is increasing in the ideal price index, and decreasing in price as $\sigma > 1$.

4.2 Mexican Exporters

To introduce RoO and the use of NAFTA in the model, we first define a set of objects. Let $\kappa \in \{0, 1\}$ be an indicator variable equal to 1 when a firm chooses to export using NAFTA, and 0 if it chooses to export using WTO. Denote by $\lambda(\omega) \in [0, 1]$ the share of inputs firm ω has to source from NAFTA countries if it chooses to use NAFTA, and let $\tau(\omega) \in [0, \infty)$ represent the ad-valorem tariff it would have to pay if it chooses to export using WTO. These two objects are exogenous to firms and specific to each variety. Motivated by our discussion in Section 3, we assume that if firms use NAFTA, they have to pay a fixed cost represented by $\zeta_{si} \in \mathbb{R}^{++}$. Firms also have to pay fixed cost $f_{si}^{j}(\omega) \in \mathbb{R}^{++}$ to be able to source inputs from foreign country j. In what follows, we drop the ω index to ease up notation.

For presentation purposes, we assume that firm behavior consists of four distinct stages. First, a firm in industry i of sector s observes its λ and τ, and fixed costs ζ and f^j $\forall j$. Second, the firm chooses whether to enter the US export market. We assume that a firm's export-specific productivity ϕ is unknown to it unless it pays a fixed cost of entry υ. Third, the firm chooses whether to export using NAFTA or WTO membership. Lastly, given the firm's previous choice, it chooses the set of countries from which it can source inputs from, that is, its sourcing strategy.

Final good producers use a continuum of inputs of measure equal to one. These inputs are specific to each industry i and sector s. Marginal costs of producing an input are not only heterogeneous across countries but also across industries and sectors, e.g. China might be better at supplying inputs used by industry i than inputs used by industry i'. We assume that the unit labor cost of producing an input a_{si}^{j} is Fréchet distributed according to:

$$F_{si}^{j}(a) = \exp(-T_{si}^{j} a^{-\theta})$$

where T_{si}^{j} captures the aggregate productivity level of country j at supplying inputs for industry i of sector s. Let $d_{si}^{j} > 1$ represent an iceberg-type trade cost between Mexico and country j, and w^j_{si} the wage paid at country j per unit of labor when producing inputs for industry i of sector s. We assume that suppliers of intermediate inputs, both domestic and at foreign countries, are competitive and thus price at marginal cost. The price paid by a Mexican firm for input $\nu \in [0,1]$ is given by:

$$z_{si}(\nu,\kappa,\lambda,J) = \begin{cases} \min\limits_{j\in N\cap J}\{d^j_{si}a^j_{si}(\nu)w^j_{si}\} & \text{if } \nu \in [0,\kappa\lambda) \\ \\ \min\limits_{j\in J}\{d^j_{si}a^j_{si}(\nu)w^j_{si}\} & \text{if } \nu \in [\kappa\lambda,1] \end{cases} \tag{7}$$

where $J(\phi,\kappa,\lambda,\tau)$ represents the sourcing strategy of firm ϕ, i.e. the countries from which it can source inputs having paid their fixed costs of sourcing. Equation (7) states that the price a firm will pay for input ν is the lowest marginal cost among the countries from which it can source input ν. This is where we introduce RoO in the model: If a firm chooses to export using NAFTA, it has to source inputs $\nu \in [0,\lambda)$ exclusively from the NAFTA countries in its sourcing strategy $N \cap J$; whereas the rest of the inputs $\nu \in [\lambda,1]$ can be freely sourced from any country in J.

The increase in firms' marginal cost when using NAFTA is proportional to the increase in expenditure in intermediate inputs induced by having to comply with RoO:

$$\int_0^{\kappa\lambda}\Big[\min_{j\in N\cap J}\{d^j_{si}a^j_{si}(\nu)w^j_{si}\} - \min_{j\in J}\{d^j_{si}a^j_{si}(\nu)w^j_{si}\}\Big]d\nu \tag{8}$$

Conditional on using NAFTA, Equation (8) shows RoO imply an increase in marginal cost, except when: (i) NAFTA countries are the best suppliers of a firm's inputs, and (ii) A firm cannot pay the fixed costs of sourcing from non-NAFTA countries, i.e. $J \subseteq N$.

Within an industry, firms are heterogeneous in terms of their export-specific productivity ϕ, which we assume is drawn from a Pareto distribution with shape parameter χ. Given input prices described in Equation (7), a firm of productivity ϕ faces marginal costs:

$$c_{si}(\phi,\kappa,\lambda,\tau,J) = \frac{1+(1-\kappa)\tau}{\phi}\left(\int_0^{\kappa\lambda} z_{si}(\nu)^{1-\rho}d^*\nu + \int_{\kappa\lambda}^{1} z_{si}(\nu)^{1-\rho}d\nu\right)^{1/(1-\rho)} \tag{9}$$

Equation (9) represents the marginal cost of producing and exporting. This is where we introduce the benefit of using NAFTA to export: if a firm chooses to export using WTO, $\kappa = 0$, then it has to pay MFN Tariff $\tau \geq 0$.

Marginal cost is decreasing in ϕ, and the rest of the expression is a CES aggregation over the price of intermediate inputs, where $\rho > 1$ represents the substitution parameter across these. The measure of inputs is split into two integrals because the distribution of input prices is different depending on whether RoO restricts an input, $\nu \in [0, \lambda)$, or it can be freely sourced, $\nu \in [\lambda, 1]$.

Using the properties of the Fréchet distribution for unit labor costs, we can express the marginal cost of a firm with productivity ϕ in industry i of sector s as:

$$c_{si}(\phi, \kappa, \lambda, \tau, J) = \frac{1}{\phi}\gamma^{-1/\theta}[1 + (1-\kappa)\tau][\kappa\lambda\Psi_{si}(\phi)^{(\rho-1)/\theta} + (1-\kappa\lambda)\Phi_{si}(\phi)^{(\rho-1)/\theta}]^{\frac{1}{1-\rho}} \tag{10}$$

with:

$$\Psi_{si}(\phi) = \sum_{h \in N \cap J} T^h_{si}(d^h_{si}w^h_{si})^{-\theta} \quad \text{and} \quad \Phi_{si}(\phi) = \sum_{h \in J} T^h_{si}(d^h_{si}w^h_{si})^{-\theta}$$

We refer to $\Psi_{si}(\phi)$ as a firm's *NAFTA sourcing capability*, and $\Phi_{si}(\phi)$ as its *total sourcing capability*. Intuitively, $T^h_{si}(d^h_{si}w^h_{si})^{-\theta}$ captures how attractive it is for a firm in industry i of sector s to include country h in its sourcing strategy. We refer to this term as a country's *sourcing potential*, and it is the incentive a firm has for paying the fixed cost of being able to source inputs from country h. Lastly, γ represents the Gamma function evaluated at $(\theta + 1 - \rho)/\theta$.

The model yields predictions for the share of inputs a firm is going to source from each of the countries in its sourcing strategy J. These shares are subject to a distortion caused by RoO. Using again the properties of the Fréchet distribution, the share of inputs coming from non-NAFTA country $j \in J \setminus N$ is:

$$x^j_{si}(\phi, \kappa, \lambda, J) = (1-\kappa\lambda)\frac{T^j_{si}(d^j_{si}w^j_{si})^{-\theta}}{\sum_{h \in J} T^h_{si}(d^h_{si}w^h_{si})^{-\theta}} \tag{11}$$

while the share of inputs sourced from NAFTA country $j \in J \cap N$ is given by:

$$x^n_{si}(\phi, \kappa, \lambda, J) = \kappa\lambda\frac{T^j_{si}(d^j_{si}w^j_{si})^{-\theta}}{\sum_{h \in N \cap J} T^h_{si}(d^h_{si}w^h_{si})^{-\theta}} + (1-\kappa\lambda)\frac{T^j_{si}(d^j_{si}w^j_{si})^{-\theta}}{\sum_{h \in J} T^h_{si}(d^h_{si}w^h_{si})^{-\theta}} \tag{12}$$

In our model, for a fixed $\kappa = 1$, RoO increase the share of inputs sourced from NAFTA countries, regardless of their sourcing potential. Note that if a firm is choosing to export using WTO, $\kappa = 0$, or faces no RoO, $\lambda = 0$, then the expression for the share of inputs sourced from any country collapses to the standard input shares derived in Eaton and Kortum (2002).

Since firms compete monopolistically, the optimal price a firm sets, taking US demand as given, is a constant markup over the marginal cost of producing and exporting:

$$p_{si}(\phi, \kappa, \lambda, \tau, J) = \frac{\sigma}{\sigma - 1} c_{si}(\phi, \kappa, \lambda, \tau, J) \tag{13}$$

Combining Equations (6), (10), and (13), a firm's operating profits for a choice of κ and J are given by:

$$\pi_{si}(\phi, \kappa, \lambda, \tau) = \phi^{\sigma-1}\gamma^{(\sigma-1)/\theta} B_{si}[1 + (1-\kappa)\tau]^{1-\sigma}[\kappa\lambda\Psi_{si}(\phi)^{(\rho-1)/\theta} + (1-\kappa\lambda)\Phi_{si}(\phi)^{(\rho-1)/\theta}]^{\frac{1-\sigma}{1-\rho}} \tag{14}$$

where B_{si} represents US market demand for varieties from industry i of sector s:

$$B_{si} = \frac{1}{\sigma}\left(\frac{\sigma}{\sigma - 1}\right)^{1-\sigma}\left[\frac{\alpha_s \eta E P_{si}^{\sigma-\epsilon}}{\sum_k P_{sk}^{1-\epsilon}}\right] \tag{15}$$

which the firm takes as given. Equation (14) shows that if a firm uses NAFTA to export, on the one hand it will avoid paying MFN tariff τ, but on the other it will experience an increase in its marginal cost. This because λ will give some weight to the NAFTA sourcing capability at the expense of total sourcing capability, with $\Psi_{si}(\phi) \leq \Phi_{si}(\phi)$. If firms do not use NAFTA to export nor are there any RoO in place, Equation (14) collapses to the expression for operating profits in Antras et al. (2017).

As described before, we assume that firm choice occurs in distinct stages i.e. a firm first chooses whether it will use NAFTA or WTO membership to export, then it chooses the set of countries in its sourcing strategy. Assume that a firm has already chosen either NAFTA or WTO. Firms will choose the sourcing strategy that maximizes their operating profits subject to paying a fixed cost of sourcing from each country:

$$\Pi_{si}(\phi, \kappa, \lambda, \tau) = \max_{I_{si}^j \in \{0,1\}_{j=1}^J} \pi_{si}(\phi, \kappa, \lambda, \tau, I^1, ..., I^J) - w \sum_{j=1}^{J} I_{si}^j f_{si}^j(\phi) \tag{16}$$

where $I_{si}^j = 1$ if the firm chooses country j to be in its sourcing strategy. We assume that fixed costs of sourcing are firm-specific in order to capture any firm-level heterogeneity in these fixed costs. For example, firms located at the border with the US should have a lower fixed cost of sourcing from this country, as it should be easier for them to find a supplier.

The optimization in Equation (16) is a combinatorial discrete choice problem for firms as they choose the combination of countries that maximizes their profits given their previous choice of using either NAFTA or WTO membership. Therefore, a firm's chosen sourcing strategy will be a function of whether it chose NAFTA or WTO to export, e.g. a firm has fewer incentives to source inputs from Non-NAFTA countries when using NAFTA to export as RoO restrict a share of its inputs to be sourced exclusively from NAFTA countries.

By backwards induction, a firm will choose the κ, either NAFTA where $\kappa = 1$ or WTO where $\kappa = 0$, that maximizes its profits subject to paying a fixed cost if using NAFTA:

$$\kappa^* = \underset{\kappa \in \{0,1\}}{\arg\max} \ \{\Pi_{si}(\phi, \kappa, \lambda, \tau) - \kappa w \zeta_{si}\} \tag{17}$$

where ζ_{si} is the fixed cost of using NAFTA to export. Note we assume that both fixed costs of sourcing and using NAFTA are expressed in Mexican labor units.

In order to close our model, free-entry into the US export market implies that expected profits of exporting have to be equal to the cost of entry into the export market:

$$\int_{\tilde{\phi}_{is}}^{\infty} \big[\Pi_{si}(\phi, \kappa, \lambda, \tau) - \kappa(\phi) w \zeta_{si}\big] dG(\phi) = w\upsilon \tag{18}$$

where $G(\cdot)$ is the cdf of the Pareto distribution and $\tilde{\phi}_{si}$ denotes the productivity of the least productive firm from industry i of sector s that chooses to enter.

To summarize firm behavior: Firms observe realizations for their productivity and fixed costs. They also observe the RoO they would have to comply with if using NAFTA, and the MFN tariffs they would have to pay if using WTO. Then they choose whether to enter the US export market, followed by whether they will export using NAFTA or WTO, and their corresponding choice of sourcing strategy. Lastly, firms meet demand, pricing at a constant markup over their marginal cost.

4.3 Equilibrium

We assume the measure of non-exporting firms is large enough such that firms exporting to the US treat wages as exogenous; which implies that our model is one of partial equilibrium.

An equilibrium is a set of prices of varieties $p_{si}(\omega)$ and Mexican wages w such that:

1. Consumers maximize utility according to Equation (4) by choosing $q_{si}(\omega)$
2. Firms maximize profits in Equation (17) by choosing κ^* and J^* given $\{\lambda, \tau, f, \zeta\}$
3. Firms meet demand for their variety, given by Equation (6)
4. Expected profits of exporting to the US are zero, as in Equation (18)

This last condition results in the equilibrium number of firms of industry i from sector s actively exporting to the US being given by:

$$N_{si} = \frac{\alpha_s \eta E[1 - G(\tilde{\phi}_{si})]}{\sigma w \Big[\upsilon + \int\limits_{\tilde{\phi}_{si}}^{\infty} \Big(\kappa(\phi)\zeta_{si} + \sum\limits_{j \in J(\phi)} f_{si}^{j}(\phi) \Big) dG(\phi) \Big]} \times \frac{P_{si}^{1-\epsilon}}{\sum\limits_{k} P_{sk}^{1-\epsilon}} \tag{19}$$

Equation (19) shows that the number of Mexican firms exporting to the US in a given industry is increasing in the share of US expenditure in Mexican imports η, the share of expenditure in its particular sector α_s and total US expenditure/income E. The equilibrium number of firms is decreasing in the elasticity of substitution σ, as firm profits are decreasing in it, in wage w, as fixed costs are expressed in labor units, in fixed costs of using NAFTA and sourcing ζ and f, and in the industry-level ideal price index $P_{si}^{1-\epsilon}$ as $\epsilon > 1$.

4.4 Input Purchases from Foreign Countries

Our model generates predictions for Mexico's purchases of intermediate inputs from foreign countries. It can be shown that for a firm with productivity ϕ, its purchases of inputs from country j can be expressed as a share of its operating profits:[12]

$$M_{si}^{j}(\phi) = (\sigma - 1) x_{si}^{j}(\phi, \kappa^*, \lambda, J^*) \pi_{si}^{o}(\phi, \kappa^*, \lambda, \tau) \tag{20}$$

where $x_{si}^{j}(\phi, \kappa^*, \lambda, J^*)$ is the share of inputs purchased from country $j \in J^*$, under optimal choices for κ^* and J^*. As Section 4.2 details, the expression for these shares is different between NAFTA and non-NAFTA countries because of the distortionary effects of RoO. Input purchases from non-NAFTA country $j \in J^* \setminus N$ are given by:

$$\begin{aligned} M_{si}^{j}(\phi) = {} & (\sigma - 1)\phi^{\sigma-1}\gamma^{(\sigma-1)/\theta}(1 + (1-\kappa^*)\tau)^{-\sigma} B_{si}(1 - \kappa^*\lambda)\Phi_{si}(\kappa^*)^{-1} T_{si}^{j}(d^j w_{si}^{j})^{-\theta} \\ & \times \Big(\kappa^*\lambda \Psi_{si}(\kappa^*)^{(\rho-1)/\theta} + (1-\kappa^*\lambda)\Phi_{si}(\kappa^*)^{(\rho-1)/\theta} \Big)^{\frac{1-\sigma}{1-\rho}} \end{aligned} \tag{21}$$

while input purchases from NAFTA country $j \in J^* \cap N$ follow:

$$\begin{aligned} M_{si}^{j}(\phi) = {} & (\sigma - 1)\phi^{\sigma-1}\gamma^{(\sigma-1)/\theta}(1 + (1-\kappa)\tau)^{-\sigma} B_{si} \Big[\kappa^*\lambda\Psi_{si}(\kappa^*)^{-1} + (1-\kappa^*\lambda)\Phi_{si}(\kappa^*)^{-1} \Big] T_{si}^{j}(d^j w_{si}^{j})^{-\theta} \\ & \times \Big(\kappa^*\lambda\Psi_{i}^{*}(\kappa)^{(\rho-1)/\theta} + (1-\kappa^*\lambda)\Phi_{i}^{*}(\kappa)^{(\rho-1)/\theta} \Big)^{\frac{1-\sigma}{1-\rho}} \end{aligned} \tag{22}$$

[12]We include this derivation in Appendix E.

and $M_{si}^j(\phi) = 0 \ \forall j \notin J^*$. The model's predictions for a sector's input purchases from country j are:

$$M_s^j = \sum_{i=1}^{I_s} \left[N_{si} \int_{\tilde{\phi}_{si}}^{\infty} M_{si}^j(\phi) dG(\phi) \right] \tag{23}$$

We are not able to analytically characterize Equation (23) as it is a highly non-linear object. A firm's input purchases from a country depend not only on its sourcing potential, but also on the sourcing potential of the other countries in the firm's sourcing strategy, which in turn is endogenous to the firm's productivity and the RoO and MFN tariff it faces, affecting whether the firm uses NAFTA or WTO membership to export. In practice, we simulate sectors' input purchases by first computing these at the firm level, following Equation (20), and then adding across our simulated firms within a sector.

Equations (22) and (23) hint at the potentially detrimental effects of a higher λ. An increase in RoO will not necessarily result in higher input purchases from a NAFTA country, as firms could optimally choose to use WTO instead. Moreover, even if a firm chooses to comply with these higher RoO and thus the share of inputs it sources from NAFTA countries increases, the induced increase in marginal costs could offset the increase in input shares and lead to an overall decrease in its imports of intermediates from a given NAFTA country.

4.5 Impact on the Use of NAFTA

This section discusses how, according to our model, the use of NAFTA is affected by RoO, MFN tariffs, sourcing potentials, fixed costs, and comparative advantage across countries. In the absence of fixed costs of using NAFTA and sourcing from foreign countries, a firm would choose to export using NAFTA if:

$$(1+\tau)\Phi^{-\frac{1}{\theta}} > \left[\lambda \Psi^{\frac{\rho-1}{\theta}} + (1-\lambda)\Phi^{\frac{\rho-1}{\theta}} \right]^{\frac{1}{1-\rho}}$$

which intuitively states that a firm will export using NAFTA if the benefit of doing so, not paying the MFN tariff, is larger than its cost, the increase in marginal cost because of RoO. Note that if there are no fixed costs, then Ψ and Φ are constant, as firms will always include all countries in their sourcing strategy. It proves convenient to re-write the above as:

$$LHS \equiv \frac{1-(1+\tau)^{1-\rho}}{\lambda} > 1 - \left(\frac{\Psi}{\Phi} \right)^{\frac{\rho-1}{\theta}} \equiv RHS \tag{24}$$

Proposition 1. *The use of NAFTA is decreasing in RoO.*

The derivative of the RHS w.r.t. λ is 0 while that of the LHS is negative:

$$-\frac{[1-(1+\tau)^{1-\rho}]}{\lambda^2} < 0$$

making Inequality (24) less likely to hold. An increase in RoO increases the price a firm has to pay for inputs restricted to be sourced within NAFTA countries. This would not be true in the unlikely case that non-NAFTA countries have zero sourcing potential for a given industry.

Proposition 2. *The use of NAFTA is increasing in MFN tariffs.*

The derivative of the RHS w.r.t. τ is 0, while that of the LHS is positive:

$$\frac{\rho-1}{\lambda}(1+\tau)^{-\rho} > 0$$

making Inequality (24) more likely to hold. Not paying MFN tariffs is the benefit of using NAFTA, therefore, an increase in these increases the incentives of using it.

Proposition 3. *The use of NAFTA is increasing in the sourcing potential of a NAFTA country.*

The sourcing potential of a country is $T^j_{si}(d^j w^j_{si})^{-\theta}$, therefore, for NAFTA country $j \in N \cap J$:

$$\frac{\partial\Psi}{\partial T^j_{si}(d^j w^j_{si})^{-\theta}} = \frac{\partial\Phi}{\partial T^j_{si}(d^j w^j_{si})^{-\theta}} = 1$$

and thus the derivative of the LHS is 0, while that of the RHS is negative given $\Phi > \Psi$:

$$\frac{1-\rho}{\theta}\left(\frac{\Psi}{\Phi}\right)^{\frac{\rho-1}{\theta}-1}\left[\frac{\Phi-\Psi}{\Phi^2}\right] < 0$$

making Inequality (24) more likely to hold. This is because the higher the sourcing potential of NAFTA countries relative to that of non-NAFTA countries, the lower the opportunity cost of complying with RoO. For example, if Mexico is the best place for a firm to source its inputs from, then RoO do not increase the firm's marginal cost because regardless it would have been sourcing from Mexico.

Proposition 4. *The use of NAFTA is decreasing in the sourcing potential of non-NAFTA countries.*

For non-NAFTA country $j \in J \setminus N$:

$$\frac{\partial\Psi}{\partial T^j_{si}(d^j w^j_{si})^{-\theta}} = 0$$

and thus the derivative of the LHS is 0, while that of the RHS is positive:

$$\frac{1-\rho}{\theta}\Big(\frac{\Psi}{\Phi}\Big)^{\frac{\rho-1}{\theta}-1}\Big[-\frac{\Psi}{\Phi^2}\Big]>0$$

making Inequality (24) less likely to hold. An increase in the sourcing potential of non-NAFTA countries increases the opportunity cost of RoO. For example, if China is the best place for a firm to source its inputs from, it is very costly to force the firm to source part of its inputs from NAFTA countries.

Propositions 3 and 4 are only neccessarily true if there are no fixed costs, as these make the model difficult to analyze. For example, if Mexico's sourcing potential increases, according to Proposition 3 the use of NAFTA should increase. However, the decrease in marginal cost could give a firm enough revenue so that it can now pay the fixed cost of sourcing from a non-NAFTA country, thereby decreasing the incentives of using NAFTA to export.

Proposition 5. *The use of NAFTA is decreasing in the fixed cost of using NAFTA to export, and increasing in the fixed cost of sourcing from a foreign country.*

The latter follows because if a firm is unable to source its inputs from a foreign country, RoO will not affect its sourcing strategy. For example, if a firm cannot source its inputs from China, it does not matter if RoO prohibit sourcing from that country.

Proposition 6. *The stronger comparative advantage is across countries, the larger the effects RoO have on the use of NAFTA.*

Parameter θ is the shape parameter of the Fréchet distribution for a country's unit labor costs, where lower values of θ imply higher variability in these, and thus stronger comparative advantage across countries. Equation (14) shows that lower values of θ will magnify any difference between firms' NAFTA and total sourcing capabilities, increasing the opportunity cost of complying with RoO. Intuitively, parameter θ acts as an elasticity of substitution across sourcing countries: Lower values of it makes countries more complementary to each other, and thus, increase the cost of being restricted in terms of input sourcing.

5 Taking the Model to the Data

This section describes the estimation of our model, which is split in three distinct steps. First, we take several parameters from the literature, decreasing the computational burden of the estimation. Second, we estimate countries' sourcing potentials at the industry level, i.e. how attractive it is for an industry to source its inputs from a given country. For this, we use data on firm-level input shares and regress these against industry-country fixed effects. Third, we use Simulated Method of Moments with a Simulated Annealing algorithm to find the fixed costs and US market demand that best match a set of simulated moments with their data counterparts, following Eaton et al. (2011).

We map industries in the model to the HS 2-digit codes in our data, which we aggregate into 6 sectors: Agriculture and Foods, Minerals and Chemicals, Skins and Textiles, Mining, Manufacturing, and Others.[13] Within a sector, industries are heterogeneous in terms of their RoO strictness, MFN tariffs, number of firms, and sourcing potentials. We take all of these directly from the data, except for sourcing potentials which we estimate in 5.2.

For ease of computation, we group the countries/regions from which firms can source their inputs as follows: Mexico, US and Canada, China, Europe,[14] and Rest of the World. We do this to make our SMM estimation computationally feasible, as the set of different sourcing strategies increases exponentially with the number of countries a firm can source from. Unlike Antras et al. (2017), profits in our model are not necessarily supermodular in productivity, and thus, do not satisfy having increasing differences in a firm's sourcing strategy. This results from the non-linearities introduced by the choice of using NAFTA and RoO. As such, we are unable to reduce the dimensionality of the firm's problem as in Jia (2008) and have to compute firm profits for each possible sourcing strategy. Details for this are in Appendix F.

5.1 Parametrization

We take several parameters from the literature, detailed in Table 1. These are the elasticity of substitution across final goods σ, the elasticity of substitution across industries ϵ, the shape parameter of the Frechét distribution for unit-labor costs θ, as well as the shape parameter χ of the Pareto distribution for firm productivity. We set parameter $\rho = 1.05$, the substitution parameter across intermediate inputs, so inputs are complementary to each other in production. The implied elasticity of substitution is given by $1/\rho$.

5.2 Estimation of Sourcing Potentials

Estimation of how attractive countries are to source inputs from follows Antras et al. (2017). In Section 4.2, we show that the share of inputs a firm sources from country j when it either

[13]Agriculture and Foods: HS Sections I-IV; Minerals and Chemicals: HS Sections V-VII; Skins and Textiles: HS Sections VIII-XII; Mining: HS Sections XIII-XV; Manufacturing: HS Sections XVI-XVIII; Others: HS Sections XIX-XXII.

[14]This group includes the ten largest exporters of intermediate inputs to Mexico from this continent: DEU, GBR, FRA, ITA, RUS, ESP, NLD, TUR, SWE, and POL.

Parameter	Value	Source
σ	3.85	Antras et al. (2017)
ϵ	3.00	Broda and Weinstein (2006)
θ	1.79	Antras et al. (2017)
χ	4.25	Melitz and Redding (2015)

Table 1: Parameters from the literature.

uses WTO or faces no RoO is given by:

$$x_{si}^{j}(\phi) = \frac{T_{si}^{j}(d_{si}^{j}w_{si}^{j})^{-\theta}}{\sum\limits_{h \in J} T_{si}^{h}(d_{si}^{h}w_{si}^{h})^{-\theta}}$$

Normalizing Mexico's sourcing potential to one, i.e. $T_{si}^{MEX}(d_{si}^{MEX}w_{si}^{MEX})^{-\theta} = 1$, and taking the ratio between the sourcing potential of country j and that of Mexico results in:

$$\frac{x_{si}^{j}(\phi)}{x_{si}^{MEX}(\phi)} = T_{si}^{j}(d_{si}^{j}w_{si}^{j})^{-\theta} \tag{25}$$

Taking logs from both sides and assuming an idiosyncratic measurement error ϵ_{si}^{j} yields:

$$lnx_{si}^{j}(\phi) - lnx_{si}^{MEX}(\phi) = lnT_{si}^{j}(d_{si}^{j}w_{si}^{j})^{-\theta} + \epsilon_{si}^{j}(\phi)$$

We regress using OLS the left-hand side, which is data on firm-level input shares, against the right-hand side, using industry-country fixed effects. In this estimation, we restrict our sample to firms either using WTO or facing no RoO, as for these firms the ratio of input shares depends only on country j's sourcing potential, as shown in Equation (25).

We need to infer input shares as we do not observe the inputs Mexican firms source domestically, only those purchased abroad. We do this in the following way. First, we use the DRC Tables for the input composition of every final product in our sample. Second, we place the key assumption that: (i) Any input that was not imported was sourced from Mexico, and (ii) Any input we observe was purchased from a foreign country, was not sourced from Mexico at all. For example, if a product is made of 60% of input A and 40% of input B, and we observe that a firm exporting this product is importing input B from China, then the share of inputs coming from China is 40% while that of Mexico is 60%. The rest of the countries have an input share of 0% as we do not observe any imports coming from them. As long as the measurement error in this calculation is idiosyncratic across firms and industries, this procedure should give us an unbiased estimation for how attractive it is to source inputs from each foreign country.

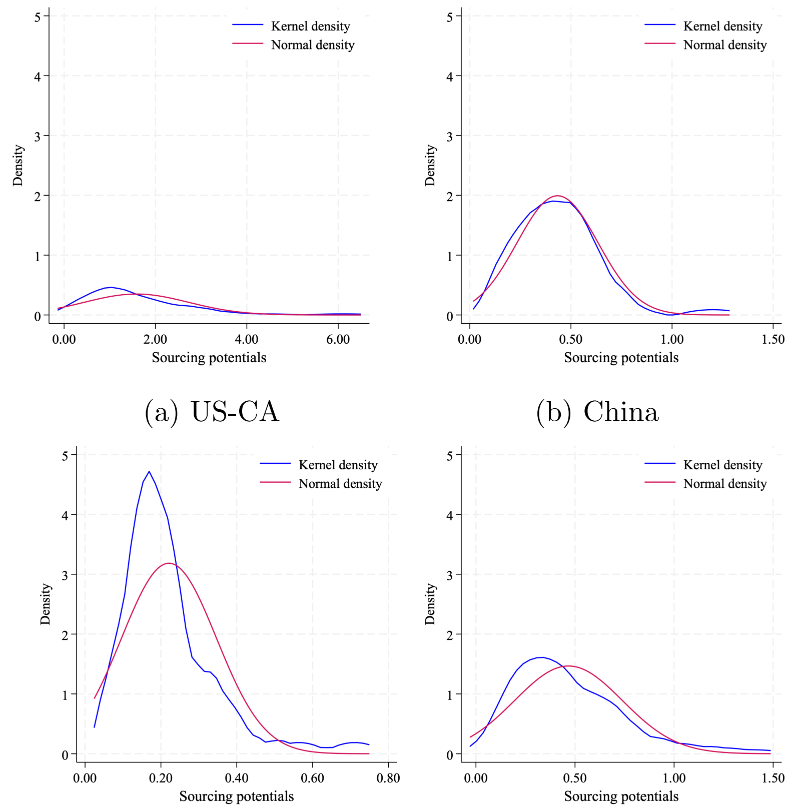
The estimation above captures how good a country is at supplying inputs of a given exporting industry i.e. how good is China at supplying electrical components. To better capture the overall benefit of sourcing from a foreign country, we need sourcing potentials to be defined at the importing industry level i.e. how attractive it is to the automotive industry in Mexico to source inputs from China. To compute this, we again use the input composition of each final product. For example, if we estimate that China has a sourcing potential of 0.4 in supplying *Input A* and 0.6 in supplying *Input B*, and we know that an industry in Mexico uses 50% of *Input A* and 50% of *Input B*, the sourcing potential of China specific to this industry in Mexico will be a weighted average equal to 0.5.

Figure 6 shows the estimates for the industry-specific sourcing potentials by country. Averaging across industries, the sourcing potentials of US-CA, China, Europe, and Rest of the World are 1.58, 0.43, 0.22, and 0.47, respectively. This implies that, on average, the total sourcing capability of a firm importing inputs from all countries is 270% higher than that of a firm only sourcing inputs from Mexico.[15] In comparison, Antras et al. (2017) estimate the total sourcing capability of a firm sourcing from all countries to only be 19% higher. The difference in our estimates can be attributed to two factors. First, their estimates are for US firms, and it is likely that the US is better than Mexico at supplying inputs to its domestic firms, i.e. estimates are relative to the sourcing potential of the home country. Second, in their paper, higher sourcing capability directly results in lower marginal cost. In our work, RoO restrict the share of inputs sourced from non-NAFTA countries, and thus our higher estimates do not imply higher marginal cost savings, i.e. China being a great supplier of a firm's inputs does not lower marginal cost by much when the firm can only source a share of its inputs from it.

To illustrate these results, the Mexican industry with the lowest potential sourcing capability is *Wood and articles of wood; wood charcoal* (HS Chapter 44), with an 65% higher total sourcing capability compared to a firm only sourcing from Mexico. The industry with the highest one is *Articles of iron or steel* (HS Chapter 73) with an 830% higher total sourcing capability. The full results for every industry-country pair are presented in Appendix G.

Sourcing potentials represent the incentives firms have for paying the fixed cost of sourcing from a given country. Therefore, in industries in which the attractiveness of sourcing from non-NAFTA countries is higher: (i) The use of NAFTA should be lower, because of a higher

[15]By construction, a firm only sourcing inputs from Mexico has a total sourcing capability equal to 1.



(a) US-CA (b) China

(c) Europe (d) Rest of the World

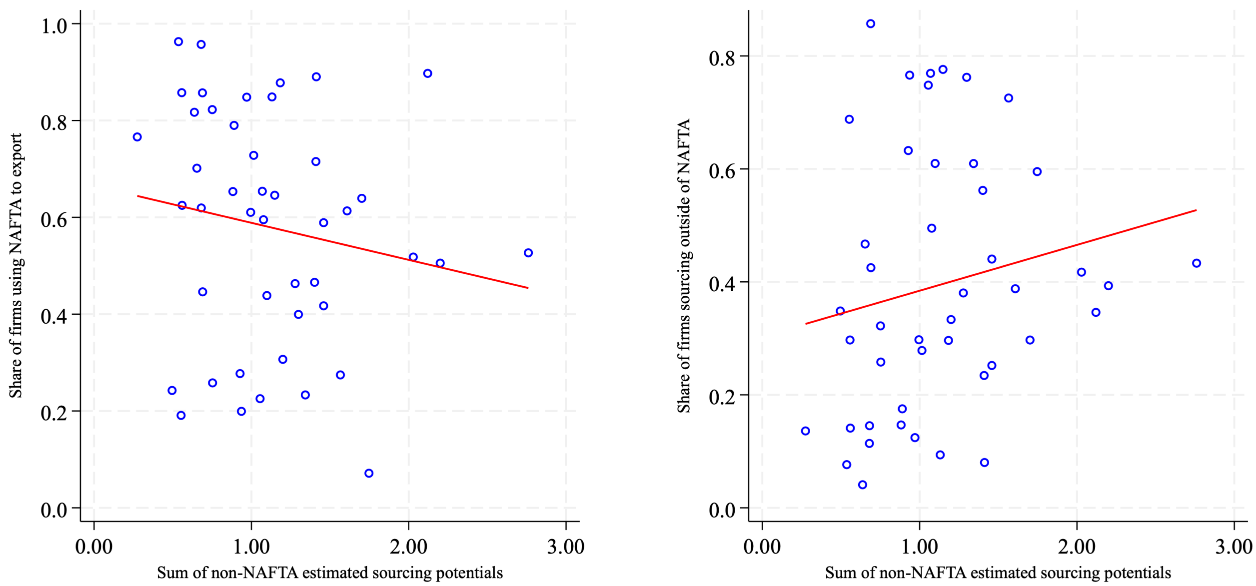
Figure 6: Kernel Densities for Estimated Sourcing Potentials.

opportunity cost of RoO, and (ii) The share of firms sourcing from these countries should be higher, as firms find it profitable to pay their fixed costs. Results support this intuition, as Figure 9 shows there is a negative industry-level correlation between our estimated sourcing potentials and the share of firms using NAFTA to export, and a positive one between these sourcing potentials and the share of firms sourcing from non-NAFTA countries.

5.3 Estimation of Fixed Costs and US Market Demand

We structurally estimate the fixed cost of using NAFTA, fixed costs of sourcing from each foreign country, and US market demand. For computational simplicity, we assume these parameters are sector-specific instead of being defined at the industry-sector level. As in Section 4.2, the fixed cost of using NAFTA is constant across firms within a sector, and fixed costs of sourcing from foreign countries are assumed to follow:

$$f_s^j(\phi) \sim \text{Log-normal}(\mu_s^j, \delta_s^j) \tag{26}$$



(a) NAFTA Usage (b) Non-NAFTA Sourcing

Figure 7: Correlations with estimated non-NAFTA sourcing potentials.

The location parameter $\mu_s^j \in (-\infty, +\infty)$ is allowed to be country-sector specific to capture any differences across countries because of proximity, common language, etc., as well as differences across sectors, e.g. how easy is it for firms to find suppliers abroad, the degree of input customization, etc. We assume $\delta_s^j = \sqrt{\log 2}$ as μ_s^j already influences both the mean and the variance of these fixed costs. Since firms, according to our computation in Section 5.2, always source inputs from Mexico, we set its fixed cost of sourcing to zero. For every sector s, we separately estimate the following set of parameters:

$$\xi_s = [\zeta_s, \mu_s^{US-CA}, \mu_s^{CHN}, \mu_s^{EUR}, \mu_s^{ROW}, B_s]$$

Estimation follows Eaton et al. (2011) in using Simulated Method of Moments together with a Simulated Annealing solution algorithm, which optimally combines random exploration of the parameter space with searching for the parameters that decrease our objective function.[16] Let x_s represent data for a sector and ξ_s a set of sector-specific parameters. Our estimation consists in finding the parameters that minimize the following objective function:

$$\min_{\xi_s} ||e(\tilde{x}_s, x_s|\xi_s)||$$

The moment error function $e(\tilde{x}_s, x_s|\xi_s)$ is expressed as the percent difference between the

[16]The algorithm uses a *temperature* which influences the acceptance rate of points that do not reduce the objective function, adapting the Metropolis-Hastings algorithm described in Metropolis et al. (1953).

vectors of simulated and data moments:

$$e(\tilde{x_s}, x_s|\xi_s) = \frac{\hat{m}(\tilde{x_s}|\xi_s) - m(x_s)}{m(x_s)}$$

where $m(\cdot)$ represents a set of R distinct moments, and $\tilde{x}_s$ is simulated data from our model under parametrization ξ_s. We use the L^2 distance norm, and therefore, our implementation of SMM consists in finding the set of parameters that minimizes the sum of squared errors:

$$\hat{\xi}_s = \arg\max_{\xi_s} e(\tilde{x_s}, x_s|\xi_s)^T I_R e(\tilde{x_s}, x_s|\xi_s)$$

with I_R being an $R \times R$ identity matrix. We define our objective function in percentage deviations so that all moments in $m(\cdot)$ are expressed in the same units and no moment receives an unintended larger weight. Informed by the empirical facts described in Section 3, the set of sector-specific moments we include to identify the true parameter vector ξ_s are:

1. Share of firms using NAFTA to export: This moment helps us pin down the fixed cost of using NAFTA to export ζ_s, as variation in this parameter will directly affect how many firms can pay the fixed cost of using NAFTA.

2. Share of firms sourcing from each country: Conditional on sourcing potentials, the costlier it is to source from a foreign country, the lower the share of firms sourcing inputs from it. We use this extensive margin of sourcing to pin down the location parameter of the distribution of fixed costs of sourcing from every country.

3. Average firm exports: To identify market demand in the US, we use average exports across all firms of a given sector.[17] In our model, average productivity and market demand are isomorphic in terms of revenue, and since we assume the same distribution of productivity across all sectors, there is a one-to-one relationship between US market demand and firm-level exports.

Our previous discussion on the relationship between the use of NAFTA and firm size being driven by fixed costs motivates us to include additional moments in our estimation. On the one hand, fixed costs of using NAFTA should be large enough to result in small firms using NAFTA less intensively. On the other, fixed costs of sourcing should be large enough to deter medium-sized firms from sourcing intensively from non-NAFTA countries, thereby increasing their use of NAFTA. These additional moments are:

[17] We use a weighted average, with weights based on industries' contribution to the total trade value of a given sector.

4. Share of firms using NAFTA to export, by quintile of firm size
5. Share of firms sourcing inputs outside of NAFTA, by quintile of firm size

Our simulation of the model for a particular guess of ξ_s is as follows: (i) For each industry i within sector s, we take N_{si} random draws for productivity from a Pareto distribution with shape parameter χ. We take the number of firms exporting to the US of a given industry N_{si} directly from the data. (ii) For each sector s we take $N_s = \sum_{i=1}^{I_s} N_{si}$ random draws for the fixed costs of sourcing from each country, following Equation (26), where I_s is the number of industries within sector s. Within a sector, industries are heterogeneous in terms of their RoO, MFN tariffs, and sourcing potentials. Within an industry, firms are heterogeneous in terms of their productivity. (iii) By backwards induction and fixing either the use of NAFTA or WTO, for every firm we find the set of sourcing countries that maximizes their profits subject to paying fixed costs of sourcing, following Equation (16). (iv) Having found firms' optimal sourcing strategy under NAFTA and WTO, we compare profits under these two and assign firms to the option that yields the largest profits, as described in Equation (17). Having fully simulated firms' choices for the use of NAFTA and global sourcing strategies, we use Equations (11), (12), (13), (14), and (20), to compute predictions for input shares, prices, firm exports and profits, and imports of intermediates.

We present the results of this estimation in Table 2. These are not the point estimates resulting from our application of SMM, but rather transformations of them so results are easier to interpret. For the fixed cost of using NAFTA ζ and fixed costs of sourcing f, we show estimates of the average fixed cost as a share of total exports X, e.g. on average for a firm in the *Agriculture and Foods* sector, being able to source inputs from China represents 20.15% of its revenue in the US. For the estimates for US market demand B, we normalize that for *Manufacturing* to be equal to 100, and thus, market demand for the rest of the sectors is relative to it. The estimated parameters are shown in Appendix H.

Our results suggest the following. First, there is heterogeneity across sectors in the fixed cost of using NAFTA. This should be driven by sectoral differences in factors such as regulation or learning to use the FTA to export. As mentioned before, when firms export using NAFTA, they have to present a *Certificate of Origin* at the border, detailing the country of origin of all their intermediate inputs. Sectors with more complex products or more complex supply chains, such as the case of *Manufacturing*, should find it costlier to keep track of the sourcing of their inputs. Differences in the cost of complying with regulations should also drive this heterogeneity. For example, sectors with higher capital intensity, such as *Mining*, should find it less costly to comply with the labor regulations in NAFTA.

Second, there is also heterogeneity in fixed costs of sourcing, both across countries and

	ζ_s/X	f_s^{CHN}/X	f_s^{EUR}/X	f_s^{US-CA}/X	f_s^{ROW}/X	B_s
Agriculture and Foods	0.54	20.15	16.66	26.51	16.04	0.45
Minerals and Chemicals	0.43	5.15	2.81	12.88	4.26	0.60
Skins and Textiles	0.62	3.40	3.07	8.48	4.52	0.47
Mining	0.04	5.28	3.20	31.96	8.71	0.01
Manufacturing	1.08	1.75	0.71	6.28	1.55	100.00
Others	1.50	2.78	2.06	16.8	4.15	0.13
Average	0.70	6.42	4.75	17.15	6.54	16.94

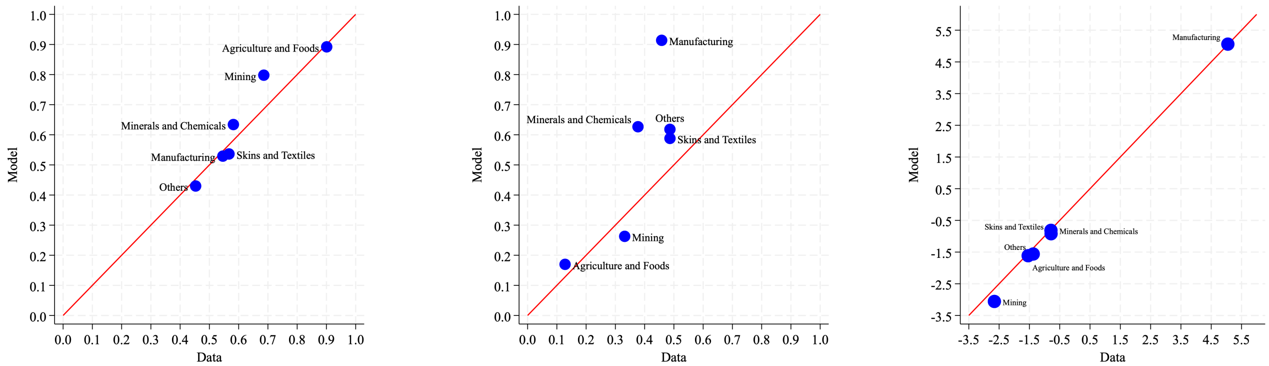
Table 2: Estimates for Fixed Costs and US Market Demand.

sectors. Heterogeneity across countries should reflect differences in factors such as language, cultural proximity, or the strength of business relationships between Mexico and foreign countries. Heterogeneity across sectors for a given country could reflect differences in the easiness with which Mexican exporters can find suppliers in foreign countries, or the degree of input customization needed for a sector's inputs. For example, foreign suppliers of inputs required by the *Manufacturing* and *Skins and Textiles* sectors in Mexico could be more connected to the global economy. Differences in fixed costs across sectors are important as it implies RoO have heterogeneous effects. For example, if in one sector not many firms can pay the fixed cost of using NAFTA to export, RoO will not have much of an effect on it. On the contrary, if a sector has low fixed costs of sourcing from foreign countries, RoO will be very costly as firms could be sourcing from efficient suppliers from around the World.

Lastly, US market demand for *Manufactures* is estimated to be much larger compared to other sectors. This is consistent with the fact that in our sample, on average, 77% of export value from Mexico to the US corresponds to this sector. However, this is likely to be partly driven by our assumption of all sectors having the same average productivity.

5.4 Fit of the Model

This section evaluates the model's fit at the sectoral and aggregate levels. At the sectoral level, Figure 8 shows the predictions of the model for: (a) The share of firms using NAFTA to export, (b) The share of firms sourcing inputs outside of NAFTA, (c) Average of log firm exports. In these figures, the x-axis shows the data moment, and the y-axis the simulated one. Therefore, the closer to the 45-degree line, the better the fit for that particular sector. Across all sectors, the model is able to fit these moments, and thus capture firm behavior regarding the use of NAFTA to export and how firms choose their sourcing strategies in response to RoO.



(a) NAFTA Usage (b) Non-NAFTA Sourcing (c) Average Log Exports

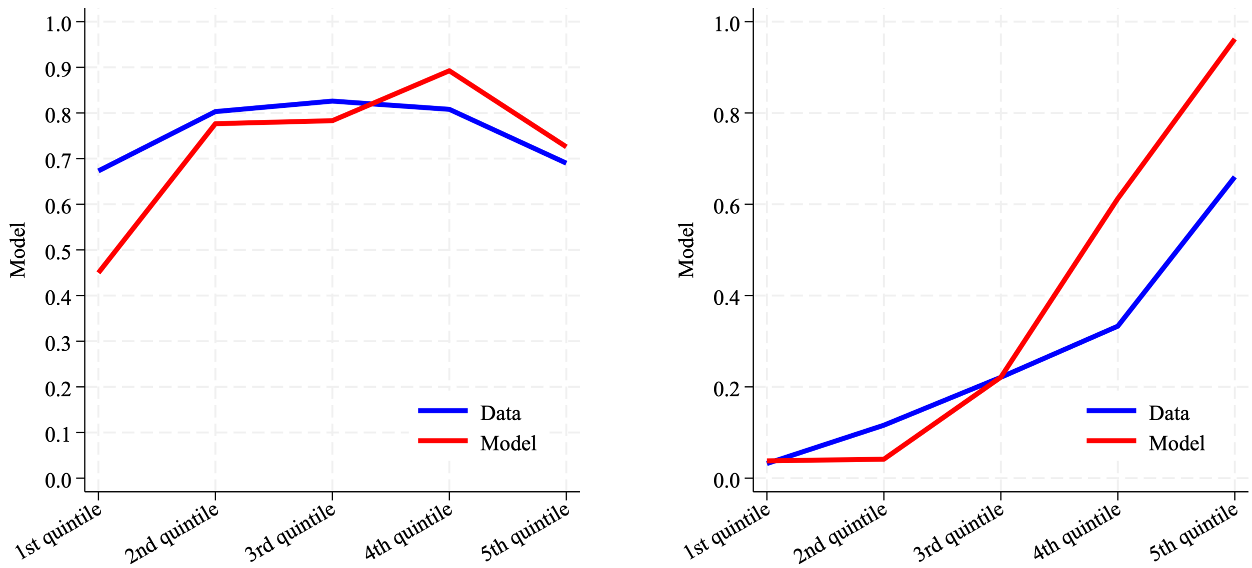
Figure 8: Sectoral fit of the model.

For the fit at the aggregate level we present Figure 9, where we ignore sectors and instead compute size quintiles according to export revenue, consistent with our empirical facts presented in Section 3. Panel 9a shows the model's replication of the inverse U-shape relationship between the use of NAFTA and firm size. Consistent with Empirical Fact 2, our model predicts that small and large firms will use NAFTA to export less intensively compared to medium-sized firms. This is the result of the fixed cost of using NAFTA being too expensive for small firms, and the fixed costs of sourcing resulting in the opportunity cost of complying with RoO being increasing in firm size.

Regarding the share of firms sourcing inputs outside of NAFTA, Panel 9b shows we replicate its increasing relationship with firm size at the aggregate level. This relationship is driven by firm size, as larger firms are more likely to be able to pay the fixed cost of sourcing from foreign countries, and by the use of NAFTA, as it decreases the incentives firms have for sourcing from non-NAFTA countries. As in the data, the model predicts that even though the largest firms use NAFTA less intensively than medium-sized firms, almost all of the largest firms source inputs from non-NAFTA countries. This should be the result of large firms finding it profitable to pay these costs, even if restricted by RoO, because of their large export and import volume. Other results for the fit of the model, both at the sectoral and aggregate levels, are presented in Appendix I.

6 Effects of Trade Policies

This section describes the counterfactuals we explore in our paper. Given the richness of our product-level data and our model capturing diverse aspects of trade policy, such as RoO



(a) NAFTA Usage

(b) Non-NAFTA Sourcing

Figure 9: Aggregate fit of the model.

and tariffs, we can conduct a wide range of policy-relevant counterfactual simulations.

The counterfactuals we study are: (i) The transition from NAFTA to USMCA, (ii) An increase in tariffs on Mexican imports, and (iii) NAFTA without RoO. Our counterfactuals study how the US and Mexico are affected from the policy change, focusing our attention on the effects over US exports of intermediates, US price index for Mexican imports, and Mexican firm profits; as these are the key variables policymakers care about the most. We emphasize the heterogeneity in responses to these policy changes across different firm sizes, highlighting the primary mechanism discussed in our paper: Firm size determines the opportunity cost of complying with RoO, thus affecting firms' use of NAFTA.

In these counterfactuals we are silent on other margins of adjustment not captured by our model. For example, we implicitly assume countries' sourcing potentials are not endogenous to policy changes. This idea is presented in Ornelas and Turner (2023) which studies how RoO can result in higher investment whenever an industry has high productivity, which could indeed be what policymakers have in mind when they implement RoO to protect domestic industries from foreign competition.

6.1 Transition to USMCA

In July 2020, NAFTA, which had been in place since 1994, was replaced by USMCA. This revised FTA brought changes both in terms of regulation and in terms of a general increase

	US-CA Exports of inputs to Mexico	US-CA Price index for Mexican imports	Mexican firm profits
Agriculture and Foods	-0.42	0.27	-0.85
Minerals and Chemicals	-0.08	0.05	-0.24
Skins and Textiles	-2.93	0.24	-1.45
Mining	-0.03	0.06	-0.08
Manufacturing	-0.05	0.05	-0.08
Others	-0.80	0.32	-1.29
Average	-0.72	0.16	-0.67

Table 3: Percent change in key variables due to an increase in RoO.

in RoO. We consider the latter in this counterfactual, in which we ask if the US and Mexico benefit from an increase in RoO. We assume the same increase in RoO across all industries. There are two reasons for this. First, assuming a common increase across all industries allows us to study how sectoral heterogeneity leads to different outcomes because of sectoral differences in firm size, sourcing potentials, and fixed costs. Second, while it is feasible to code the change in the RoO strictness for all HS 6-digit products, as USMCA's RoO are detailed in the documentation for the treaty, it is out of the scope of this paper to do so.

We assume a general increase of 25% in the strictness of RoO on all products. For example, if a particular product had a RoO strictness of 10% under NAFTA, under USMCA we will assume it has a 12.5% RoO strictness. This increase of 25% is in line with the increase in RoO for the automotive industry, studied in Head et al. (2022). They find that the increase in RoO decreased the share of regional content in the automotive sector, as the new rule fell to the right side of the Laffer Curve.

Table 3 shows the results for our variables of interest in terms of their percentage change. Averaging across sectors, US exports of intermediates would decrease on average by 0.72%, while US prices for Mexican imports would increase on average by 0.16%. For Mexico, firm profits would be 0.67% lower. These results suggest that neither the US nor Mexico benefited from the increase in RoO that the transition to USMCA implied.

To study the mechanisms behind these effects, we focus on discussing the change in US exports of intermediates, as the explanation for the effects on the other key variables follows from our discussion. We identify three distinct effects: A (i) Substitution effect, a (ii) Scale effect, and a (iii) Switching effect, which can either increase or dampen the first two effects. First, when higher RoO are implemented across all sectors, firms are forced to substitute some of the inputs they were sourcing from non-NAFTA countries towards NAFTA countries if they want to keep using NAFTA. This should have been the main mechanism policymakers had in mind when implementing higher RoO in the USMCA agreement. This substitution does not necessarily imply higher US exports of intermediates, as Mexican firms could choose to start sourcing these inputs either from Mexico or Canada, still complying with RoO. The extent to which this substitution effect does imply an increase in US exports depends on whether firms can source their inputs from the US, and on the relative sourcing potential of the US to that of Mexico, e.g. Mexican sectors with the largest increases in their import from the US are those for which the US is better than Mexico at sourcing their inputs.

Second, as our model suggests, an increase in RoO should lead to an increase in firms' marginal cost, unless firms are either unable to source from non-NAFTA countries or are already sourcing all their inputs from NAFTA countries. Increases in marginal cost directly imply higher US import prices, leading to lower demand for Mexican imports, and thus, lower input purchases from all countries, including the US. This is our scale effect because of the increase in RoO; effect that is stronger in sectors with either larger firms, as these firms were able to source from cheaper non-NAFTA suppliers, or sectors for which NAFTA countries have a relatively lower sourcing potential compared to non-NAFTA countries. For this purpose, we present Tables 4 and 5. The former shows shows the distribution of firm size across sectors, while the latter shows the relative sourcing potential of US-CA to that of non-NAFTA countries.

The third mechanism proposed in these counterfactuals is a switching effect. When RoO increase, some firms might no longer find it optimal to export using NAFTA and switch to export using WTO. It is unclear whether these firms will increase or decrease their purchases of inputs from the US. On the one hand, these purchases might increase as firms can now source from the cheapest suppliers around the World, leading to lower marginal costs and higher demand. On the other, switching to WTO implies firms will source a smaller share of their inputs from the US as they do not comply with RoO, and will now have to pay MFN tariffs which increase the price of US imports.

For sectors with a higher US-CA sourcing potential, such as *Manufacturing* or *Mining*, the positive substitution effect on US exports of inputs should be higher as it is more likely that firms will source from the US when required to source from NAFTA countries. In terms of the negative scale effect, sectors in which US-CA has a relatively higher sourcing potential should experience less of a decrease in demand as for these sectors, the increase in marginal cost because of higher RoO should be lower compared to sectors for which NAFTA countries are poor suppliers of their inputs.

For sectors with larger firms, such as *Manufacturing* or *Skins and Textiles*, the positive substitution effect on US exports should be higher, as these firms can source from the US

	1st quintile	2nd quintile	3rd quintile	4th quintile	5th quintile
Agriculture and Foods	0.18	0.37	0.21	0.14	0.09
Minerals and Chemicals	0.00	0.13	0.10	0.48	0.30
Skins and Textiles	0.07	0.11	0.21	0.28	0.33
Mining	0.66	0.02	0.15	0.12	0.04
Manufacturing	0.00	0.00	0.00	0.00	1.00
Others	0.03	0.01	0.38	0.42	0.17

Table 4: Share of firms of each quintile in each sector.

	SP of US-CA to non-NAFTA	RoO Strictness	MFN Tariff
Agriculture and Foods	0.99	0.09	0.08
Minerals and Chemicals	1.39	0.02	0.04
Skins and Textiles	0.91	0.34	0.11
Mining	2.68	0.07	0.07
Manufacturing	1.96	0.01	0.03
Others	2.29	0.12	0.06

Table 5: Relative sourcing potential, RoO strictness, and MFN tariffs by sector.

when required to comply with stricter RoO. However, the negative scale effect should also be higher, as these sectors were importing more intensively from non-NAFTA countries and thus face larger increases in marginal cost when having higher RoO. Additionally, sectors with a higher share of larger firms should benefit from firms switching from NAFTA to WTO as these firms can now access non-NAFTA sourcing, leading to lower marginal cost and increased exports. Table 6 shows the responses to the increase in RoO by quintiles of firm size. Consistent with Panel 5a, medium to large firms are the ones for which the use of NAFTA decreases the most, while smaller firms experienced lessened effects. This ties back to Table 4 as sectors with larger firms should be the ones for which both the substitution and scale effects are the strongest.

For the switching effect, we present Table 7. It shows the share of firms that either keep using NAFTA or switch to WTO to export their products. On average, firms that keep using NAFTA do increase the share of their inputs coming from US-CA, implying the substitution effect is positive. However, these same firms experience an increase in marginal cost because of lower non-NAFTA sourcing, indicating a negative and detrimental scale effect. Firms that switch to WTO no longer comply with RoO, which results in higher sourcing from non-NAFTA countries. However, these firms now have to pay MFN tariffs, which ultimately

	Change						
	1st quintile	2nd quintile	3rd quintile	4th quintile	5th quintile	Aggregate	Units
Share of firms using NAFTA	-0.02	-0.21	-2.18	-4.25	-4.73	-2.28	p.p. Δ
Share of firms sourcing from China	-0.03	0.04	-0.90	-1.90	-0.65	-0.69	p.p. Δ
Share of firms sourcing from Europe	-0.01	-0.01	-0.22	-0.45	0.41	-0.06	p.p. Δ
Share of firms sourcing from US-CA	0.01	-0.04	-0.41	-0.26	-0.01	-0.14	p.p. Δ
Share of firms sourcing from ROW	-0.02	0.07	-0.91	-2.45	-0.65	-0.79	p.p. Δ
Share of inputs coming from US-CA	0.01	-0.01	-0.25	0.12	-0.12	0.02	p.p. Δ
Average Marginal Cost	0.00	0.21	1.05	1.34	2.31	0.70	% Δ
Average Exports	-0.04	-0.13	-1.20	-1.87	-0.15	-0.17	% Δ

Table 6: Responses to the increase in RoO by firm size.

results in their marginal cost increasing as well.

	NAFTA to WTO	WTO to NAFTA	Stayed WTO	Stayed NAFTA	Units
Share of firms	0.02	0.00	0.21	0.77	-
	Change				
Share of firms sourcing from China	5.11	0.00	0.00	-1.04	p.p. Δ
Share of firms sourcing from Europe	11.34	0.00	0.00	-0.41	p.p. Δ
Share of firms sourcing from US-CA	-5.22	0.00	0.00	-0.03	p.p. Δ
Share of firms sourcing from ROW	3.9	0.00	0.00	-1.14	p.p. Δ
Share of inputs coming from US-CA	-8.67	0.00	0.00	0.19	p.p. Δ
Average Marginal Cost	17.94	0.00	0.00	0.22	% Δ
Average Exports	-7.83	0.00	0.00	-0.15	% Δ

Table 7: Responses to the increase in RoO by transitions between NAFTA and WTO.

To conclude our discussion on the effects of the increase in RoO as a result of the transition from NAFTA to USMCA, across all sectors, purchases of inputs from the US would decrease, even if for some sectors the share of inputs coming from the US would indeed increase. The detrimental effects of higher prices for Mexican imports, coupled with the fact that 2.28% of firms would stop using NAFTA, dominate any potential gains from stricter RoO and thus, result in lower bilateral trade and higher prices for US consumers.

6.2 Increase in tariffs on Mexican imports

On May 30th 2019, Donald Trump published a tweet[18] announcing that the US would impose a 5% tariff on all goods coming into the country from Mexico. The objective of this measure was to exert political pressure on Mexico to address the issue of illegal immigration. On June 7th of that same year, it was announced that an agreement had been reached, with Mexico accepting to adopt stricter measures at the border. In this counterfactual, we quantify the effects this policy change would have had on the US and Mexico.

It is hard to interpret precisely what Donald Trump meant in those *tweets*, as "all Mexican imports will pay a 5% tariff" does not provide much detail on the exact implementation of the policy. For the purposes of this counterfactual, we interpret it as if all Mexican firms had to pay at least a 5% tariff. If a firm uses NAFTA to export, it will have to pay a 5% tariff. If a firm uses WTO to export, then it would have had to pay at least a 5% tariff, i.e. if in the baseline a firm had to pay a tariff lower than 5%, then we increase the tariff to 5%; whereas if a firm had to pay a higher tariff, then the counterfactual implies no change.

Table 8 details the results for the key variables policymakers should care for in terms of their percentage change given the increase in tariffs.[19] Averaging across sectors, US exports of intermediates would have decreased by 13.65%, while the US price index for Mexican imports would have increased by 4.95%. For Mexico, firm profits would have been 11.68% lower. These results suggest it would have been very costly for the US to implement this measure as Mexico is one of its main trading partners, even if it gains political leverage. From Mexico's point of view, the policy would have also been highly detrimental as exports to the US represent, on average, 80.1% of Mexico's total export value.

For discussing the mechanisms behind these results, Table 9 presents the change in key moments by quintiles of size. When exporters have to pay a tariff even if using NAFTA, the incentive for it decreases, which lowers the share of firms using NAFTA across all firm sizes. Lower NAFTA usage does not result in higher non-NAFTA sourcing, as higher tariffs decrease revenue, which lowers the ability to source from foreign countries. Therefore, marginal costs increase because of higher tariffs on all Mexican imports and less efficient sourcing. These two effects are the largest for medium-sized firms, which explains why these firms experience the largest decrease in their exports. The largest firms experience the lowest increase in their marginal costs as for them foreign sourcing decreases the least. Therefore, sectors with a higher share of smaller to medium-sized firms, as detailed in Table 4, are those for which bilateral trade decreases the most, namely *Agriculture and Foods* and *Mining*.

[18] Source: https://twitter.com/realDonaldTrump/status/1134240653926232064

[19] We do not include results for the change in US tariff revenue as we do not consider this was the motivation behind the intended policy change.

	US-CA Exports of inputs to Mexico	US-CA Price index for Mexican imports	Mexican firm profits
Agriculture and Foods	-17.04	4.86	-13.42
Minerals and Chemicals	-15.07	5.58	-13.92
Skins and Textiles	-12.04	4.16	-8.95
Mining	-13.53	5.74	-14.82
Manufacturing	-12.15	4.79	-11.25
Others	-12.05	4.57	-7.74
Average	-13.65	4.95	-11.68

Table 8: Percent change in key variables due to an increase in tariffs.

	Change						
	1st quintile	2nd quintile	3rd quintile	4th quintile	5th quintile	Aggregate	Units
Share of firms using NAFTA	-46.09	-48.65	-46.35	-54.61	-40.64	-47.27	p.p. Δ
Share of firms sourcing from China	-0.23	-0.85	-1.33	0.92	-0.68	-0.43	p.p. Δ
Share of firms sourcing from Europe	-0.07	-0.13	-1.04	-1.47	-1.74	-0.89	p.p. Δ
Share of firms sourcing from US-CA	-1.34	-1.16	-12.18	-1.98	-0.20	-3.37	p.p. Δ
Share of firms sourcing from ROW	-0.24	-1.16	-0.84	0.56	-0.80	-0.50	p.p. Δ
Share of inputs coming from US-CA	-0.88	-0.43	-5.59	-1.12	-0.69	1.39	p.p. Δ
Average Marginal Cost	6.36	6.31	8.64	6.53	4.71	6.63	% Δ
Average Exports	-15.43	-16.19	-17.59	-14.43	-12.3	-12.34	% Δ

Table 9: Responses to the increase in tariffs by firm size.

Table 10 shows the same moments but according to whether firms would keep using the same trade regime or switch to a different one as a result of the increase in tariffs. Around 47% percent of the firms would switch from NAFTA to WTO. For these firms, no longer being constrained by RoO would not translate into higher sourcing from Europe, but sourcing from China and the Rest of the World would increase. According to our estimates in Section 5.2, Europe's sourcing potential for Mexican firms is lower than that of other countries, so firms would not find it profitable to source from Europe even if no longer restricted by RoO. Moreover, as these firms would no longer use NAFTA, the share of firms sourcing from the US and Canada would have decreased by 5.15 percentage points, which, together with the increase in marginal cost, would have decreased purchases of inputs from these countries.

Firms that would keep using NAFTA to export, 32% of firms, would decrease their sourcing from all foreign countries even if not restricted by higher RoO. The fact that now

	NAFTA to WTO	WTO to NAFTA	Stayed WTO	Stayed NAFTA	Units
Share of firms	0.47	0.00	0.21	0.32	-
			Change		
Share of firms sourcing from China	0.63	0.00	-0.21	-2.14	p.p. Δ
Share of firms sourcing from Europe	-0.50	0.00	-0.11	-1.97	p.p. Δ
Share of firms sourcing from US-CA	-5.15	0.00	-0.31	-2.71	p.p. Δ
Share of firms sourcing from ROW	0.62	0.00	-0.22	-2.32	p.p. Δ
Share of inputs coming from US-CA	-3.09	0.00	-0.08	-0.83	p.p. Δ
Average Marginal Cost	10.20	0.00	0.62	6.23	% Δ
Average Exports	-13.36	0.00	-5.68	-13.95	% Δ

Table 10: Responses to the increase in tariffs by transitions between NAFTA and WTO.

they would have to pay tariffs even if using NAFTA, would decrease their revenue and therefore their ability to pay fixed costs of sourcing. Lastly, firms that would keep using WTO would exhibit the smallest changes, as some of these firms would not experience any change because of the counterfactual, i.e. firms that were already paying tariffs higher than 5%. Firms that had MFN tariffs lower than 5% also would experience an increase in marginal cost because of the higher tariffs, which would decrease their revenue, decreasing their foreign sourcing and further increasing their marginal cost. As a summary, sectors with the largest share of firms using NAFTA to export, namely *Agriculture and Foods*, *Minerals and Chemicals*, and *Mining* according to Figure 8, are those for which purchases of inputs from the US would have decreased the most, and the ones that would have experienced the largest price increases. These results highlight the significant costs policies aimed at gaining political leverage would have, to the detriment of a country's own manufacturers of intermediate goods and consumers.

6.3 NAFTA without Rules of Origin

The purpose of RoO is to protect local industries and to encourage bilateral trade among FTA member countries. While these effects can be achieved, as discussed in Ornelas and Turner (2023), sourcing potentials are likely fixed in the short run. Therefore, RoO have a detrimental effect on trade as they restrict exporters from being able to take advantage of comparative advantage across the World. This section quantifies the efficiency gains from removing RoO and allowing Mexican exporters to source their inputs freely from the best suppliers. Importantly, we do not ask what would happen today if NAFTA had not had

	US-CA Exports of inputs to Mexico	US-CA Price index for Mexican imports	Mexican firm profits
Agriculture and Foods	1.89	-1.41	4.32
Minerals and Chemicals	0.33	-0.19	0.97
Skins and Textiles	12.44	-3.50	21.34
Mining	0.10	-0.26	0.35
Manufactures	0.19	-0.14	0.34
Others	2.93	-1.36	5.82
Average	2.98	-1.15	5.52

Table 11: Percent change in key variables due to the removal of RoO.

RoO to begin with, as sourcing potentials today might be different. If RoO had never been implemented, the sourcing potential of NAFTA countries could be lower today, implying our results can be interpreted as a lower bound for the effects of NAFTA never having RoO.

For this counterfactual, we set RoO strictness to be equal to zero across all industries. However, we still assume fixed costs of using NAFTA and MFN tariffs whenever firms choose to export using WTO membership. If RoO are removed, the cost of using NAFTA to export decreases while the benefit of it, not paying MFN tariffs, remains the same. Table 11 shows the changes in the key variables policymakers in the US and Mexico likely care about.

Across all sectors, the removal of RoO would be beneficial for both countries. The US would increase its exports of intermediates, and its consumers would face lower prices for their Mexican imports. Mexican firms would see their profits increase. The US firms that would benefit the most are those supplying inputs to the *Skins and Textiles* and *Others* sectors in Mexico. US consumers of goods from these sectors would experience the largest decrease in the price of their imports, as well as the ones for which Mexican firms would experience the largest increase in profits. The sectors that would benefit the least are *Mining* and *Manufacturing*, which could be the result of: (i) Already having lower RoO, as shown in Table 5. (ii) US-CA are good suppliers of inputs for the *Mining* sector, so the removal of RoO does not matter as much because they were already sourcing from NAFTA. (iii) Firms in the *Mining* sector are smaller in size, according to Table 4, therefore they were less likely to source from non-NAFTA countries, and thus the removal of RoO would have a small effect. As in Section 6.1, we discuss the effects on US exports of intermediates in terms of three mechanisms: A substitution, an income, and a switching effect.

For the substitution effect, intuitively the removal of RoO should decrease the share of inputs being sourced from US-CA. Inspection of Table 12 reveals this is not necessarily the

	Change						
	1st quintile	2nd quintile	3rd quintile	4th quintile	5th quintile	Aggregate	Units
Share of firms using NAFTA	1.80	3.52	9.29	6.22	22.44	8.65	p.p. Δ
Share of firms sourcing from China	0.13	-0.59	7.25	16.35	4.17	5.46	p.p. Δ
Share of firms sourcing from Europe	0.02	0.21	2.78	5.61	6.66	3.06	p.p. Δ
Share of firms sourcing from US-CA	0.02	1.16	3.09	0.95	0.04	1.05	p.p. Δ
Share of firms sourcing from ROW	0.10	-0.79	8.33	16.17	3.90	5.54	p.p. Δ
Share of inputs coming from US-CA	0.01	0.55	1.31	-3.9	-2.34	-0.11	p.p. Δ
Average Marginal Cost	-0.31	-2.03	-6.85	-4.75	-8.07	-3.52	% Δ
Average Exports	1.25	4.45	14.08	16.79	0.99	1.17	% Δ

Table 12: Responses to the removal of RoO by firm size.

case, as smaller firms would actually increase the share of their inputs coming from US-CA. The removal of RoO would induce smaller firms to use NAFTA, decreasing marginal costs as they would no longer pay MFN tariffs, and in turn, increasing revenue so these firms can now pay the fixed cost of sourcing from US-CA. For larger firms, the substitution effect is indeed negative, as they would decrease the share of inputs they source from US-CA. Since larger firms are able to source from non-NAFTA countries, once RoO no longer restrict them, they increase the share of their inputs coming from these countries, as shown in Table 12. US suppliers selling to Mexican sectors in which there is a higher share of smaller firms actually experience a beneficial substitution effect, while firms selling to sectors with larger firms will see their exports of intermediates decrease.

In this counterfactual, a stronger scale effect benefits the US and Mexico. The removal of RoO implies firms can now source their inputs from the cheapest suppliers across the World, which should decrease marginal cost, increasing demand and input purchases from the US. The extent to which this is the case depends on firms' ability to source from non-NAFTA countries. Table 12 shows that larger firms are the ones that would increase their sourcing from these countries the most, thus experiencing the largest decreases in marginal cost. US firms selling to Mexican sectors with larger firms should experience the strongest scale effect, as even if the share of inputs sourced from them decreases, these sectors experience an increase in their exports and thus, increase their purchases of intermediates from the US. In summary, the beneficial scale effect should be negligible for sectors with smaller firms, but beneficial for those with larger firms.

Lastly, for discussing the switching effect we present Table 13. Firms that would benefit the most from the removal of RoO are those that switch from WTO to NAFTA, experi-

	NAFTA to WTO	WTO to NAFTA	Stayed WTO	Stayed NAFTA	Units
Share of firms	0.00	0.09	0.12	0.79	-
	Change				
Share of firms sourcing from China	0.00	6.56	0.00	6.17	p.p. Δ
Share of firms sourcing from Europe	0.00	7.33	0.00	3.05	p.p. Δ
Share of firms sourcing from US-CA	0.00	8.67	0.00	0.38	p.p. Δ
Share of firms sourcing from ROW	0.00	6.34	0.00	6.29	p.p. Δ
Share of inputs coming from US-CA	0.00	2.43	0.00	-1.37	p.p. Δ
Average Marginal Cost	0.00	-25.43	0.00	-2.10	% Δ
Average Exports	0.00	21.57	0.00	0.84	% Δ

Table 13: Responses to the removal of RoO by transitions between NAFTA and WTO.

encing on average a 21.57% increase in their exports. Their marginal cost would decrease significantly as they would no longer pay MFN tariffs, and their increased revenue would now allow them to source from foreign countries. Firms that would keep using NAFTA do increase their exports but to a lower extent, as the removal of RoO would allow them to source a larger share of inputs from non-NAFTA countries, decreasing their marginal cost by 2.10%. US firms selling to Mexican sectors in which firms use NAFTA less intensively, and US consumers purchasing goods from them, would be the ones that benefit the most. Likewise, sectors benefiting the most would be those for which non-NAFTA countries are relatively better suppliers of their inputs, as it is the case of the *Skins and Texiles* sector according to Table 5.

This counterfactual suggests that removing RoO would benefit the US and Mexico across all sectors. The degree to which a sector benefits depends on the size of its firms, the relative sourcing potential of NAFTA countries, and how strict were RoO. For sectors with larger firms, the removal does imply a lower share of intermediates being sourced from the US. However, the effect of lower marginal costs achieved by firms being able to source from cheaper suppliers would be larger, and thus, US exports of intermediates would increase. Sectors in which firms are smaller would also benefit, as removing RoO would still lead to an increase in the share of firms using NAFTA, decreasing their marginal cost as these firms would no longer pay MFN tariffs.

7 Conclusions and Policy Implications

The main message of this paper is that firm size matters for the effect RoO have on the use of NAFTA. This is rationalized by the fact that Mexican exporters face: (i) Fixed costs of using NAFTA, and (ii) Fixed costs of sourcing from foreign countries. The former implies small firms are less able to pay the fixed cost of using NAFTA, while the latter implies large firms are more able to source from foreign countries, making the opportunity cost of complying with RoO increasing in firm size.

Restrictive trade policies have detrimental effects on the US and Mexico, with sectoral heterogeneity in these responses being the result of: (i) The distribution of firm size, and (ii) How good suppliers of inputs NAFTA countries are relative to non-NAFTA ones. On average, across sectors, we quantify that a 25% increase in the strictness of RoO would lead to 0.72% lower US exports of intermediates to Mexico, 0.16% higher US prices for Mexican imports, and 0.67% lower Mexican firm profits. Imposing an ad-valorem tariff of at least 5% on all Mexican imports would decrease US exports by 13.65%, increase US prices by 4.95%, and decrease Mexican firm profits by 11.68%. On the contrary, efficiency gains from removing RoO would imply 2.98% higher US exports of intermediates to Mexico, 1.15% lower US prices for Mexican imports, and 5.52% higher Mexican firm profits.

Our paper has two policy implications. First, it is costly to protect local industries from foreign competition, as RoO result in lower sourcing efficiency precisely in sectors in which NAFTA countries have a comparative disadvantage. Moreover, RoO should be especially costly for developing countries such as Mexico, as these are likely to have less diversified economies and less efficient suppliers of intermediates. Second, RoO do not necessarily result in higher regional content in exports, as firms could choose to no longer use the FTA to export. Moreover, even if the share of regional content increases, bilateral trade could decrease as a result of lower sourcing efficiency. The objective of trade policy should not be to maximize the share of the pie countries within an FTA get but rather maximize the amount of pie these countries are getting in the end.

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Appendix

A Direct Requirement Coefficients in HS

According to the BEA, Direct Requirement Coefficients "show the amount of inputs purchased directly to produce one dollar of output." That is, the exact input composition of every final product, where the sum of these coefficients across a product's inputs adds up to one. As described in Section 2, Direct Requirement Coefficient (DRC) Tables are in 1997 NAICS, while the rest the data used in this paper is in HS. Correspondence tables between these two classification systems are readily available, however the match is of the many-to-many type i.e. a NAICS code can match to multiple HS 6-digit codes, and an HS 6-digit code can match to multiple NAICS codes.

Whenever a NAICS code for an input corresponds to more than one HS code, we uniformly distribute the direct requirement coefficient, i.e. how much does a particular output use of a given input, across all of its corresponding HS codes. This procedure yields a correspondence table where outputs are defined in NAICS, inputs are defined in HS, and the shares across inputs each output uses add up to one. Lastly, whenever an HS code for an output corresponds to more than one NAICS code, we take the average of the direct requirement coefficients across all the NAICS codes corresponding to this particular HS 6-digit code. The end-product of this computation is the exact input composition of every product at the HS 6-digit level.

To illustrate how we construct HS input composition tables, we use the following example. Suppose the DRC Tables look like Table 14.

NAICS Output	NAICS Inputs	DR Coefficient
A	C	0.6
A	D	0.4
B	C	0.8
B	D	0.2

Table 14: Example of Direct Requirement Coefficients Tables.

While the NAICS-HS correspondence looks like that of Table 15. Notice that the match NAICS-HS is of the many-to-many type, e.g. NAICS code A corresponds to more than one HS code, it corresponds to HS codes 1 and 2; while HS code 1 corresponds to more than one NAICS code, it corresponds to NAICS codes A and B.

NAICS Code	HS Code
A	1
A	2
B	1
B	3
C	3
C	4
D	4
D	5

Table 15: Example of the NAICS-HS Correspondence.

The first step is to create a match where outputs are defined in NAICS and inputs are in HS. We expand Table 14 by uniformly distributing the direct requirement coefficients of each NAICS input code across its corresponding HS codes, according to Table 15. This is shown in Table 16. By construction, note that for each NAICS output, the sum of the DR coefficients across its HS inputs adds up to one. We include NAICS-HS input combinations for which DR coefficients are implicitly equal to 0, e.g. HS code 5 does not correspond to NAICS code C.

NAICS Output	NAICS Inputs	HS Inputs	Adjusted NAICS DR Coefficient
A	C	3	0.3
A	C	4	0.3
A	C	5	0.0
A	D	3	0.0
A	D	4	0.2
A	D	5	0.2
B	C	3	0.4
B	C	4	0.4
B	C	5	0.0
B	D	3	0.0
B	D	4	0.1
B	D	5	0.1

Table 16: NAICS Outputs - HS Inputs Correspondence.

We add the DR coefficients across every NAICS output - HS input combination, and then match NAICS outputs to HS outputs according to Table 15. Note that HS code 1 corresponds to both NAICS codes A and B. Table 17 shows how the DR coefficients table would look for HS output code 1.

HS Output	HS Inputs	Adjusted HS DR Coefficient
1	3	0.3
1	4	0.5
1	5	0.2
1	3	0.4
1	4	0.5
1	5	0.1

Table 17: HS Outputs - HS Inputs Correspondence.

Lastly, we average the DR coefficients across every HS output-input combination; this is not necessary whenever an HS code corresponds to a unique NAICS code. Table 18 shows the final product of this computation, the exact input composition of HS output code 1 in terms of its HS input codes. It is important that the HS direct requirement coefficients add up to one because our computation of RoO strictness is a weighted average of the inputs restricted under RoO for each final product.

HS Output	HS Inputs	Adjusted HS DR Coefficient
1	3	0.35
1	4	0.50
1	5	0.15

Table 18: Input Composition of HS Code 1.

B Regression Tables and Robustness Checks

In this appendix we include the estimation tables and robustness checks we conduct for the empirical facts in our paper. Table 19 shows the estimation results for the probability of using NAFTA to export, both for Equation 1 and for a regression where instead of controlling for the product-level RoO strictness and MFN tariffs, we control for industry fixed-effects to account for any unobserved heterogeneity at the industry-level. These fixed effects should already capture variation across industries in their RoO and MFN tariffs.

Figure 10 shows the predicted share of firms using NAFTA by deciles of firm size, assuming for simplicity that RoO strictness and MFN tariffs are equal to zero. In blue are the

	(1) Pr(NAFTA)	(2) Pr(NAFTA)	(3) Pr(NAFTA)
2nd decile	0.124***	0.0981***	0.103***
	(7.11)	(3.57)	(3.61)
3rd decile	0.166***	0.129***	0.135***
	(8.16)	(3.99)	(4.02)
4th decile	0.201***	0.148***	0.155***
	(9.72)	(4.45)	(4.54)
5th decile	0.212***	0.144***	0.152***
	(9.95)	(4.24)	(4.36)
6th decile	0.202***	0.125***	0.136***
	(9.26)	(3.52)	(3.72)
7th decile	0.203***	0.123***	0.136***
	(9.34)	(3.43)	(3.70)
8th decile	0.186***	0.111**	0.129***
	(8.23)	(3.01)	(3.38)
9th decile	0.137***	0.0317	0.0463
	(5.35)	(0.67)	(0.95)
10th decile	0.0249	0.0168	0.0476
	(0.78)	(0.33)	(0.91)
RoO Strictness	-0.00508***		0.00191
	(-10.64)		(1.41)
MFN Tariff	0.00818***		-0.00967***
	(4.81)		(-5.26)
Constant	0.623***	0.621***	0.663***
	(29.33)	(20.36)	(15.83)
HS Chapter F.E.	✗	✓	✓
Observations	105,959	159,104	146,081

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

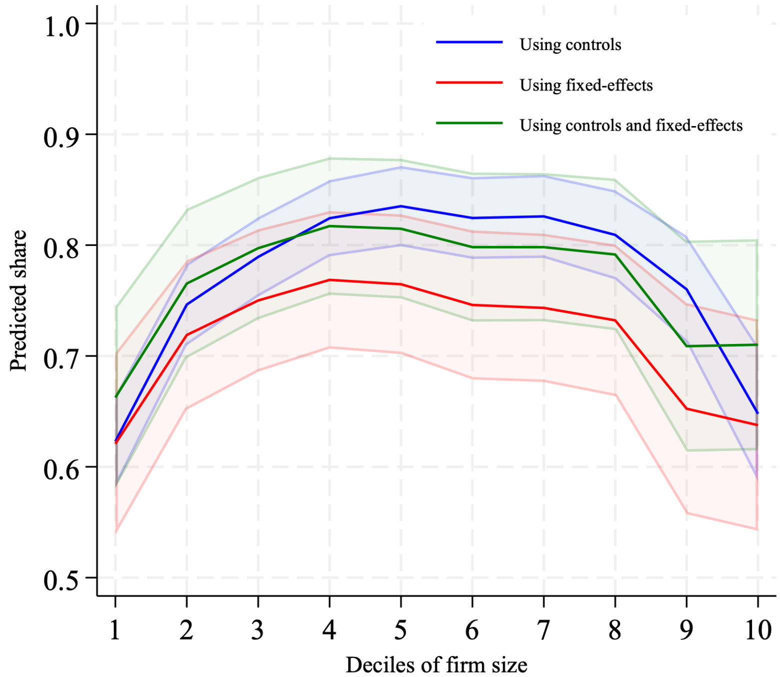
Table 19: Regression Output for the Probability of using NAFTA

same results as in Figure 3, in red we show the estimated coefficients when controlling for industry fixed effects, and in green when we control for both RoO strictness, MFN tariffs, and industry fixed effects. Results show that our result of an inverse U-shape relationship between the use of NAFTA and firm size is result to controlling for industry fixed effects, thus to any source of heterogeneity at the industry-level. To further check the robustness of these findings, we estimate the following relationship:

$$\mathbb{N}_{ikjt} = \beta_0 + \beta_1 \text{Size}_{it} + \beta_2 \text{Size}_{it}^2 + \alpha_1 \text{RoO}_j + \alpha_2 \text{MFN}_j + \iota_t + \epsilon_{ikjt} \tag{27}$$

where $\mathbb{N}_{ikjt} = 1$ if firm i of size k exporting product j at time t is using NAFTA to export, and Size_{it} represents a proxy for firm i's size at time t. We consider two different proxies: (i) Percentiles of firm size, as described in Section 3. (ii) The log of a firm's total exports. We also either control for RoO strictness and MFN tariffs, or include industry fixed effects. Results of these estimations are shown in Table 20.

In our data, we cannot identify firms that are part of either Global Value Chains or Maquilas. It is a possibility that these types of firms are unable to choose whether to use NAFTA or WTO, or choose their sourcing strategy and compliance with RoO. Therefore, including them in our data sample could introduce a bias in our estimates, e.g. if a Maquila



Source: Author's calculations using Mexico's customs data, BEA's 1997 IO Tables, NAFTA's Annex 401, and US HTS 2022.
Note: Prediction shows the estimated coefficients controlling either for the effect of RoO and MFN Tariffs, or including HS Chapter fixed-effects. Colored areas show the 95% confidence interval. Standard errors are clustered at the firm-level.

Figure 10: Predicted share of exporters using NAFTA by size decile.

firm has to export using NAFTA, then the probability of using NAFTA to export is not affected by RoO strictness, and thus, this will introduce a downward bias in our estimates for the marginal effect of RoO strictness over the probability of using NAFTA to export. This same intuition applies to firms that are part of a GVC, where Mexican firms might not have enough market power for them to choose their use of NAFTA and their sourcing strategy. To address these concerns, we perform the following additional robustness checks: (i) Estimate Equation 1 but excluding the automotive and textiles industries,[20] as anecdotal evidence suggests these are the industries in which most of the Mexican firms that are part of either GVCs or Maquilas concentrate. (ii) Estimate the same equation but now remove one industry at a time, thus providing evidence that a particular industry does not drive our results for the inverse U-shape relationship.

Figure 11 shows our results for the inverse U-shape relationship between the use of NAFTA and firm size, excluding observations for either the Textiles or Automotive industries. Results for removing one industry at a time and studying how the inverse U-shape

[20]For textiles, we drop all observations corresponding to HS Chapters 61, 62, and 63. For automobiles, we drop HS Chapter 87.

	(1) Pr(NAFTA)	(2) Pr(NAFTA)	(3) Pr(NAFTA)	(4) Pr(NAFTA)
Size percentile	0.0104***	0.00607***		
	(11.51)	(6.79)		
Percentile sq	-0.000100***	-0.0000529***		
	(-11.01)	(-6.77)		
RoO Strictness	-0.00508***		-0.00520***	
	(-10.64)		(-10.94)	
MFN Tariff	0.00793***		0.00769***	
	(4.67)		(4.54)	
Log of exports			0.161***	0.0701***
			(10.63)	(4.96)
Log of exports sq			-0.00697***	-0.00287***
			(-9.96)	(-4.33)
Constant	0.586***	0.685***	-0.105	0.405***
	(25.95)	(30.06)	(-1.30)	(5.29)
HS Chapter F.E.	✗	✓	✗	✓
Observations	105,959	70,935	105,959	70,935

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 20: Robustness Checks for the Probability of using NAFTA

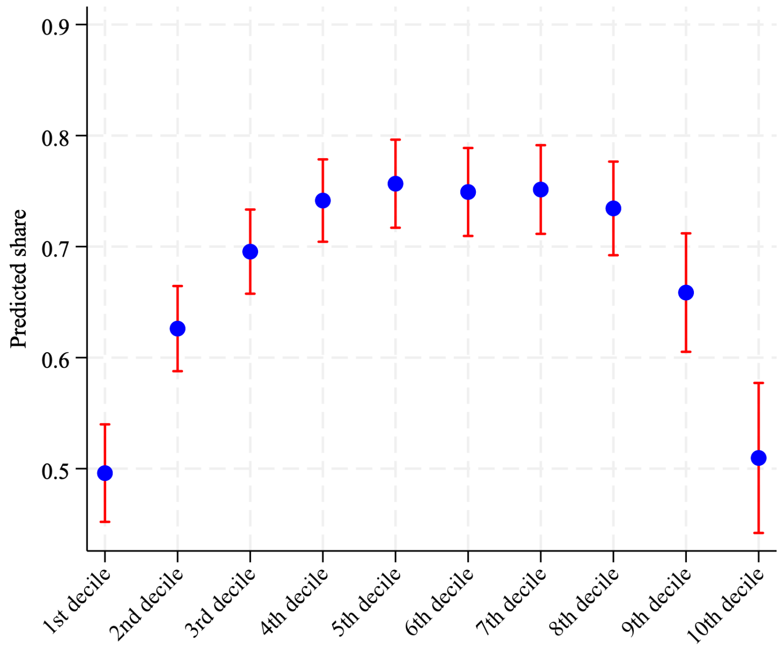
relationship changes are shown in Figure 12, which plots the *convex hull* of the predicted share of firms using NAFTA by size decile, i.e. we estimate Equation 1 removing one industry at a time. Then for each estimation we predict the share of firms using NAFTA to export by size decile. Then for each decile, we find the lowest and the highest prediction. Figure 12 plots the area between these two predictions.

These results support our empirical findings for the inverse U-shape relationship between the use of NAFTA and firm size. This relationship is robust to controlling for product-level incentives of using NAFTA, including industry fixed effects to account for any industry-level heterogeneity, using alternative proxies for firm size, and showing that the results does not depend on particular industries, which might be affected by the presence of GVCs or Maquilas.

Table 21 shows the full results of estimating Equation 3, where we omit including a dummy for the first decile for the intercept and for the interactions with RoO strictness and MFN tariffs, thus the results should be interpreted relative to the first decile.

In terms of the effect of firm size on the probability of sourcing inputs outside of NAFTA, estimation results for Equation 2 are shown in Table 22. We conduct the same robustness checks as those for the probability of using NAFTA to export. First, Table 23 shows estimates for the following equation:

$$\mathbb{S}_{ist} = \beta_0 + \beta_1 \text{Size}_{it} + \beta_2 \text{Size}_{it}^2 + \iota_{st} + \epsilon_{ikjt} \tag{28}$$



Source: Author's calculations using Mexico's customs data, BEA's 1997 IO Tables, NAFTA's Annex 401, and US HTS 2022.
Note: Red intervals indicate the 95% confidence interval. Standard errors are clustered at the firm-level. Data sample used for the estimation excludes firms in the Textiles or Automotive industries; those from HS Chapters 61, 62, 63, and 87.

Figure 11: Predicted share of exporters using NAFTA removing Textiles and Automotive.

where $\mathbb{S}_{ist} = 1$ if firm i of industry s is sourcing inputs outside of NAFTA at time t, and Size_{it} represents again different proxies for firm size. Results are robust to using these alternative measures. Next, we estimate the same relationship but again: (i) Removing observations for Textiles or Automotive industries from our sample. (ii) Estimating the relationship by removing one industry at a time.

Results for (i) are shown in Figure 13, which provides evidence on our empirical finding for the distortion caused by RoO not driven by the Textiles or Automotive industries. For (ii), we estimate Equation 29 but instead of separately estimating the relationship for firms using NAFTA and those using WTO, we explicitly control for the effect of using NAFTA to export and allow it to change by firm size:

$$\mathbb{S}_{ikst} = \beta_0^n + \sum_{k=2}^{10} \beta_k^n \mathbb{I}_{ikt} + \sum_{k=1}^{10} \alpha_k^n \mathbb{I}_{ikt} \mathbb{N}_{ikt} + \iota_{st}^n + \epsilon_{ijt} \tag{29}$$

Figure 14 shows the mean and convex hull for α_k across size deciles. There are 53 industries in our sample, therefore we have 53 sets of $\{\alpha_k^n\}_{k=1}^{10}$. For a given decile k, the line in the middle is the average across estimations:

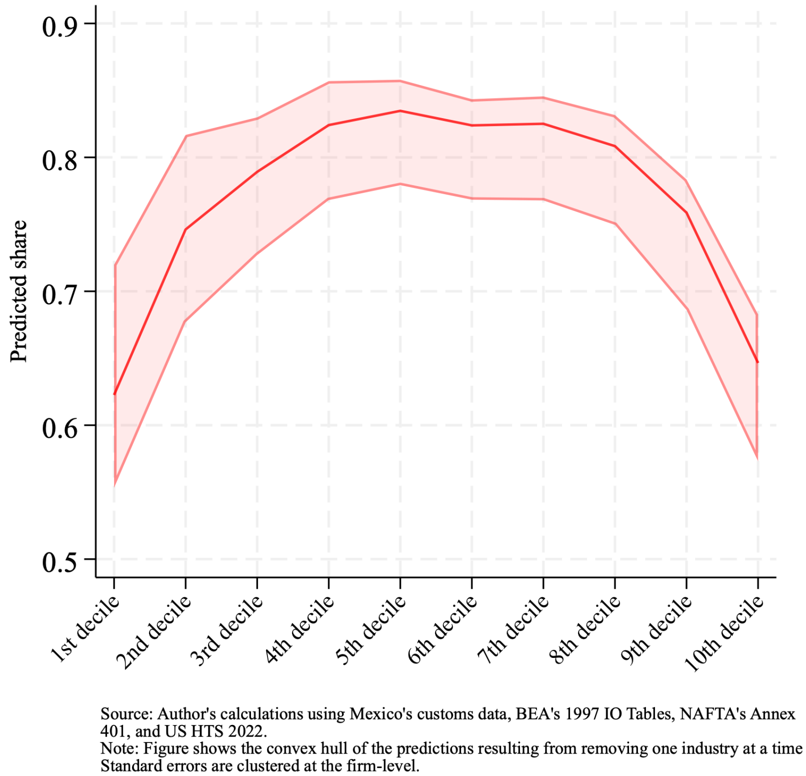


Figure 12: Predicted share of exporters using NAFTA removing one industry at a time.

$$\bar{\alpha}_k = \frac{1}{53}\sum_{n=1}^{53}\alpha_k^n$$

The colored area shows both the lowest estimated effect $\alpha_k^{min} = \min_n \alpha_k^n$ and the largest one $\alpha_k^{max} = \max_n \alpha_k^n$, i.e. the colored area does not represent the size of the distortion, but rather the set of predicted distortions obtained by removing one industry at a time. The distortion induced by RoO is the distance between the zero line and any point inside the convex hull of the predictions.

These results provide evidence on the robustness of our empirical fact for the U-shape relationship between firm size and the distortion in non-NAFTA sourcing induced by RoO.

C Additional Empirical Facts

This section provides additional empirical facts we observe in the data. Figure 15 shows the time series for the share of firms using NAFTA to export by export destination. The share of using NAFTA remained constant over our sample periods, although a degree of

	(1)
	Pr(NAFTA)
2nd decile	0.0966**
	(3.15)
3rd decile	0.137***
	(3.55)
4th decile	0.235***
	(6.04)
5th decile	0.242***
	(5.91)
6th decile	0.236***
	(5.69)
7th decile	0.216***
	(5.24)
8th decile	0.157***
	(3.49)
9th decile	-0.0340
	(-0.54)
10th decile	-0.266***
	(-3.95)
RoO strictness	0.00346***
	(4.20)
2nd decile × RoO strictness	-0.00338***
	(-3.94)
3rd decile × RoO strictness	-0.00747***
	(-7.31)
4th decile × RoO strictness	-0.00977***
	(-8.63)
5th decile × RoO strictness	-0.0105***
	(-8.98)
6th decile × RoO strictness	-0.0103***
	(-8.23)
7th decile × RoO strictness	-0.0119***
	(-9.38)
8th decile × RoO strictness	-0.0130***
	(-9.74)
9th decile × RoO strictness	-0.0130***
	(-9.51)
10th decile × RoO strictness	-0.00992***
	(-5.87)
MFN Tariff	-0.0117**
	(-3.01)
2nd decile × MFN Tariff	0.00879*
	(2.24)
3rd decile × MFN Tariff	0.0170***
	(3.66)
4th decile × MFN Tariff	0.0144**
	(3.11)
5th decile × MFN Tariff	0.0162***
	(3.44)
6th decile × MFN Tariff	0.0155**
	(3.17)
7th decile × MFN Tariff	0.0208***
	(4.36)
8th decile × MFN Tariff	0.0273***
	(5.17)
9th decile × MFN Tariff	0.0419***
	(6.74)
10th decile × MFN Tariff	0.0529***
	(7.04)
Constant	0.661***
	(22.60)
Observations	105,959

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 21: Estimated Marginal Effects of RoO and MFN tariffs.

	(1) Firms using WTO	(2) Firms using NAFTA
2nd decile	0.0557***	0.0408***
	(5.06)	(7.56)
3rd decile	0.140***	0.0892***
	(5.56)	(11.60)
4th decile	0.241***	0.119***
	(9.18)	(11.81)
5th decile	0.348***	0.152***
	(9.43)	(14.43)
6th decile	0.492***	0.200***
	(15.23)	(16.23)
7th decile	0.527***	0.237***
	(16.00)	(15.38)
8th decile	0.620***	0.271***
	(18.71)	(15.38)
9th decile	0.708***	0.356***
	(22.29)	(17.65)
10th decile	0.854***	0.623***
	(40.76)	(24.04)
Constant	0.0214**	-0.0793***
	(3.06)	(-11.00)
HS Chapter F.E.	✓	✓
Observations	13,293	57,642

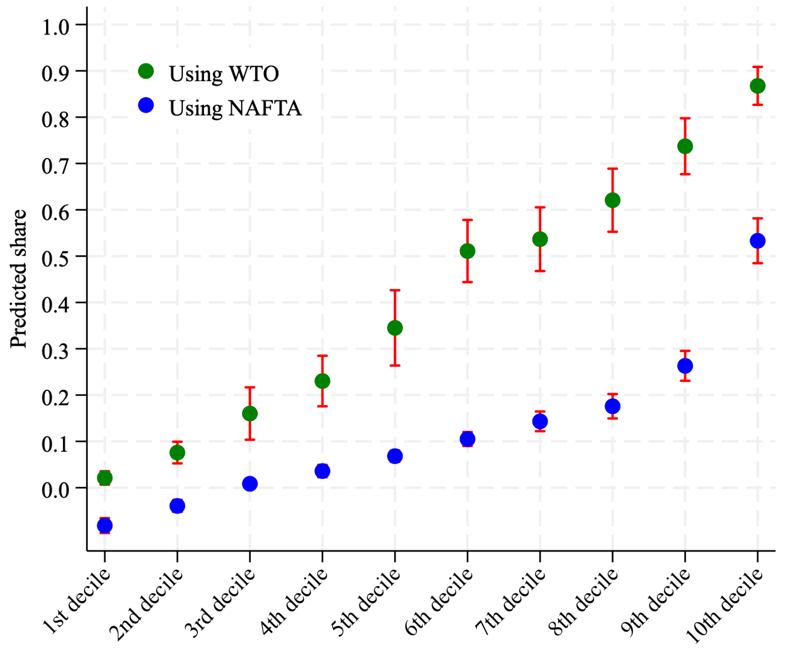
t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 22: Regression Output for the Probability of Non-NAFTA sourcing.

	(1) Firms using WTO	(2) Firms using NAFTA	(3) Firms using WTO	(4) Firms using NAFTA
Size percentile	0.0131***	-0.000320		
	(10.90)	(-0.28)		
Percentile squared	-0.0000364**	0.0000610***		
	(-3.11)	(4.53)		
Log of exports			0.120***	-0.0963***
			(7.04)	(-4.87)
Log of exports sq			-0.00113	0.00756***
			(-1.56)	(7.29)
Constant	-0.00446	-0.0145	-0.687***	0.243**
	(-0.25)	(-0.82)	(-7.48)	(2.67)
HS Chapter F.E.	✓	✓	✓	✓
Observations	45,339	111,347	45,339	111,347

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 23: Robustness Checks for the Probability of non-NAFTA Sourcing



Source: Author's calculations using Mexico's customs data, BEA's 1997 IO Tables, NAFTA's Annex 401, and US HTS 2022.
Note: Red intervals indicate the 95% confidence interval. Standard errors are clustered at the firm-level. Data sample used for the estimation excludes firms in the Textiles or Automotive industries; those from HS Chapters 61, 62, 63, and 87.

Figure 13: Predicted non-NAFTA sourcing removing Textiles and Automotive.

seasonality can be observed in the Figure. This seasonality is likely driven by changes in the composition of Mexican exports throughout the year, e.g. if vegetables are mostly exported during Winter months, and vegetable producers use NAFTA more intensively. The Figure also shows that the intensity of the use of NAFTA is mostly the same whether exporting to the US or to Canada, although volatility is higher for the latter.

Consistent with our structural model, there is industry-level heterogeneity in both the use of NAFTA and sourcing from non-NAFTA countries, which is presented in Figures 16 and 17, respectively. Industries correspond to an HS 1-digit level of disaggregation. In the case of the use of NAFTA, this observed heterogeneity intuitively should be driven either by heterogeneity in the benefits of using NAFTA or in its costs. In terms of benefits, industries are heterogeneous in terms of the MFN tariffs they would have to pay if exporting using WTO membership, and in terms of the costs either in terms of their RoO or the fixed cost of using NAFTA. In our model, we incorporate these features by directly feeding in RoO and MFN tariffs at the industry level and allowing the fixed cost of using NAFTA to be industry-specific.

Turning our attention to sourcing outside of NAFTA countries, once again, the hetero-

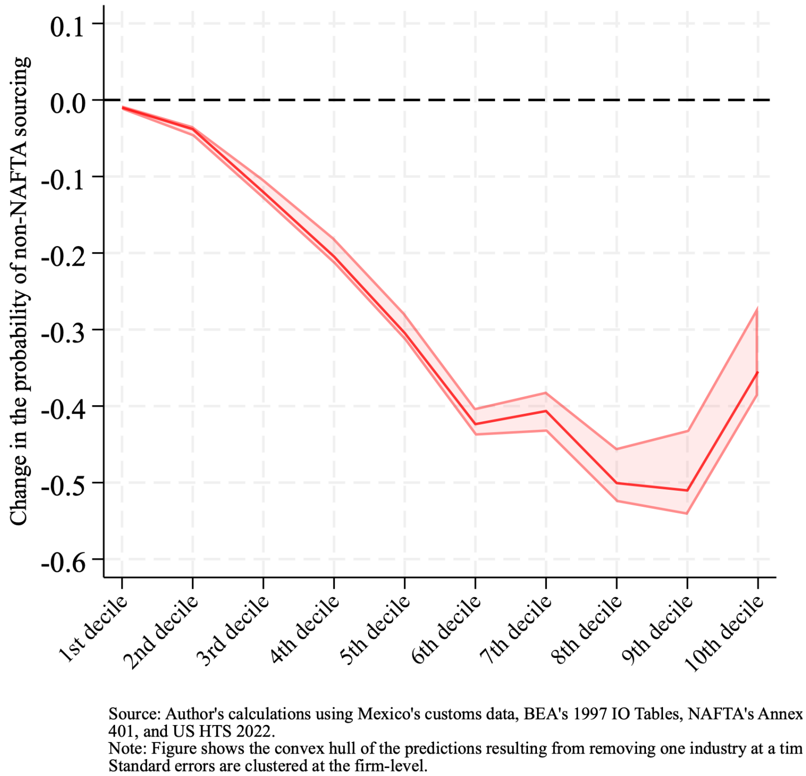
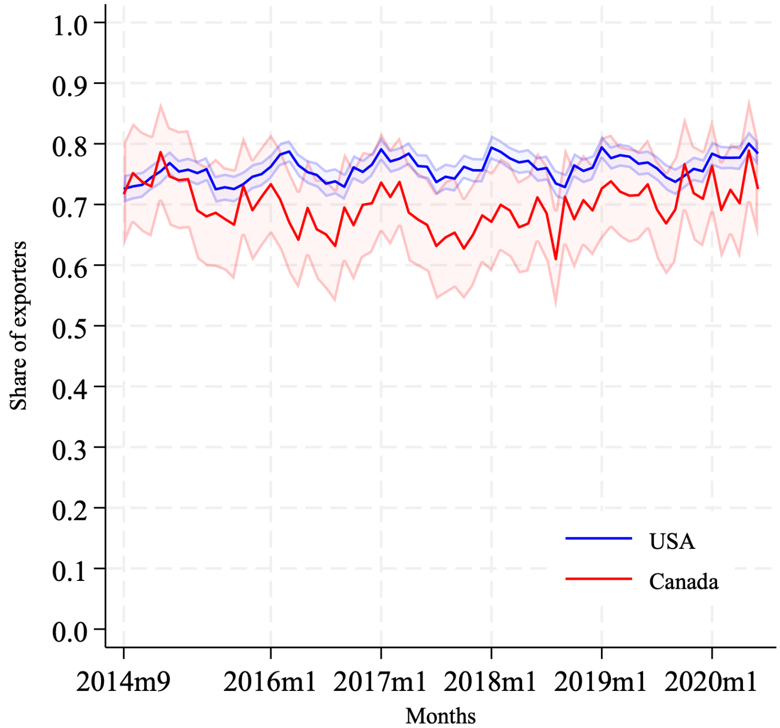


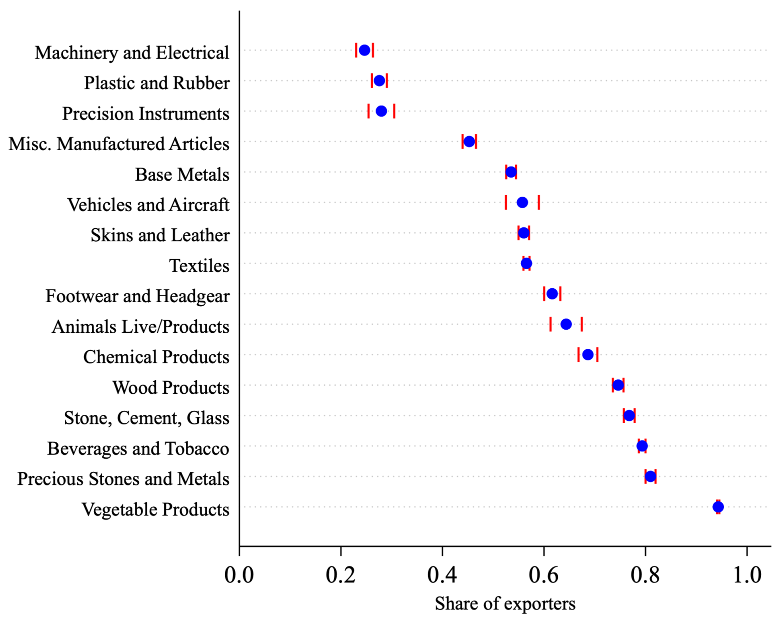
Figure 14: Distortion in non-NAFTA sourcing removing one industry at a time.

geneity should be driven by the different benefits and costs of sourcing from non-NAFTA countries. Industries should be heterogeneous in terms of how attractive it is to source from non-NAFTA countries, depending on the patterns of comparative advantage across the World e.g. if for Mexican firms in a particular industry, the US is a great supplier of their inputs, then there is not much of an incentive to source from non-NAFTA country. Costs of sourcing outside of NAFTA should also be heterogeneous across industries, as some of them should find it easier to source inputs from foreign countries due to the nature of their inputs, how connected worldwide is their industry, etc. In our model, we allow for the attractiveness of sourcing from foreign countries and the fixed costs of sourcing to be heterogeneous at the industry level.



Source: Author's calculations using Mexico's customs data and US HTS 2022.
Note: Colored areas represent the 95% confidence interval.

Figure 15: Share of exporters using NAFTA by Export Destination.



Source: Author's calculations using Mexico's customs data and HTS 2022.
Note: Red interval represents the 95% confidence interval.

Figure 16: Share of exporters using NAFTA by HS Section.

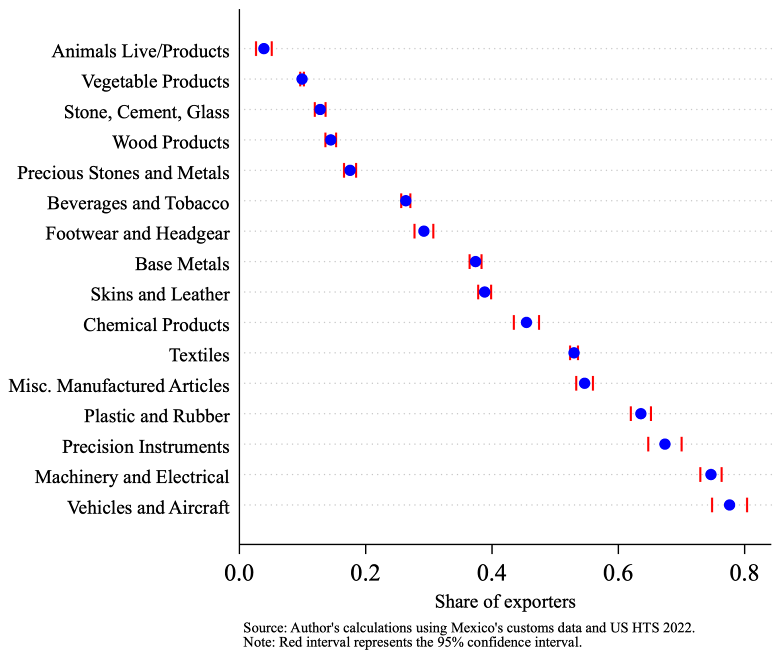


Figure 17: Share of exporters sourcing outside of NAFTA by HS Section.

D Marginal Cost of Producing and Exporting

According to Equation 9, the marginal cost of producing and exporting is given by:

$$c_{si}(\phi,\kappa,\lambda,\tau,J) = \frac{1+(1-\kappa)\tau}{\phi}\left(\int_0^{\kappa\lambda} z_{si}(\nu)^{1-\rho} d^*\nu + \int_{\kappa\lambda}^{1} z_{si}(\nu)^{1-\rho} d\nu\right)^{1/(1-\rho)}$$

Which we can rewrite as:

$$c_{si}(\phi,\kappa,\lambda,\tau,J) = \frac{1+(1-\kappa)\tau}{\phi}\left(\kappa\lambda\int_0^{\infty} z^{1-\rho} dG^*_{si}(z) + (1-\kappa\lambda)\int_0^{\infty} z^{1-\rho} dG_{si}(z)\right)^{1/(1-\rho)}$$

Taking into account the distribution for prices depends on whether it is an input restricted under RoO, $G^*_{si}(z)$, or an unrestricted one, $G_{si}(z)$. Following Eaton and Kortum (2002):

$$\int_0^{\infty} z^{1-\rho} dG^*_{si}(z) = \Gamma\Big(\frac{\theta-1-\rho}{\theta}\Big)\left[\sum_{h\in N\cap J} T^h_{si}(d^h w^h_{si})^{-\theta}\right]^{\frac{-(1-\rho)}{\theta}}$$

And:

$$\int_0^{\infty} z^{1-\rho} dG_{si}(z) = \Gamma\Big(\frac{\theta-1-\rho}{\theta}\Big)\left[\sum_{h\in J} T^h_{si}(d^h w^h_{si})^{-\theta}\right]^{\frac{-(1-\rho)}{\theta}}$$

Which allows us to rewrite marginal cost as:

$$c_{si}(\phi,\kappa,\lambda,\tau,J) = \frac{1}{\phi}\gamma^{-\frac{1}{\theta}}\Big[1+(1-\kappa)\tau\Big]\left[\kappa\lambda\Psi^{\frac{\rho-1}{\theta}} + (1-\kappa\lambda)\Phi^{\frac{\rho-1}{\theta}}\right]^{1/(1-\rho)}$$

With:

$$\gamma = \Gamma\Big(\frac{\theta-1-\rho}{\theta}\Big)^{-\frac{\theta}{1-\rho}}$$

$$\Psi = \left[\sum_{h\in N\cap J} T^h_{si}(d^h w^h_{si})^{-\theta}\right]^{\frac{-(1-\rho)}{\theta}}$$

$$\Phi = \left[\sum_{h\in J} T^h_{si}(d^h w^h_{si})^{-\theta}\right]^{\frac{-(1-\rho)}{\theta}}$$

E Purchases of Intermediate Inputs

This section shows how firm ϕ's purchases of inputs from country j can be expressed as a share of its operating profits, as stated in Equation 20. Using 13 we can write operating profits as:

$$\begin{aligned} \pi^o_{si}(\phi, \kappa^*, \lambda, \tau) &= [p_{si}(\phi, \kappa, \lambda, \tau, J) - c_{si}(\phi, \kappa, \lambda, \tau, J)]q_{si}(\phi) \\ \Rightarrow c_{si}(\phi, \kappa, \lambda, \tau, J)q_{si}(\phi) &= (\sigma - 1)\pi^o_{si}(\phi, \kappa^*, \lambda, \tau) \end{aligned} \tag{30}$$

As firm ϕ is sourcing share x^j_{si} of its inputs from country j, the share of its marginal cost coming exclusively from its purchases from j will be then given by:

$$\begin{aligned} c^j_{si}(\phi, \kappa, \lambda, \tau, J) &= x^j_{si}(\phi, \kappa, \lambda, J)c_{si}(\phi, \kappa, \lambda, \tau, J) \\ \Rightarrow c_{si}(\phi, \kappa, \lambda, \tau, J) &= \frac{c^j_{si}(\phi, \kappa, \lambda, \tau, J)}{x^j_{si}(\phi, \kappa, \lambda, J)} \end{aligned}$$

And then rewrite Equation 30 as:

$$\begin{aligned} q_{si}(\phi)\frac{c^j_{si}(\phi, \kappa, \lambda, \tau, J)}{x^j_{si}(\phi, \kappa, \lambda, J)} &= (\sigma - 1)\pi^o_{si}(\phi, \kappa^*, \lambda, \tau) \\ \Rightarrow q_{si}(\phi)c^j_{si}(\phi, \kappa, \lambda, \tau, J) &= (\sigma - 1)x^j_{si}(\phi, \kappa, \lambda, J)\pi^o_{si}(\phi, \kappa^*, \lambda, \tau) \end{aligned}$$

Since c^j_{si} is the marginal cost exclusively coming from j, i.e. the value of inputs purchased from j for the production of one unit of the final good, and $q_{si}(\phi)$ represents the number of units sold, it follows that:

$$M^j_{si}(\phi) = (\sigma - 1)x^j_{si}(\phi, \kappa, \lambda)\pi^o_{si}(\phi, \kappa, \lambda, \tau)$$

F Firm profits are not Supermodular

This section shows how in our model, firm profits are not necessarily supermodular in productivity and thus could not feature increasing differences in a firm's sourcing strategy. For this reason, we cannot reduce the dimensionality of the firm's problem as in Antras et al. (2017), following Jia (2008), and have to compute firm profits under each possible sourcing strategy.

According to Topkis's Modularity Theorem, if the expression for profits in Equation 16 satisfies being supermodular in $(I_{si}^{j}(\phi), \phi)$ where $I_{si}^{j}(\phi) = 1$ if firm ϕ sources inputs from j, then $I_{si}^{*}(\phi) = (I_{si}^{1}(\phi), ..., I_{si}^{J}(\phi))$ is non-decreasing in ϕ, i.e. the cardinality of a firm's sourcing strategy is increasing in its productivity. For profits to be supermodular, two conditions have to be satisfied:

1. Let $X = [0, 1]^{J}$ and $Y = \mathbb{R}^{+}$, where X and Y are lattices and thus $X \times Y$ is a lattice as well. $\pi_{si}(\phi)$ has to have increasing differences in $(I_{si}(\phi), \phi) \iff \pi_{si}(\phi)$ features increasing differences in $(I_{si}^{j}(\phi), \phi)$ $\forall j \in J$, given $I_{si}^{k}(\phi)$ for $k \neq j$.

2. $\pi_{si}(\phi)$ features increasing differences in $(I_{si}^{j}(\phi), I_{si}^{k}(\phi))$, given $I_{si}^{h}(\phi)$ for $h \neq j, k$.

Our proof relies on showing that our profit function does not necessarily satisfy increasing differences in $(I_{si}^{j}(\phi), \phi)$, therefore it does not have to be supermodular, implying that the cardinality of a firm's sourcing strategy might not increase with firm productivity. Let $\phi_H > \phi_L$, for profits to feature increasing differences in $(I_{si}^{j}(\phi), \phi)$ the following has to hold true:

$$\begin{aligned} \mathbb{E}\Big[\pi_{si}(1, \phi_H) - \kappa(\phi_H) w \zeta_{si} - \pi_{si}(0, \phi_H) + \kappa(\phi_H) w \zeta_{si}\Big] \geq \mathbb{E}\Big[\pi_{si}(1, \phi_L) - \kappa(\phi_L) w \zeta_{si} - \pi_{si}(0, \phi_L) + \kappa(\phi_L) w \zeta_{si}\Big] \\ \Rightarrow \mathbb{E}\Big[\pi_{si}(1, \phi_H) - \pi_{si}(0, \phi_H)\Big] \geq \mathbb{E}\Big[\pi_{si}(1, \phi_L) - \pi_{si}(0, \phi_L)\Big] \end{aligned} \tag{31}$$

since $I_{si}^{j'} \geq I_{si}^{j} \Rightarrow I_{si}^{j'} = 1 \wedge I_{si}^{j} = 0$. We do not consider the case for which $I_{si}^{j'} = I_{si}^{j} = 0$ as it is trivially satisfied. Note that we are fixing other countries in the firm's sourcing strategy, i.e. $I_{si}^{k'} = I_{si}^{k}$ $\forall k \neq j$. Using the objective function in Equation 16, each side of the inequality can be expressed as:

$$\phi^{\sigma-1}\gamma^{(\sigma-1)/\theta} B_{si}[1+(1-\kappa)\tau]^{1-\sigma}[\Lambda(1, \phi) - \Lambda(0, \phi)] - w\mathbb{E}\Big[f_{si}^{j}(\phi)\Big] - w\sum_{k \neq j} I_{si}^{j}\mathbb{E}\Big[f_{si}^{j}(\phi)\Big] + w\sum_{k \neq j} I_{si}^{j}\mathbb{E}\Big[f_{si}^{j}(\phi)\Big]$$

Where:

$$\Lambda(I_{si}^{j}, \phi) \equiv [\kappa\lambda\Psi_{si}(I_{si}^{j}, \phi)^{(\rho-1)/\theta} + (1-\kappa\lambda)\Phi_{si}(I_{si}^{j}, \phi)^{(\rho-1)/\theta}]^{\frac{1-\sigma}{1-\rho}}$$

Which allows us to rewrite Inequality 31 as:

$$\phi_H^{\sigma-1}[\Lambda(1, \phi_H) - \Lambda(0, \phi_H)] - w\mathbb{E}\Big[f_{si}^{j}(\phi_H)\Big] \geq \phi_L^{\sigma-1}[\Lambda(1, \phi_L) - \Lambda(0, \phi_L)] - w\mathbb{E}\Big[f_{si}^{j}(\phi_L)\Big]$$

Since we assume that fixed costs of sourcing do not depend on firm size, expectations cancel and we get:

$$\phi_H^{\sigma-1}[\Lambda(1,\phi_H)-\Lambda(0,\phi_H)] \geq \phi_L^{\sigma-1}[\Lambda(1,\phi_L)-\Lambda(0,\phi_L)]$$

By assumption $\phi_H > \phi_L$ and $\sigma > 1$, so for the above to necessarily hold true it needs to be the case that:

$$\Lambda(1,\phi_H)-\Lambda(0,\phi_H) \geq \Lambda(1,\phi_L)-\Lambda(0,\phi_L) \tag{32}$$

Following the definition for $\Lambda(I_{si}^j,\phi)$ and since $\sigma > \rho$, Inequality 32 is true if $\phi_L \leq \phi_H \Rightarrow \Lambda(\phi_L) \leq \Lambda(\phi_H)$. Assume $\phi_L \leq \phi_H$, firms' chosen sourcing strategies $J^*(\phi_H)$ and $J^*(\phi_L)$ have to satisfy that for the high productivity firm:

$$\begin{aligned}
&\phi_H^{\sigma-1}\gamma^{(\sigma-1)/\theta}B_{si}[1+(1-\kappa(\phi_H))\tau]^{1-\sigma}\Lambda(J^*(\phi_H)) - w\sum_{j\in J^*(\phi_H)} I_{si}^j\mathbb{E}\Big[f_{si}^j(\phi_H)\Big] - \kappa(\phi_H)w\zeta_{si} \\
\geq\ &\phi_H^{\sigma-1}\gamma^{(\sigma-1)/\theta}B_{si}[1+(1-\kappa(\phi_L))\tau]^{1-\sigma}\Lambda(J^*(\phi_L)) - w\sum_{j\in J^*(\phi_L)} I_{si}^j\mathbb{E}\Big[f_{si}^j(\phi_L)\Big] - \kappa(\phi_L)w\zeta_{si}
\end{aligned}$$

And for the low productivity firm:

$$\begin{aligned}
&\phi_L^{\sigma-1}\gamma^{(\sigma-1)/\theta}B_{si}[1+(1-\kappa(\phi_L))\tau]^{1-\sigma}\Lambda(J^*(\phi_L)) - w\sum_{j\in J^*(\phi_L)} I_{si}^j\mathbb{E}\Big[f_{si}^j(\phi_L)\Big] - \kappa(\phi_L)w\zeta_{si} \\
\geq\ &\phi_L^{\sigma-1}\gamma^{(\sigma-1)/\theta}B_{si}[1+(1-\kappa(\phi_H))\tau]^{1-\sigma}\Lambda(J^*(\phi_H)) - w\sum_{j\in J^*(\phi_H)} I_{si}^j\mathbb{E}\Big[f_{si}^j(\phi_L)\Big] - \kappa(\phi_H)w\zeta_{si}
\end{aligned}$$

The above follows from the fact that for the high productivity firm ϕ_H sourcing strategy $J^*(\phi_H)$ yields larger profits, and correspondingly for the low productivity firm ϕ_L. Adding these two inequalities and using the fact that fixed costs of sourcing do not depend on firm productivity, gives us:

$$[\phi_H^{\sigma-1}-\phi_L^{\sigma-1}]\Big([1+(1-\kappa(\phi_H))\tau]^{1-\sigma}\Lambda(J^*(\phi_H)) - [1+(1-\kappa(\phi_L))\tau]^{1-\sigma}\Lambda(J^*(\phi_L))\Big) \geq 0$$

Since $\phi_L \leq \phi_H$ and $\sigma > 1$, this implies that:

$$[1+(1-\kappa(\phi_H))\tau]^{1-\sigma}\Lambda(J^*(\phi_H)) \geq [1+(1-\kappa(\phi_L))\tau]^{1-\sigma}\Lambda(J^*(\phi_L))$$

For $\Lambda(\phi_H) \geq \Lambda(\phi_L)$ to necessarily be the case, it has to be true that:

$$\begin{gathered}[1 + (1 - \kappa(\phi_H))\tau]^{1-\sigma} \leq [1 + (1 - \kappa(\phi_L))\tau]^{1-\sigma} \\ \Rightarrow (1 - \kappa(\phi_H))\tau \geq (1 - \kappa(\phi_L))\tau \\ \Rightarrow \kappa(\phi_H) \leq \kappa(\phi_L)\end{gathered}$$

That is, that whenever a firm uses NAFTA to export, $\kappa(\phi_H) = 1$, any other firm with lower productivity has to use it as well, $\kappa(\phi_L) = 1$. In our model, this is not necessarily true. Because of fixed costs of using NAFTA, it could be the case that a medium-sized is using NAFTA to export, while a smaller less-productive firm is not. Since $\phi_L \leq \phi_H \not\Rightarrow \Lambda(\phi_L) \leq \Lambda(\phi_H)$, profits in our model do not necessarily feature increasing differences in $(I^j_{si}(\phi), \phi)$, and thus are not necessarily supermodular in productivity. This implies we cannot invoke Topkis's Modularity Theorem to argue that the cardinality of a firm's sourcing strategy is increasing in its productivity, and have to brute-force the firm's optimization problem by computing profits for each possible sourcing strategy.

Intuitively, this is the case because the use of NAFTA and RoO introduce additional non-linearities in our model. For example, a low productivity firm might not be able to pay the fixed cost of using NAFTA, and therefore it chooses to source from non-NAFTA countries. A more productive firm might be able to pay this fixed cost and choose to use NAFTA, which then could lead to the firm choosing to source its inputs exclusively from member countries. In this example, the set of countries from which the lower productivity firm can source inputs from is larger than that of the higher productivity firm.

G Full Results for Sourcing Potentials

For some industries in foreign countries, Mexican firms never imports some of their inputs from them, which implies that the input shares for these product-country combinations are equal to 0. When regressing the log-difference with respect to the corresponding input share for Mexico against industry-country fixed effects, if we ignored these observations for which input shares are equal to 0, we would introduce an upward bias in our estimates for sourcing potentials. For example, suppose in China *Industry A* is made of *Inputs* 1-100. Mexico does not import from China any product from *Industry A* except for *Input* 100, and it coincides with Mexico barely sourcing this product domestically. This implies the relative input share of China to that of Mexico for *Input* 100 is large, and since *Inputs* 1-99 are not imported at all, the observation for *Inputs* 100 is the only one used in the estimation. A bias is introduced as *Input* 100 is just a small part of *Industry A*, but we would estimate a large sourcing potential of China for this industry. To avoid dropping observations and introducing these biases, whenever an input is not sourced from a foreign country, we assign an input share equal to 0.1 to this input-country combination.

Table 24 shows the full results of our estimation for foreign countries' sourcing potentials. As a reminder, these estimates are interpreted as relative to the sourcing potential of Mexico, which is normalized to be equal to 1. For US-CA, the industry (HS Chapter) with the lowest sourcing potential is *Sugars and sugar confectionery* with 0.26, while the one with the highest one is *Articles of iron or steel* with 6.10. For China, the industry (HS Chapter) with the lowest sourcing potential is *Wood and articles of wood* with 0.10, while the one with the highest one is *Other made up textile articles* with 1.20. For Europe, the industry (HS Chapter) with the lowest sourcing potential is *Wood and articles of wood* with 0.06, while the one with the highest one is *Preparations of meat, or fish, or crustaceans* with 0.71. For the Rest of the World, the industry (HS Chapter) with the lowest sourcing potential is *Cocoa and cocoa preparations* with 0.08, while the one with the highest one is *Other made up textile articles* with 1.38. Lastly, for the total sum of estimated sourcing potentials, the industry (HS Chapter) with the lowest sourcing potential is *Wood and articles of wood* with 0.65, while the one with the highest one is *Articles of iron or steel* with 8.30.

H Point-Estimates using SMM

Table 25 shows the point estimates resulting from our estimation using SMM. The estimates for the location parameter of the log-normal distribution for fixed costs of sourcing depend on our simplifying assumption for the shape parameter, i.e. $\delta_s^j = \sqrt{log2}$, which results in the variance of fixed costs of sourcing being given by $\mathbb{V}(f_{si}^j) = exp(2\mu_{si}^j + log2)$

I Further Details on the Fit of the Model

Figure 18 shows the model's predictions in terms of the extensive margin of sourcing: The share of firms, for each sector, that source inputs from either NAFTA, China, Europe, or the Rest of the World.

Figure 19 shows the model's fit regarding the share of inputs sourced from each foreign country. These moments relate to those in Figure 18, as a firm choosing not to source from a given country implies that its input share is equal to zero. On the other hand, if a firm decides to source inputs from a country, then input shares are determined by the estimated sourcing potentials discussed in Section 5.2. In this figure, we observe that the prediction

HS Chapter	Description	Sector	HS Section	SP US-CA	SP China	SP Europe	SP ROW	Total SP
03	Fish and crustaceans	1	1	0.70	0.24	0.07	0.32	1.33
04	Dairy Produce, Eggs, Natural Honey	1	1	0.86	0.28	0.18	0.27	1.60
06	Live trees and other plants	1	2	0.51	0.43	0.36	0.62	1.92
07	Edible vegetables	1	2	0.69	0.22	0.19	0.27	1.37
08	Edible fruits and nuts	1	2	0.68	0.18	0.14	0.22	1.21
09	Coffee, tea, mate and spices	1	2	0.34	0.22	0.19	0.27	1.03
16	Preparations of meat, or fish, or crustaceans	1	4	1.45	0.65	0.71	0.76	3.57
17	Sugars and sugar confectionery	1	4	0.26	0.33	0.20	0.21	1.01
18	Cocoa and cocoa preparations	1	4	1.06	0.65	0.45	0.08	2.24
19	Preparations of cereals, flour, starch or milk	1	4	0.58	0.26	0.19	0.23	1.26
20	Preparations of vegetables, fruit, or nuts	1	4	1.30	0.34	0.28	0.39	2.32
21	Mischellaneous edible preparations	1	4	0.59	0.21	0.15	0.20	1.15
32	Tanning or dyeing extracts	2	6	2.90	0.37	0.33	0.50	4.10
33	Essential oils and resionoids, perfumery, cosmetics	2	6	1.09	0.25	0.15	0.25	1.74
36	Explosibes, pyrothehnic products	2	6	0.81	0.21	0.11	0.18	1.31
38	Mischellaneuous chemical products	2	6	1.43	0.28	0.16	0.31	2.18
39	Plastics and articles thereof	2	7	0.92	0.20	0.11	0.24	1.47
40	Rubber and articles thereof	2	7	1.11	0.39	0.19	0.35	2.04
42	Articles of leather	3	8	1.82	0.72	0.23	0.65	3.43
43	Furskins and artificial fur	3	8	1.27	0.69	0.56	0.78	3.30
44	Wood and articles of wood	3	9	0.38	0.10	0.06	0.11	0.65
46	Manufactures of straw, esparto or other plaiting materials	3	9	0.72	0.20	0.11	0.25	1.28
54	Man-made filaments	3	11	1.36	0.52	0.10	1.12	3.11
56	Wadding, felt and nonwovens, special yarns, ropes	3	11	1.16	0.57	0.10	0.90	2.72
61	Articles of appareal and clothing accessories, knitted	3	11	0.88	0.47	0.11	0.52	1.98
62	Articles of appareal and clothing accessories, not knitted	3	11	0.77	0.48	0.11	0.49	1.84
63	Other made up textile articles	3	11	2.06	1.20	0.18	1.38	4.82
64	Footwear, gaiters and the like	3	12	1.02	0.51	0.19	0.30	2.02
65	Headgear and parts thereof	3	12	1.62	0.61	0.18	0.62	3.03
66	Umbrellas, walking sticks, whips	3	12	2.50	0.51	0.35	0.60	3.96
67	Prepared feathers and down articles	3	12	2.50	0.51	0.35	0.60	3.96
69	Ceramic products	4	13	1.66	0.34	0.21	0.34	2.54
70	Glass and glassware	4	13	0.46	0.38	0.19	0.39	1.43
71	Precious stones, precious metals	4	14	1.45	0.42	0.20	0.28	2.34
73	Articles of iron or steel	4	15	6.10	0.79	0.39	1.01	8.30
74	Copper and articles thereof	4	15	2.13	0.53	0.29	0.31	3.26
83	Mischellaneous articles of base metal	4	15	4.37	0.63	0.31	0.77	6.08
84	Nuclear reactors, boilers, machinery and mechanical appliances	5	16	2.93	0.52	0.22	0.56	4.23
85	Electrical machinery and equipment and parts thereof	5	16	2.04	0.44	0.18	0.44	3.10
87	Vehicles other than railway or tramway	5	17	2.42	0.44	0.19	0.53	3.57
90	Optical, photographic, precision, medical apparatus	5	18	1.60	0.40	0.16	0.38	2.53
91	Clocks and watches and parts thereof	5	18	1.69	0.52	0.20	0.35	2.76
92	Musical instruments	5	18	1.39	0.26	0.14	0.29	2.08
94	Furniture, bedding, mattresses, cushions, lamps	6	20	3.21	0.53	0.23	0.64	4.61
95	Toys, games and sports requisites	6	20	3.38	0.47	0.22	0.64	4.72
96	Miscellaneous manufactured articles	6	20	2.67	0.46	0.27	0.55	3.95
Average				0.26	0.10	0.06	0.08	0.65
Maximum				1.58	0.43	0.22	0.47	2.71
Minimum				6.10	1.20	0.71	1.38	8.30

Table 24: Industry-level Sourcing Potentials by Foreign Country.

for firms' input shares from foreign countries are mostly in line with the data except for the case of input shares from the NAFTA region, where the model predicts a lower share of inputs being sourced from these countries. Additionally, we over predict input shares from Europe and Rest of the World for the *Manufacturing* sector. We interpret this as the result of overestimating these countries' sourcing potentials for this sector.

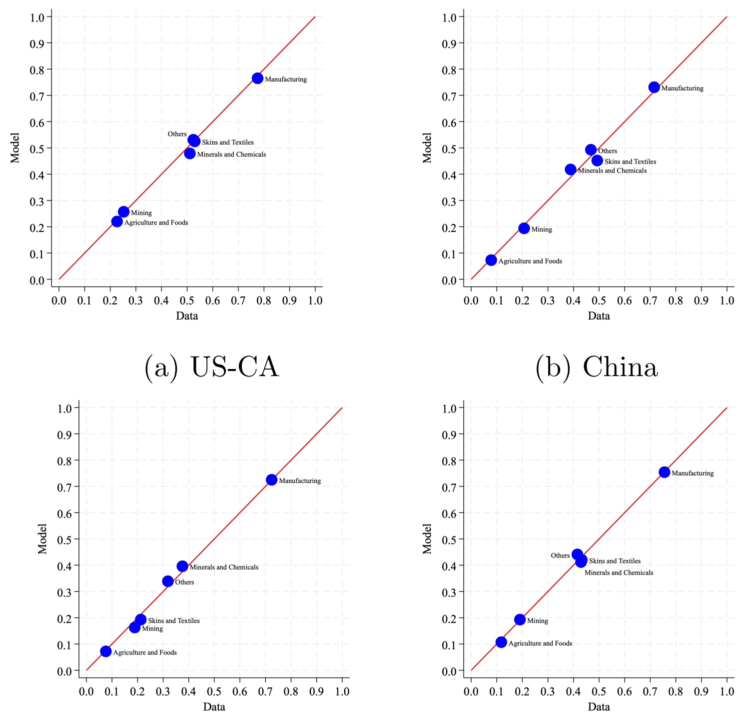
Table 26 shows the aggregate fit in terms of the share of firms using NAFTA and sourcing from non-NAFTA countries, both by quintiles of firm size. These moments are the ones shown in Figures 9a and 9b. The table also shows the share of firms sourcing inputs from each foreign country and input shares for these countries.

	ζ_s	μ_s^{CHN}	μ_s^{EUR}	μ_s^{US-CA}	μ_s^{ROW}	B_s
Agriculture and Foods	0.001	-3.490	-3.681	-3.216	-3.718	0.007
Minerals and Chemicals	0.002	-4.101	-4.707	-3.185	-4.292	0.009
Skins and Textiles	0.003	-4.513	-4.614	-3.599	-4.227	0.007
Mining	0.000	-5.943	-6.443	-4.143	-5.443	0.000
Manufactures	1.687	0.657	-0.243	1.935	0.535	1.566
Others	0.004	-5.304	-5.604	-3.504	-4.901	0.002

Table 25: Point Estimates for Fixed Costs and US Market Demand.

	Data	Model
Share of firms using NAFTA	0.76	0.73
... 1st quintile	0.67	0.45
... 2nd quintile	0.80	0.78
... 3rd quintile	0.83	0.78
... 4th quintile	0.81	0.89
... 5th quintile	0.69	0.73
Share of firms sourcing outside of NAFTA		
... 1st quintile	0.03	0.04
... 2nd quintile	0.12	0.04
... 3rd quintile	0.22	0.22
... 4th quintile	0.33	0.61
... 5th quintile	0.66	0.96
Share of firms sourcing from...		
... Mexico	1.00	1.00
... China	0.07	0.28
... Europe	0.04	0.18
... US and Canada	0.27	0.37
... Rest of the World	0.09	0.27
Share of inputs coming from...		
... Mexico	0.77	0.73
... China	0.03	0.04
... Europe	0.03	0.01
... US and Canada	0.12	0.17
... Rest of the World	0.05	0.05

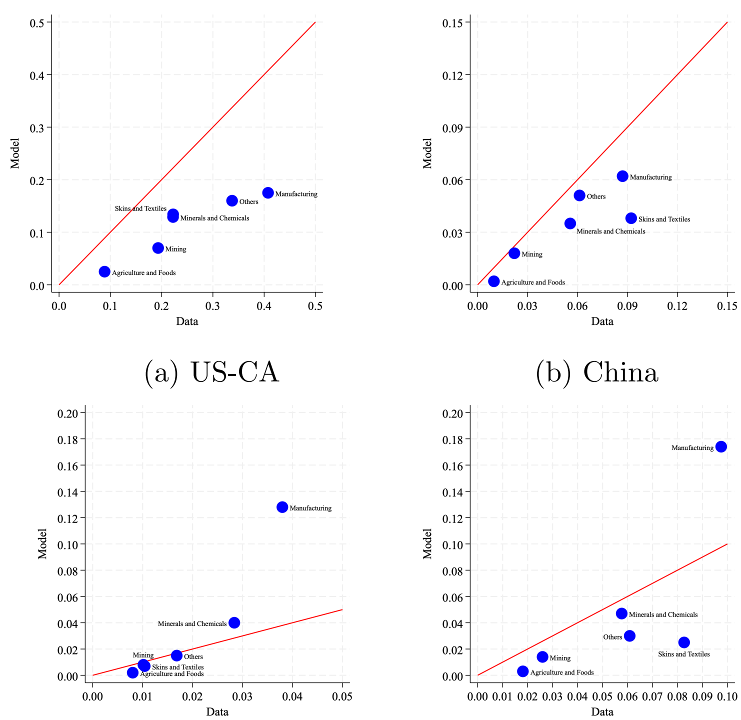
Table 26: Fit of the Model at the aggregate level.



(a) US-CA (b) China

(c) Europe (d) Rest of the World

Figure 18: Sectoral fit of the model in terms of the extensive margin.



(a) US-CA (b) China

(c) Europe (d) Rest of the World

Figure 19: Sectoral fit of the model in terms of input shares.