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Market Access and Welfare under Free Trade Agreements: Textiles under NAFTA

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The effective market access granted to textiles and apparel under the North American Free Trade Agreement (NAFTA) is estimated, taking into account the presence of rules of origin. First, estimates are provided of the effect of tariff preferences combined with rules of origin on the border prices of Mexican final goods exported to the United States and of U.S. intermediate goods exported to Mexico, based on eight-digit Harmonized System tariff-line data. A third of the estimated rise in the border price of Mexican apparel products is found to compensate for the cost of complying with NAFTA's rules of origin, and NAFTA is found to have raised the price of U.S. intermediate goods exported to Mexico by around 12 percent, with downstream rules of origin accounting for a third of that increase. Second, simulations are used to estimate welfare gains for Mexican exporters from preferential market access under NAFTA. The presence of rules of origin is found to approximately halve these gains.

Improved market access may not have been the main reason that Mexico entered the North American Free Trade Agreement (NAFTA), but it was certainly among the anticipated benefits at the negotiations. By 2002, NAFTA preferences in goods markets should have given Mexican exporters a 4 percent

average price margin over competitors in U.S. markets. On the basis of the tariff data, the average tariff preference for textiles and apparel was close to 8 percent.

Were it not for rules of origin that must be satisfied to sell in the United States at the tariff-inclusive price, market access would be expected to result in substantial rents for Mexican exporters to the United States. However, NAFTA negotiations reveal the importance of rules of origin in preferential trading arrangements. Krueger (1993) notes that the November 1992 draft chapter on rules of origin was 193 pages long and that the United States supported more stringent rules of origin, while Canada and Mexico preferred a low regional value-added content rule. She also notes that the interesting case to analyze was that in which the "US had a significant cost advantage relative to Mexico, but a cost disadvantage vis-à-vis the rest of the world" (p. 11). This is almost the exact case for trade in textiles (i.e., intermediate goods) between Mexico and the United States.

Krishna (2005) summarizes several contributions since Krueger's study, and more empirical research is starting to appear (see Cadot and others 2005b). As a result of this work, rules of origin are being increasingly recognized as the primary causes of the disappointing trade expansion effects of preferential trading arrangements. Rules of origin constrain the sourcing policies of final good producers, generating higher input and administrative compliance costs. Recent studies that rely on utilization rates of preferences to assess the effects of rules of origin on the benefits of trade preferences (Estevadeordal 2000; Anson and others 2005; Cadot and others 2005; Carrère and de Melo 2005) have found evidence of non-negligible compliance costs.

Trade flows, however, offer no information on the distribution of the rents generated by trade preferences, which is necessary to determine the likely welfare effects of preferential market access combined with rules of origin. To make further progress and assess the welfare effects of market access under free trade agreements, the effects of preferences on prices rather than on quantities or utilization rates must be estimated. This implies estimating the pass-through effects of tariff preferences on consumer prices (i.e., the extent to which tariff preferences translate into a corresponding increase in foreign producer prices)—an exercise similar to estimating exchange rate pass-through—which is carried out in section I. These estimates are then used in a simulation model to quantify the likely welfare effects for Mexican producers of preferential access in textiles and apparel under rules of origin in the United States.

Two recent studies estimate the effects of trade preferences on member-country prices in agreements between developed and developing countries using the textiles and apparel sector, where preferences are typically substantial. Olarreaga and Özden (2005) looked at the effect the Africa Growth and Opportunity Act had on the unit values of U.S. apparel imports from Africa, and Özden and Sharma (2004) explore rent capture by apparel producers from the Caribbean Basin Initiative. Their research shows that preferences translate

into higher border prices for preferred exporters and that pass-through of the tariff reductions is also substantial (between a third and a half).

However, the premise that higher border prices imply higher rents for producers is not necessarily true. First, as Olarreaga and Özden (2005) note, part of the increase in the border price may be captured by intermediaries in the exporting country, which may in fact be large companies based in the importing country. Second, as Özden and Sharma (2004) note, part of the border price increase may simply cover the additional cost of complying with rules of origin (higher input prices and other administrative costs).[1]

Cadot, Estevadeordal, and Suwa-Eisenmann (2005) suggest that rules of origin under NAFTA have the political function of creating a captive market for U.S. intermediate goods. In this case, the price of U.S. intermediate goods should be sensitive to rules of origin and tariff preferences downstream. This hypothesis is tested by regressing the border price of U.S. intermediate goods exported to Mexico (relative to the border price of those same goods when exported to nonpreferential destinations) on rules of origin and tariff preferences applied by the United States on downstream (re-exported) Mexican goods. Vertical links are captured using an input–output table.

This article contributes to the literature in three ways. First, it estimates pass-through effects in the presence of rules of origin from intermediate good producers to final good producers in partner countries (in this case, from textile producers in the United States to Mexican apparel producers). Second, it links pass-through estimates directly to rules of origin through the use of proxies. This is the first time that estimates of the pass-through effects of tariff preferences directly take into account the effects of rules of origin. Third, it sets up a partial equilibrium simulation model that gives the order of magnitude of these estimated effects on welfare.

When rules of origin are not controlled for, the elasticity of the border price of Mexican exports to U.S. tariff preference margins is close to 80 percent.[2] After rules of origin are controlled for, however, Mexican apparel producers retain only about half the preference margin. Rules of origin and tariff preferences downstream indeed affect U.S. intermediate good prices in a statistically significant way, contributing over half of the predicted price rise of U.S. exports

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1. The approach in this research is extended in the following ways. As in Olarreaga and Özden (2005), border prices for preferential and most-favored-nation apparel shipments are compared using unit values calculated from International Trade Commission trade data at the eight-digit level of the Harmonized System (HS). As in Özden and Sharma (2004), these border price differences are regressed on tariff preference margins and control variables. But instead of quantity variables, a vector of dummy variables for rules of origin are included using a database compiled by Estevadeordal (2000). In a second step, on the basis of those estimates, simulation techniques are used to calculate the likely market access improvement for Mexican exporters of apparel to the United States under NAFTA.

2. That is, a reduction of NAFTA tariffs below most-favored-nation tariffs by x percentage points translates into an increase in Mexican producer prices by $0.8x$ percentage points, and so a decrease in U.S. consumer prices by $0.2x$ percentage points or a 20 percent pass-through.

that is attributable to NAFTA (30 percent for rules of origin alone), and U.S. intermediate good producers are able to retain a sizable share of the rents generated by Mexican preferential tariffs. Inspired by these reduced-form econometric estimates, a partial equilibrium structural model is then simulated to calculate the orders of magnitude of the reduced welfare gain for Mexican exporters to the United States that is due to the presence of rules of origin.

I. MODELING PREFERENCE PASS-THROUGH UNDER RULES OF ORIGIN

Table 1 describes the data used in section II to estimate the pass-through effects under NAFTA. The 865 tariff lines (at the eight-digit level of the Harmonized System, HS) of the data set are spread across the 11 textiles and apparel chapters. Exports are concentrated in two sectors, knitted apparel (HS-61) and nonknitted apparel (HS-62), both final sectors according to the Broad Economic Categories classification used here. On average, utilization rates for exports of Mexican textiles and apparel that entered the U.S. market under NAFTA are fairly high, although they are lower for final goods (around 70 percent) than for intermediate goods. The preference margins were just about equal to the U.S. most favored nation tariff rates in 2002. Because the statistical work is carried out at the HS eight-digit level, tariffs and utilization rates are weighted by import shares (to prevent giving undue weight to tariff lines with marginal trade flows).

The cumulative density function confirms that utilization rates are higher for intermediate goods than for final goods, though the majority of Mexican exports to the United States are in the final goods category (figure 1). This heterogeneity in utilization rates at the HS eight-digit level reflects a combination of heterogeneity in firm cost characteristics and possibly of heterogeneity in product characteristics.[3]

As in most preferential trade agreements, preferential rules of origin in textiles and apparel under NAFTA include a change of tariff classification that can be applied at either the chapter level (HS two-digit level) or the heading level (HS four-digit level).[4] This requires the Mexican final product shipped to

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3. Carrère and de Melo (2005) develop a simple model in which heterogeneity in compliance costs across firms leads to utilization rates in the range $(0 < u_i < 1)$ and exploit this heterogeneity to come up with an estimate of the breakdown of compliance costs associated with RoO into a (fixed) administrative component and a distortionary component.

4. In addition to the product-specific rules described in table 1, rules of origin also include regime-wide rules. In the case of NAFTA, these include a *de minimis* (or tolerance) criterion, which stipulates a 7 percent maximum share of nonoriginating materials that can be used without affecting the origin of the final product; bilateral cumulation, which stipulates that producers in Mexico can use inputs from the United States (and Canada) without affecting the final good's originating status provided that the inputs are themselves originating (i.e., provided that they themselves satisfy the area's rules of origin); roll-up, which states that nonoriginating materials (which have acquired origin by meeting specific processing requirements) maintain this origin when used as inputs in a subsequent transformation (i.e., the non-originating materials are no longer taken into account in calculating value added; and a self-certification method. In the case of NAFTA, duty-drawbacks are not allowed. For more details, see Cadot and others (forthcoming), table 2.

TABLE 1. Mexican Exports of Textiles and Apparel to the United States and Description of Rules of Order under North American Free Trade Agreement

| | | | | | | Rules of origin (percent of HS eight-digit tariff lines) | | | | |
| | | | | | | Change in tariff classification | | Technical requirement and change in tariff classification | | |
Chapter	Number of HS eight-digit tariff lines	Share of total (percent)	Share of Mexican exports to United States (percent)	Mean utilization rate[a] (percent)	Mean tariff preference margin[a] (percent)	At heading level (HS four-digit)	At chapter level (HS two-digit)	At heading level (HS four-digit)	At chapter level (HS two-digit)	Final goods
Section 11: Textiles and textile articles	865	100	100	80.70 (77.93)	9.97 (6.63)	15.84	34.2	0.69	49.25	53.53
Chapter										
50: Silk	1	0.12	0.01	—	—	100	0	0	0	0
51: Wool, fine, or coarse animal hair; horsehair yarn and woven fabric	24	2.77	0.33	98.85 (99.86)	12.82 (17.45)	91.67	8.33	0	0	4.17
52: Cotton	90	10.4	1.96	92.60 (97.95)	8.36 (8.15)	68.89	27.78	3.33	0	3.33
53: Other vegetable textile fibers; paper yarn and woven fabrics of paper yarn	13	1.5	0.02	83.65 (83.69)	1.67 (3.09)	53.85	46.15	0	0	0
54: Man-made filaments	67	7.75	2.61	94.3 (99.81)	11.86 (19.78)	0	98.51	0	1.49	5.97
55: Man-made staple fibers	68	7.86	1.79	90.34 (98.81)	11.31 (9.44)	57.35	38.24	1.47	2.94	5.88
56: Wadding, felt, and nonwovens; special yarns; twine, cordage, ropes, and cables and articles thereof	52	6.01	1.32	71.89 (81.63)	7.34 (6.97)	0	98.078	0	1.92	1.92
57: Carpets and other textile floor coverings	27	3.12	0.18	95.96 (97.58)	3.07 (3.71)	0	100	0	0	100
58: Special woven fabrics; tufted textile fabrics; lace; tapestries; trimmings; embroidery	45	5.2	0.47	87.48 (97.09)	7.04 (8.49)	0	100	0	0	4.44

(*Continued*)

TABLE 1. Continued

| | Number of HS eight-digit tariff lines | Share of total (percent) | Share of Mexican exports to United States (percent) | Mean utilization rate[a] (percent) | Mean tariff preference margin[a] (percent) | Rules of origin (percent of HS eight-digit tariff lines) | | | | |
| | | | | | | Change in tariff classification | | Technical requirement and change in tariff classification | | Final goods |
						At heading level (HS four-digit)	At chapter level (HS two-digit)	At heading level (HS four-digit)	At chapter level (HS two-digit)	
59: Impregnated, coated, covered or laminated textile fabrics, textiles articles of a kind suitable for industrial use	42	4.86	0.79	87.68 (95.98)	4.53 (5.05)	7.14	90.48	0	2.38	0
60: Knitted or crocheted fabrics	4	0.46	0.01	99.77 (99.76)	18.02 (17.71)	0	100	0	0	0
61: Articles of apparel and clothing accessories, knitted or crocheted	145	16.76	33.85	69.41 (62.16)	13.13 (6.40)	1.38	2.069	0	96.55	100
62: Articles of apparel and clothing accessories, not knitted or crocheted	205	23.7	48.74	71.03 (82.91)	11.11 (6.03)	0	0.49	0	99.51	100
63: Other made-up textile articles; sets; worn clothing and worn textile articles; rags	82	9.48	7.91	88.10 (92.80)	7.85 (5.59)	1.22	2.44	2.44	93.9	86.59

—, not available.

[a]Figure in parentheses is the weighted average, which reflects the importance of each tariff line in total Mexican exports to the United States.

Note: Exceptions to change in tariff classification (generally prohibiting the use of nonoriginating materials from a certain subheading, heading, or chapter) also exist but are not mentioned since they concern 99 percent of the tariff lines in section 11. The sample period is 2002; sample data are from the textiles and apparel sector (HS eight-digit level, section 11).

Source: Authors' analysis based on data described in the text.

FIGURE 1. Cumulative Density Function of Utilization Rates by Mexican Exporters under NAFTA in Textiles and Apparel Sector 2002

Final goods (463 observations)   **Intermediate goods (402 observations)**
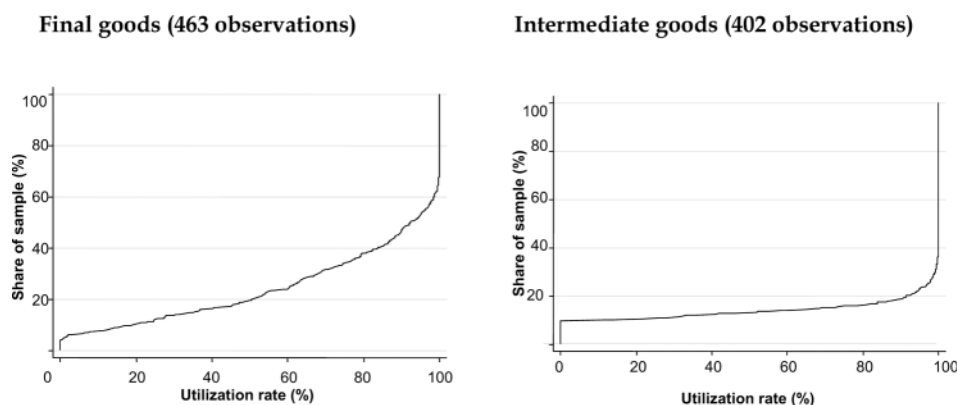
Source: Authors' analysis based on data described in the text.

the United States to be classified in a chapter (or heading) of the HS different from its imported intermediate components. Clearly, a change of chapter is more restrictive than a change of heading. Most sectors subject to a change in heading or chapter are classified as intermediate. Except carpets (chapter 57), final goods not only include a change of tariff classification but also rely on a technical requirement imposed on the final good's production process to confer origin. Changes of tariff classification and technical requirements are not the only criteria applied. In the case of textiles and apparel, 99 percent of the tariff lines also include an exception (not included in table 1). Exceptions lead to considerable complication for customs officials in determining origin in preferential agreements.[5]

The textiles and apparel sector has several characteristics that merit attention here. First, there is product differentiation, which suggests that there might be price interaction between member and nonmember countries. If so, modeling this interaction might be useful (as in Chang and Winters 2002), rather than assuming perfect competition (as in Özden and Sharma 2004).

Second, virtually all nonpreferential trade in textiles and apparel products is governed by the Agreement on Textiles and Clothing, the successor to the Multi-Fibre Arrangement. Under the Agreement on Textiles and Clothing agreed on as part of the Uruguay Round, quotas on garments were to be progressively enlarged until final phaseout in January 2005. But importing

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5. Since an exception applies to virtually all tariff lines in textiles and apparel, it cannot be included in the statistical analysis here, which relies on the use of dummy variables. Furthermore, exceptions can be positive (the criterion does not apply) or negative (a further criterion must apply). Exceptions usually require a further criterion, beyond a change of tariff classification, to be met. A particularly vivid example in the case of NAFTA is the case of men's overcoat made of wool (HS-62011). Establishing origin requires in most instances a change in chapter with the restriction that the visible lining must be produced from yarn and finished in either party (see the detailed description in Brenton and Imawaga 2005).

countries backloaded the enlargement of binding quotas until the very end of the transition phase—the end of 2004 (Spinanger 1998). Thus, during the sample period (2000–02), most of the world's nonpreferential trade in garments was still affected by binding quotas. Intra-NAFTA trade in textiles and apparel, by contrast, has been governed by annex 300B of NAFTA, which superseded the Multi-Fibre Arrangement and the Agreement on Textiles and Clothing and mandated an immediate elimination of quotas on "originating" Mexican goods (those that comply with the stipulated rules of origin) and a gradual elimination of quotas for "nonoriginating" Mexican goods (those that do not comply with the stipulated rules of origin).[6] Under a regime of binding quantitative restrictions on nonpreferred exporters, price interaction did not exist between Mexican producers and non-NAFTA exporters because Mexicans were operating along a residual demand curve, whose elasticity was unaffected by the pricing decisions of quota-constrained competitors. These observations justify the monopolistic competition modeling framework below with product differentiation.

Modeling Pass-Through: A Monopolistic Competition Framework

The model outlined here features monopolistic competition with Dixit–Stiglitz preferences on the final good market but disregards price competition between suppliers. This allows an expression of the pass-through that depends on the presence of rules of origin to be derived.[7]

Suppose then that n different Mexican final goods, indexed by j, are sold on the U.S. market in competition with goods imported from the rest of the world. Let x_j be the quantity of Mexican goods sold and x_j^* the quantity of foreign goods sold (i.e., imports from the rest of the world). There is no U.S. production of final goods. And let X_0 be an aggregate of other goods consumed by U.S. households. Preferences are

$$(1) \qquad U(\cdot) = X_0 + \sum_{j=1}^{n} \ln X_j$$

where

$$(2) \qquad X_j = \left[x_j^{\rho_j} + \left(x_j^* \right)^{\rho_j} \right]^{1/\rho_j}.$$

6. The NAFTA Treaty, annex 300B, section 1, §2.

7. A similar framework with product differentiation (the so-called "Armington framework") but without monopolistic competition across suppliers is also adopted in the simulation exercise of section III. This slightly different framework is largely equivalent since it also implies less than full rent capture by Mexican exporters even without rules of origin on intermediate goods and obviates the need to make assumptions about economies of scale that is typical in the monopolistic competition framework. To shorten the presentation of the simulation model in section III, all instances in this section where the simulation model departs from the structure presented here are noted.

The quasi-linearity of U ensures that the marginal utility of income is constant and equal to 1, while the log form of the second term ensures that an interior budget allocation holds between the n Mexican goods and other goods. This means that tariff changes have no income effects, an assumption maintained in the simulations of section III. Additivity of preferences implies strong separability, so two-stage budgeting holds, confining the price effects of tariff preferences to apparel products. The elasticity of substitution between Mexican and foreign brands of good j is

$$(3) \qquad \sigma_j = \frac{1}{(1 - \rho_j)}$$

where p_j is the border price of Mexican goods and p_j^* the border price of foreign goods. When q_j is the internal price of Mexican goods, q_j^* the internal price for foreign goods, and t_j the ad valorem tariff,

$$(4) \qquad q_j = (1 + t_j)p_j.$$

An equation that accounts for the difference between most-favored-nation and NAFTA tariffs will be introduced shortly.

Let

$$(5) \qquad Q_j \equiv q_j^{1-\sigma_j} + (q_j^*)^{1-\sigma_j}.$$

The U.S. demand for the Mexican brand of good j is then

$$(6) \qquad x_j = \left(\frac{q_j^{-\sigma_j}}{Q_j} \right) E_j$$

where

$$(7) \qquad E_j = q_j x_j + q_j^* x_j^*$$

is the subexpenditure on good j. The own-price elasticity of U.S. demand for Mexican final good j is

$$(8) \qquad \varepsilon_j = \sigma_j + \frac{(1 - \sigma_j)q_j^{1-\sigma_j}}{Q_j}.$$

The equations for the foreign good are similar.

Mexican final goods are produced by combining value-added with m different intermediate goods indexed by i under a Leontief technology with input–output coefficient a_{ij}. Each intermediate good can come from either the United States or the rest of the world, because the goods are perfect substitutes.[8] Let $\bar{z}_{ij}$ denote the

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8. In the simulations below, intermediate goods by origin enter into production according to a constant elasticity of substitution aggregator function.

quantity of "composite" (U.S and foreign) intermediate good i used in the production of final good j; that is, $\bar{z}_{ij} = z_{ij} + z_{ij}^*$. Then,

$$(9) \qquad x_j = \min\left\{F_j(K_j, L_j); \frac{\bar{z}_{1j}}{a_{1j}}; \cdots ; \frac{\bar{z}_{mj}}{a_{mj}}\right\}.$$

In the absence of rules of origin, perfect substitutability means that Mexican choice of intermediate goods (U.S. or foreign) would be bang–bang. If U.S. intermediate goods were all more expensive than foreign ones, for instance, they would not be used at all. However, with rules specifying a minimum content r_j (expressed here for simplicity as a proportion of total intermediate use), Mexican exporters have to use U.S. intermediate goods in proportion r_j and foreign intermediate goods in proportion $1 - r_j$.[9]

Let $C_j(x_j)$ be the cost function dual to F_j and $\phi_j(p_j) \equiv C_j[x_j(p_j)]/x_j(p_j)$ the corresponding unit-cost function, and suppose that $\phi_j' > 0$. If p_i is the price of U.S. intermediate good i and p_i^* the price of its foreign substitute, the marginal cost of Mexican final good j is

$$\Phi_j = \phi_j + \sum_{i=1}^m a_{ij}\left[r_j p_i + (1 - r_j)(1 + t_i)p_i^*\right]$$

$$(10)$$

$$= \phi_j + \sum_{i=1}^m a_{ij}\bar{p}_i$$

where

$$(11) \qquad \bar{p}_i = r_j p_i + (1 - r_j)q_i^*$$

and

$$(12) \qquad q_i^* = (1 + t_i)p_i^*.$$

A similar expression holds for the functional forms adopted in section III, where binding rules of origin raise final good unit costs.

Optimal pricing by Mexican final good exporters implies

$$(13) \qquad \left(1 - \frac{1}{\varepsilon_j}\right)q_j = (1 + t_j)\left(\phi_j + \sum_{i=1}^m a_{ij}\bar{p}_i\right).$$

9. As summarized in table 1, there is actually no regional value content in the textiles and apparel sector, the most common rules of origin requiring changes of tariff classification. Exceptions apply to 99 percent of textiles and apparel tariff lines, and technical requirements apply to 50 percent of them. Given the large increase in Mexican intermediate purchases from the United States since NAFTA, it can be safely assumed that these requirements were designed to raise the regional value content of Mexican production. Several papers collected in Cadot and others (forthcoming) document how NAFTA's exceptions, changes of tariff classification, and technical requirements have been calibrated to make U.S. sourcing the only option.

Because $\bar{p}_i$ is an increasing function of r_j whenever $p_i > q_i^*$, the supply price of the Mexican final good in the United States is itself an increasing function of the local content requirement r_j.[10]

MEXICAN PASS-THROUGH. Mexican pass-through is addressed here first, then a slightly different version of the model is used to study U.S. pass-through. Assume first that the price of U.S. intermediate goods is fixed. Let p_j^N stand for NAFTA producer prices, p_j^M for most-favored-nation producer prices, t_j^N for NAFTA tariffs, and t_j^M for most-favored-nation tariffs. And let $\Delta p_j \equiv p_j^N - p_j^M$ and $\Delta t_j \equiv t_j^M - t_j^N$. Differentiating equation 13 and linearizing show that

$$(14) \qquad \frac{\Delta p_j}{p_j^M} \simeq \psi_j \frac{\Delta t_j}{1 + t_j^M} + \Theta_j r_j$$

where $\Theta_j > 0$ and $\psi_j > 0$ are expressions given in full in supplemental appendix 1 (available at http://wber.oxfordjournals.org). The first term captures the impact of NAFTA tariff preferences on Mexican producer prices, so $1 - \psi_j$ measures the pass-through effect (i.e., the impact on U.S. consumer prices) resulting from preferential market access. The second term, which depends on input–output relationships, the price of U.S. intermediate goods, and the elasticity of demand for the final Mexican good in the United States, measures the impact on Mexican border prices of increases in the price of the intermediate good "exported" from the United States and induced by rules of origin.

In this model, both preferential rates and rules of origin are assumed to be exogenous. In general (and certainly in the case of NAFTA, as explained by Estevadeordal 2000), negotiations can be viewed as a game played by three parties in which negotiation is over two instruments: speed of preferential tariffs phaseout and rules of origin criteria. Thus, there is a potential for multicollinearity between r_j and $\Delta t_j / (1 + t_j^M)$ in equation 14. However, this article uses the most recent trade data (2000–02), covering a period when the phaseout was virtually complete, and nearly all tariff preferences were equal to most-favored-nation tariffs.[11] The U.S. most-favored-nation tariff can be considered free from endogeneity to NAFTA's rules of origin.[12] But a more ambitious assessment of rules of origin would rely on a political economy approach, as in Cadot, Estevadeordal, and Suwa-Eisenmann (2005).

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10. If $p_i \leq q_i^*$, the local content requirement is not binding.

11. For example, on the Mexican method sample below for 2000–02, the preference margin for Mexican imports was equal to the U.S. most-favored-nation tariff for 1,176 of 1,304 tariff lines—that is, 90 percent of the HS eight-digit tariff lines.

12. In the context of the debate on the relation between preferential trade arrangements and multilateral trade liberalization, Limão (forthcoming) finds evidence that the U.S. most-favored-nation tariffs could be endogenous because U.S. preferential trade arrangements led to less subsequential multilateral trade liberalization.

U.S. PASS-THROUGH. To consider the market for U.S. intermediate good i, the assumption that its price is fixed is relaxed. Let $z_i\,(p_i)$ be its U.S. supply; if it is exhausted by Mexican demand, the market-clearing condition is

$$(15) \qquad \sum_{j=1}^{n} a_{ij}x_j\left(p_j\right) = z_i(p_i).$$

Differentiating equation 15 and letting ε_i^s be the supply elasticity of intermediate goods and ε_j^s the supply elasticity of final goods result in:

$$(16) \qquad \frac{\Delta p_i}{p_i^M} \simeq \frac{z_i}{p_i^2 \varepsilon_i^s} \sum_{j=1}^{n} a_{ij}x_j\varepsilon_j^s \frac{\Delta p_j}{p_j^M},$$

which is similar in form to equation 14 but depends on downstream final good prices.[13]

II. PASS-THROUGH ESTIMATION AND RESULTS

In equation 14, rules of origin took the form of a regional value content. This is not the case in the textiles and apparel sector, though exceptions and technical requirements have similar effects. Dummy variables are used to capture the effects of the current rules, with each representing a specific legal form of rules of origin. CC_j is equal to 1 if a change of chapter on good j is required, and $TECH_j$ is equal to 1 if a technical requirement is imposed.[14] The equation to be estimated for the Mexican pass-through is thus

$$(17) \qquad \frac{\Delta p_j}{p_j^M} = \alpha_0 + \alpha_1 \frac{\Delta t_j}{1 + t_j^M} + \alpha_2 CC_j + \alpha_3 TECH_j + u_j.$$

All parameter estimates are expected to be positive, and $1 - \alpha_1$ measures the Mexican pass-through.

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13. This may raise an endogeneity issue. As in equation 14, $\Delta p_i/p_i^M$ depends on a weighted sum of $\Delta p_i/p_i^M$ in which the weights are the input–output coefficients b_{ij}. In equation 14, $\Delta p_i/p_i^M$ can be similarly shown to depend on a weighted sum of $\Delta p_i/p_i^M$ through Θ_j (see supplemental appendix 1). Thus, the link between the regressor and the error term in equation 14 is through two nested weighted sums and is thus, although linear, very indirect.

14. As an alternative, Estevadeordal (2000) index could have been used as a proxy for the effect of rules of origin. Such an approach would not be appropriate for the textiles and apparel sector. First, besides the ubiquitous exceptions, only three types of rules of origin are used: change in tariff classification at the heading level, change in tariff classification at the chapter level, and a technical requirement. Thus, for textiles and apparel, Estevadeordal's index takes only three different values (out of seven). Given that, changes in headings and changes in chapters are perfectly collinear (i.e., a tariff line without a change in chapter systematically has a chapter heading and vice versa), using Estevadeordal's index does not add more variability to the rules of origin indicator than the dummies CC and $TECH$. Moreover, the specification used here does not impose an a priori ranking between the different combinations of rules of origin.

The equation to be estimated for the U.S. pass-through is

(18)
$$\frac{\Delta p_i}{p_i^M} = \beta_0 + \beta_1 \frac{\Delta t_i}{1 + t_i^M} + \beta_2 CC_i + \beta_3 TECH_i + \beta_4 \sum_j b_{ij} \frac{\Delta t_j}{\left(1 + t_j^M\right)}$$
$$+ \beta_5 \sum_j b_{ij} CC_j + \beta_6 \sum_j b_{ij} TECH_j + \varepsilon_i$$

The U.S. pass-through of Mexican tariff preferences, measured by $1 - \beta_1$, is estimated after controlling for two types of effects relevant to the determination of U.S. intermediate good prices. The first type, measured by coefficients β_2 and β_3, is the effect of rules of origin applying to U.S. intermediate goods themselves. To avoid unnecessarily complicating the calculations, this effect is not considered when intermediate goods are not assumed to be produced with imported intermediate goods, but it does occur in the simulation in section III where Mexican final goods use imported intermediate goods.

The second type is demand effects, which are measured by coefficients β_4 (effect of downstream U.S. preferences on Mexican goods using intermediate i filtered by input–output coefficients a_{ij}), β_5, and β_6 (the same effect for downstream rules of origin). These effects are instruments for the prices of downstream final goods, which are endogenous, as argued above. Intuitively, a higher U.S. preference on downstream Mexican goods raises the induced demand for intermediate goods and thus their price. Likewise, stiffer rules of origin downstream pick up the "captive market" effect discussed in the introduction. Thus, all coefficients are expected to be positive, and the null hypothesis for β_5 and β_6 is that there is no captive market effect.

Equation 16 is estimated with panel data using the weighted least squares estimator, which performs better than ordinary least squares on the sample because it modulates the importance of each observation in the final solution (details are supplied in supplemental appendix 4). This method assigns each tariff line a weight that reflects its importance in total Mexican exports to the United States (NAFTA and most-favored-nation regimes combined). In the same way, equation 17 is estimated on cross-section data using the weighted least squares estimator with a weight that reflects the importance of each line in total U.S. exports to Mexico.[15] (Input–output data are available for only 1 year.)

Data

Unit values and tariff preference margins are compiled at the HS eight-digit level from U.S. Department of Commerce, Department of Treasury, and International

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15. It could be that unobserved commodity characteristics affect the difference between NAFTA and most-favored-nation export prices, even at the HS-8 level. In principle, this could be corrected by the use of difference-in-difference estimation (comparing before and after NAFTA). However, the difference between NAFTA and most-favored-nation export prices cannot be computed before NAFTA, so this method is unusable here.

Trade Commission data, as detailed in supplemental appendixes 2 and 3.[16] For equation 17, the sample includes all HS eight-digit lines of section 11 (textiles and textile articles as defined in the HS trade classification; see supplemental appendix 2) for 2000–02. Only tariff lines with positive U.S. imports of Mexican products and strictly positive U.S. imports from Mexico under NAFTA are included—that is, only tariff lines with positive rates of utilization u_{jt} of NAFTA's preferential regime, since when $u_{jt} = 0$, there is no rent to share.[17]

Two methods are used to compute $\Delta p_j / p_j^M$, the dependent variable in the estimation of the Mexican pass-through in equation 17. The first method, called the Mexican method because it compares the unit value of the same Mexican good imported under NAFTA and most-favored-nation tariff rates, has the advantage of using two unit values that are strictly comparable in the calculation, but it reduces the size of the sample by excluding tariff lines with 100 percent utilization rates (nearly half the observations). The second method, called the rest of the world (ROW) method, includes all observations but measures the relative price $\Delta p_j / p_j^M$ as the percentage difference between the border price (unit value) of a good imported from Mexico under NAFTA and the border price of the same good imported from all U.S. import sources including Mexico under the most-favored-nation regime. In contrast to the Mexican method, the ROW method introduces some product heterogeneity.

The sample used for the estimation of equation 18 includes all intermediate goods used in manufacturing Mexican textiles and apparel products for export to the United States under the same conditions as before—that is, positive Mexican imports from the United States under NAFTA with utilization rates of 0–100 percent. Tariff preference is now computed on Mexico's imports of U.S. intermediate good i, while the rules of origin are the same as before (because the same rules apply to all of NAFTA's signatories). In addition to tariff preferences and rules of origin on imports of U.S. intermediate goods i, the regression includes tariff preferences and rules of origin on downstream

16. Unit values are calculated by dividing import values by volumes. This method yields notoriously noisy proxies for the true prices at which goods are sold, as customs records of physical volumes are typically less reliable than their records of values, and both are affected by composition problems. Composition problems are somewhat mitigated at deep levels of disaggregation, but then the quantities involved tend to be smaller, and aberrant numbers are encountered more frequently. The HS eight-digit level is arguably the best compromise in this regard. U.S. tariffs are calculated by taking the ratio of collected duties to custom value at the tariff-line level in order to take into account any special subregime or partial exemption.

17. There may be no rent to capture from those lines because of very stringent rules of origin. This would indicate a sample selection problem. However, the lines with $u_{jt} = 0$ account for only 6.7 percent of the total HS-8 tariff lines, and there is no evidence that rules of origin are more restrictive for those lines (for instance, only 37 percent of lines with $u_{jt} = 0$ have to satisfy a technical requirement compared with 68 percent for lines with $0 < u_{jt} < 100$). Nevertheless, with a selection bias, the cost of rules of origin for Mexican exporters is underestimated (based on the assumption that if complying with rules of origin is costly enough, and if tariff preferences do not compensate for these larger costs, the utilization rate would be 0), which reinforces the argument defended in the article.

TABLE 2. Descriptive Statistics, Mexican Pass-Through (percent)

Good j	Mexican method		ROW method	
	All goods	Only final goods	All goods	Only final goods
Number of observations	1,304	913	2,497	1,324
u_{jt} [a]	73.24	69.58	75.68	71.78
$\frac{\Delta p_{jt}}{p_{jt}^{M}}$ [a]	4.58	4.87	3.99	4.55
$\frac{\Delta t_{jt}}{1+t_{jt}^{M}}$ [a]	6.07	5.87	6.22	5.79
CC_{j} [b]	91.87	92.36	82.66	92.56
$TECH_{j}$ [b]	65.57	80.36	48.34	88.60
Intermediate goods	29.98	—	46.98	—
Final goods	70.02	—	53.02	—

—, not applicable.

[a]Weighted averages (reflecting the importance of each tariff line j in total Mexican exports to the United States).

[b]Share of HS eight-digit level tariff lines.

Note: The sample period is 2000–02. Sample data are from the textiles and apparel sector (HS eight-digit level, section 11).

Source: Authors' analysis based on data described in the text.

good j weighted by input–output coefficients b_{ij}.[18] Table 2 reports descriptive statistics for the variables used in equation 16 and table 3 for the variables in equation 18.

A change of chapter because of rules of origin together with bilateral cumulation implies that when nonoriginating (rest of the world) inputs are used, the transformation in Mexico must be substantial enough for the final good to belong to a chapter that is not identical to that of its nonoriginating components. This amounts to an implicit regional value content for value-added and originating inputs, taken together, relative to the value of nonoriginating inputs. Such a requirement is more complicated that in the simple model of section I but has essentially the same effect—and is modeled as a regional value content in the simulation in section III. Cadot, Estevadeordal, and Suwa-Eisenmann (2005) document how technical requirements tend to be fine-tuned to suit special interests, with equivalent cost-raising effects.

Under the Mexican method, 91.9 percent of tariff lines at the HS eight-digit level had to satisfy a change of classification at the chapter levels, and 65.6

18. Because of lack of data, these "input–output" coefficients are computed from the U.S. input–output table for 2000 converted from U.S. input–output codes (approximately 300 lines) to the HS eight-digit level, the degree of disaggregation at which unit values are measured. "Blowing up" of aggregate coefficients into HS eight-digit level disaggregation was done by attributing to each HS eight-digit line a value of intermediate good sales equal to the inverse of the number of HS eight-digit lines falling in its U.S. input–output code category.

TABLE 3. Descriptive Statistics, U.S. Pass-Through (percent)

Good i	All goods	Only intermediate goods
Number of observations	837	473
$\frac{\Delta p_i}{p_i^M}$ [a]	12.16	13.33
$\frac{\Delta t_i}{(1+t_i^M)}$ [a]	12.32	13.76
CC_i [b]	82.32	68.92
$TECH_i$ [b]	42.29	7.61
$\sum_j a_{ij} \frac{\Delta t_j}{(1+t_j^M)}$ [a]	5.71	5.72
$\sum_j a_{ij} CC_j$ [a]	34.01	42.33
$\sum_j a_{ij} TECH_j$ [a]	68.80	67.24

[a]Weighted averages (reflecting the share of each U.S. intermediate sales of line i to Mexican textiles and apparel sector).
[b]Percentage of HS eight-digit tariff lines.
Note: The sample period is 2000. Sample data are from the textiles and apparel sector (HS eight-digit level, section 11).
Source: Authors' analysis based on data described in the text.

percent had technical requirements on the product or process (see table 2). The share of tariff lines affected by technical requirements strongly increases if the sample is restricted to final goods.

Results

Table 4 reports the Mexican pass-through estimates using the Mexican method. (Results obtained using the ROW method, which were almost identical, are in table S5.1.) The first set of estimates includes only the tariff preference margin (and time effects) as explanatory variables. Coefficients for the rate of tariff preference are always significant at the 5 percent level and robust to the choice of method, suggesting that Mexican producers retain about 80 percent of the preference margin. The null hypothesis of no pass-through (no change in U.S. consumer price or border price increase equal to 100 percent of the tariff preference) cannot be rejected at the 5 percent level, indicating that Mexican producers retained a fairly large share of the rents created by trade preference. The extent of pass-through is consistent with a differentiated product model with a relatively high elasticity of substitution between suppliers to the United States. Furthermore, because the effects of tariff changes in a period with no rules of origin are not estimated here, it is unknown whether these effects reflect some of the cost-increasing effects for Mexican producers that result from applying rules of origin.

However, when dummy variables for the presence of rules of origin are included, the picture changes. Part of the border price increase now compensates Mexican producers for the cost of complying with NAFTA's rules of origin,

TABLE 4. Regression Results, Mexican Pass-Through, Mexican Method

$\frac{\Delta p_{jt}}{P^M_{jt}}$	All goods		Only final goods		All goods		Only final goods	
	Coefficient	t-statistics	Coefficient	t-statistics	Coefficient	t-statistics	Coefficient	t-statistics
$\frac{\Delta t_{jt}}{1+t^M_{jt}}$	0.784**	3.29	0.799**	3.33	0.501**	2.98	0.474**	3.04
CC_j	—	—	—	—	0.998*	1.97	1.054**	2.73
$TECH_j$	—	—	—	—	1.674**	3.75	1.989**	4.51
Number of observations	1,304		913		1,304		913	
Adjusted R^2	0.51		0.51		0.55		0.56	

—, not applicable;
*, significant at the 10 percent level;
**, significant at the 5 percent level.

Note: Constant and time effects are included but not reported. The sample period is 2000–02. Sample data are from the textiles and apparel sector (HS eight-digit level, section 11). The estimator used is weighted least squares.

Source: Authors' analysis based on data described in the text.

whose coefficients are large, positive, and significant.[19] The coefficient on the tariff preference falls from 0.784 to 0.501, meaning that Mexican producers retain only about half the tariff preference margin. This suggests that previous estimates of the share of rents retained by producers were significantly overestimated.

The coefficients on rules of origin variables also suggest that these requirements have a significant effect on price and therefore—presumably—on production costs.[20] This is consistent with Carrère and de Melo's (2005) research on the relative costs of various types of rules of origin under NAFTA. As intuition suggests, the effect of rules of origin is also stronger and more precisely estimated when the sample is restricted to final goods (as defined in the Broad Economic Categories classification).

If such a significant share of the preferences granted to Mexican producers is lost, where do they go? On one hand, rules of origin may well be dissipative barriers (like discriminatory product standards), raising production costs without directly creating offsetting rents elsewhere. On the other hand, they may generate rents upstream in the value chain. To explore this hypothesis, the pass-through of Mexican preferences by U.S. exporters of intermediate goods is now analyzed.

Mexico's tariff preference has a highly significant and quantitatively large effect, with a pass-through of only 38 percent over the whole sample and no pass-through at all when the sample is restricted to intermediate goods (table 5). This suggests that U.S. intermediate good suppliers may have substantial market power relative to Mexican final good assemblers. Since the United States sells mostly intermediate textile products to Mexico, it would appear that U.S. producers retain 93 percent of the price increase available to U.S. suppliers from not having to pay the Mexican tariff.

The effect of rules of origin on the price of U.S. exports to Mexico is not significant, suggesting, as expected, that rules of origin affect final good

19. Because dummy variables serve as proxies for rules of origin and the dependent variable is measured in percentage points, the coefficients give the estimated price increase, measured in percentage points, attributable to the presence of rules of origin.

20. By 2000–02, quantitative restrictions on all Mexican textiles and apparel exports had been phased out. A few residual quotas remained on nonoriginating Mexican goods in peculiar cases (for example, upon use of NAFTA's safeguard clause; see U.S. Customs Service 1998). As for quantitative restrictions on most-favored-nation producers under the Agreement on Textiles and Clothing, they contributed to create a rent for Mexican producers that is not taken into account in the equation here. If those rents were positively correlated with the presence of rules of origin, the estimates here might attribute to the presence of rules of origin the effect of the rent from quantitative restrictions and then overestimate the rules of origin coefficient, though the coefficient on the price term would still be consistent (provided that the rents would be uncorrelated with the price term). The authors are grateful to a referee for pointing this out.

TABLE 5. Regression Results, U.S. Pass-Through

$\frac{\Delta p_i}{p_i^M}$	All goods		Only intermediate goods	
	Coefficient	*t*-statistics	Coefficient	*t*-statistics
$\frac{\Delta t_i}{1+t_i^M}$	0.620**	6.54	0.928**	6.76
CC_i	−1.516	−1.31	1.405	0.72
$TECH_i$	2.319	1.11	1.983	1.51
$\sum_j a_{ij} \frac{\Delta t_i}{1+t_j^M}$	0.689**	3.86	0.637**	2.07
$\Sigma_j a_{ij} CC_j$	0.037*	1.86	0.022	0.54
$\Sigma_j a_{ij} TECH_j$	0.053**	2.01	0.119**	2.39
Cst	−3.848*	−1.67	−9.898**	−2.28
Number of observations	837		473	
Adjusted R^2	0.54		0.51	

—, not applicable;
*, significant at the 10 percent level;
**, significant at the 5 percent level.
Note: Constant and time effects are included but not reported. The sample period is 2000–02. Sample data are from the textiles and apparel sector (HS eight-digit level, section 11). The estimator used is weighted least squares.
Source: Authors' analysis based on data described in the text.

assemblers in Mexico more than intermediate good producers in the United States. By contrast, U.S. tariff preferences on downstream final goods have a large and significant effect on the price of U.S. intermediate goods used to fabricate them. The strength of the effect (with a pass-through of only 31–36 percent) is indeed a surprise, given how imperfectly the input–output links are measured. More important here, rules of origin downstream matter, although their effect is quantitatively small (unsurprising, given that the effect is filtered by input–output coefficients). For the entire sample, changes of chapter and technical requirements are significant, confirming anecdotal evidence that technical requirements are often manipulated by upstream interests to distort the input choices of downstream industries.

The estimates in table 5 lead to a decomposition of the sources of the price increase of U.S. intermediate (textile) exports of textiles and apparel to Mexico of 12.16 percent, computed from the raw data in table 3. The predicted rise in the price of U.S. exports to Mexico for all exports computed from the estimated coefficients in table 5 at the sample mean is 12.6 percent, which is close to the observed value of 12.2 percent (see table 3). Similar decomposition results hold when only exports of intermediate goods are considered. The predicted price rise attributable to the combination of tariff preferences and rules of origin can be decomposed as follows: 46 percent is due to the Mexican tariff preference $\left[\Delta t_i / \left(1 + t_i^M\right)\right]$, 24 percent to U.S. preferences downstream $\sum_j b_{ij}\left[\Delta t_j / \left(1 + t_j^M\right)\right]$, and 30 percent to rules of origin downstream

$(\sum_j b_{ij} CC_j + \sum_j b_{ij} TECH_j)$. The last two effects are felt upstream through input–output coefficients.[21]

In sum, on the basis of the results for Mexican exports of final goods to the United States and for U.S. exports of intermediate goods to Mexico, only half the price increase from selling in the United States without having to pay the U.S. tariff is retained by Mexican exporters, while U.S. exporters retain over 90 percent of the price increase from being able to sell in the Mexican market without having to pay the tariff. Rules of origin contribute significantly to the lower pass-through for Mexican exporters but not for U.S. exporters. Finally, U.S. exporters of intermediate goods appear to derive market power from the increase in demand for their products from downstream Mexican producers of final apparel goods. These results are captured in the stylized simulations reported below.

III. NAFTA Welfare Effects for Mexican Producers: Some Simulations

Taken together, the econometric evidence seems to suggest that Mexican producers of final goods may have hardly increased their sales to the United States, while U.S. producers of intermediate goods substantially increased their sales to Mexico. If so, the welfare benefits from earning higher rents from sales in the U.S. market since the signing of NAFTA should be less than in the absence of rules of origin.

The data confirm these predictions. NAFTA resulted in a sharp increase of 24 percent in the ratio of intermediate good (textiles) purchases by Mexico from the United States relative to purchases from the rest of the world since NAFTA, while the corresponding ratio of sales of final goods to the United States relative to the rest of the world increased only 2 percent. Likewise, NAFTA has been accompanied by a pattern of vertical exchange of the offshore assembly type whereby the United States ships semifinished goods for assembly in Mexico and then reimports them as finished products.[22] Taken together, these quantity

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21. It may be tempting to interpret the negative value for the constant as evidence of strategic price cuts in response to a decrease in the prices charged by either U.S. producers or nonpreferred ones, as documented by Winters and Chang (2000) in the context of Spain's accession to the European Union and by Chang and Winters (2002) in the context of Mercosur. However, this interpretation of the constant would be dubious in our context: strategic price cuts ought to be systematically related to the depth of tariff preferences and thus should not be picked up by the constant.

22. Let R^Z denote the 2-year average value of the ratio of Mexican intermediate good purchases from the United States to those from the rest of the world, and let R^F denote the 2-year average value of the ratio of Mexican sales of final goods to the United States to those to the rest of the world. Likewise let V, the ratio of specialization in intermediate purchases in the United States over final sales to the United States be an indicator of the extent of vertical trade between Mexico and the United States. Let 1998–2000 averages be representative of NAFTA and 1992–94 be representative of pre-NAFTA averages. The figure cited in the text refers to the increase in these indicator values following the implementation of NAFTA. See Anson and others (2005) for a further description of these results.

developments suggest poor Mexican access to the U.S. market and a shift to a vertical pattern of Mexican–U.S. trade, as predicted by the exante analysis of Krueger (1993). Along with the econometric results, these quantity developments suggest the fruitfulness of carrying out illustrative simulations that help capture the likely welfare effects of the presence of rules of origin revealed in the pass-through estimates.

Model Sketch

To calculate orders of magnitude of the effects of NAFTA on Mexican exporters, simulations are carried out with a partial equilibrium structural model (see supplemental appendix 6) inspired from the model presented in section I and calibrated to take into account the results in tables 4 and 5. Suppose that Mexican apparel producers sell all their output abroad, either to the United States under NAFTA, X^{US}, or to the rest of the world, X^{ROW}. (No domestic sales simplifies the welfare analysis, but it results in an overestimate of the welfare gains from NAFTA preferences because higher prices for Mexican consumers are not taken into account.) They direct their sales to each market depending on relative profits per unit, according to a constant elasticity of transformation function with elasticity Ω.

Likewise, to simplify the evaluation, Mexican producers purchase all their intermediate goods abroad, either from the United States, Z^{US}, or from the rest of the world, Z^{ROW}. A Leontief technology links value-added and aggregate intermediate demand, a_z. Assume an upward-sloping supply curve for value added in the Mexican textiles and apparel industry (if value-added has an infinitely elastic supply, there would be no opportunity costs for capital and labor, and welfare effects of NAFTA would be 0). And let ε_X be this elasticity of supply and P_X^{US} the unit producer price of Mexican apparel exported to the U.S. market. The unrestricted unit cost under nonbinding rules of origin is C_z, and the restricted cost under binding rules of origin is C_Z^R. To capture the market power to U.S. producers of the rules of origin negotiated under NAFTA (the captive market effect), it is assumed that under NAFTA, only Mexican producers purchase U.S. intermediate goods at increasing cost—that is, they face a finite supply elasticity of U.S. intermediate goods ($\varepsilon_Z^{US} < \infty$). Finally, let λ be the administrative cost component of complying with rules of origin, assumed to be fixed per unit of apparel sold to the United States. In line with the econometric evidence in table 5, U.S. producers of intermediate goods are not penalized by the presence of rules of origin negotiated under NAFTA.

Mexican apparel producers sell most of their apparel to the United States (80 percent in the illustrative simulations in table 6) and are assumed to be price-takers when they sell their apparel to the rest of the world. U.S. demand for apparel is represented by a Marshallian demand curve with elasticity ε, and, as in section I, income effects are omitted. U.S. consumers choose between apparel from Mexico and the rest of the world according to a constant elasticity of substitution function with elasticity σ_Q.

TABLE 6. Simulation Results

Percent	1	2	3	4	5	6	7
ε_Z^{US}	8	8	8	8	5	5	5
λ	0	0	2	2	2	2	2
$\Delta t_X \equiv \left(t_X^M - t_X^N\right)$	10	10	10	10	10	10	10
$\Delta t_Z \equiv \left(t_Z^M - t_Z^N\right)$	0	10	10	10	10	10	10
$\left(\frac{Z}{X}\right)$	40	40	40	40	40	60	60
$\left[\frac{z^{US}}{z^{US}+Z^{ROW}}\right]_0$	30	30	30	30	30	30	40
$\left(\frac{z^{US}}{z^{US}+Z^{ROW}}\right)_1^{(R)}$	30	32	32	$(38)^a$	$(38)^a$	$(38)^a$	$(52)^a$
Results	Percent change from corresponding base values						
X^{US}	11.0	15.5	13.2	9.8	8.7	10.9	9.5
P_X^{US}	7.2	6.1	4.6	5.5	5.7	5.2	5.5
P_Z^{US}	0.0	0.0	0.0	0.0	6.7	7.1	7.7
$C_Z\left(C_Z^R\right)$	0.0	−9.1	−9.1	(−2.1)	(0.2)	(0.4)	(1.9)
W_P	20.1	30.4	20.6	18.2	15.6	20.6	17.4
G	9.6	−22.3	−23.6	−31.7	−32.4	−31.0	−46.5
W_T	19.5	27.2	22.9	15.0	12.6	13.9	9.1

$Z(X)$, intermediate good; λ, administrative costs (percent of unit cost); G, government tariff revenue; W_P (= $P_{VA}X$), private welfare [see also equation 19 in the text; W_T (= $G + W_P$) is total welfare].

^{a}Corresponds to a binding regional value content.

Note: All simulations, assume $\varepsilon = 1$, $\varepsilon_X = 1$, $\sigma = 1$, $\sigma_Q = 5$, $\Omega = 1$. $ES_0 = \left[X^{US}/\left(X^{US} + X^{ROW}\right)\right] = 80$ percent. See equation 22 in the text for definition of variables.

Source: Authors' estimates.

For a small NAFTA preference margin $(\Delta t \equiv t^M - t^N < 0)$, the percentage increase in producer surplus from preferential market access $\hat{W}_p$[23] (here equal to the private welfare benefit under the assumption of no domestic demand) is

$$(19) \qquad \hat{W}_p = \left(1 + \hat{P}_{VA}\right)^{1+\varepsilon_X} - 1 \approx (1 + \varepsilon_X)\hat{P}_{VA}.$$

Nothing prevents $\hat{W}_p$ from being negative, in which case Mexican apparel producers would not export under NAFTA.

As in section I, the distortionary cost of rules of origin is black boxed through a regional value content equivalent. If subscript 0 denotes profit maximizing per unit use of U.S. intermediate goods before NAFTA and subscript 1 denotes the corresponding use by the representative competitive Mexican firm when it faces binding rules of origin and preferential access, on the cost side

$$(20) \qquad z^R \equiv \frac{Z_1^{US}}{Z_1^{ROW}} > z^0 \equiv \frac{Z_0^{US}}{Z_0^{ROW}}$$

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23. Let hats (ˆ) denote a percentage change in the variables.

which gives the restricted cost function for intermediate goods

$$(21) \qquad\qquad C_Z^R = P_Z^R(z^R, P_z^{ROW}; \sigma)$$

where P_z^{ROW} is the price of intermediate goods purchased outside NAFTA and σ the elasticity of substitution in use between intermediate goods from the United States and the rest of the world. Thus, $C_Z^R > C_Z$ in the presence of binding rules of origin, and equation 18 captures the distortionary costs associated with rules of origin.

Equilibrium in the U.S. market for Mexican apparel requires U.S. demand for Mexican goods, Q_{US}^{Mex}, to equal Mexican supply to the United States, X^{US}, as reflected in equation 22. NAFTA has effects on the demand and supply sides. On the demand side, the preference margin, Δt, reduces the consumer price of Mexican apparel, P_Q^{Mex}, sold in the United States. On the supply side, rules of origin (r, λ) raise the unit cost of sales to the United States, $P_X^{US}(r, \lambda)$. Likewise, when U.S. producers of intermediate goods have market power, Mexican production costs are raised. Equilibrium under NAFTA in the Mexican apparel industry is achieved by adjusting the unit price of Mexican apparel exports to the United States until $P_Q^{Mex} = P_X^{US}$. The reduced-form expression corresponding to the underlying structural model (see supplemental appendix 6) for equilibrium in the Mexican apparel sector can then be written in terms of demand and supply elasticities, and share parameters describing the sector before NAFTA can be written as:

$$(22) \qquad Q_{US}^{Mex}\left[P_Q^{Mex}(\Delta t); \varepsilon, \Omega, \sigma_Q\right] = X^{US}\left[P_X^{US}(r, \lambda); \varepsilon_X, a_Z, \varepsilon_Z^{US}, \sigma\right]$$

where ε is the U.S. apparel price elasticity of import demand and σ_Q the elasticity of substitution between apparel from Mexico and the rest of the world in U.S. apparel demand.

Welfare Estimates

Table 6 describes the results of illustrative simulations with calibration inspired from the pre-NAFTA shares given above and the pass-through estimates reported in section II. Because no econometric estimates of the various elasticities are available, they are all assumed to be equal to unity (i.e., $\varepsilon = \sigma = \Omega = \varepsilon_X = 1$), except for those influencing Mexican and U.S. pass-through, that is, σ_Q and ε_Z^{US}.[24] The simulations start in a pre-NAFTA situation where Mexican apparel producers benefit from a 10 percent tariff preference in the United States and U.S. producers of intermediate goods benefit from a 10 percent tariff preference when they sell in Mexico. These starting values are roughly in line with the

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24. Assuming $\sigma_Q = 5$ gives a value of the pass-through of approximately 0.7, which is close to the econometric estimates in table 4. Likewise, $\varepsilon_Z^{US} = 5$ yields an estimated pass-through of close to 0.7, also in line with the results in table 5.

aggregate data in tables 2 and 3 if factoring in that Mexican producers of apparel probably had a margin of preference in excess of the most-favored-nation tariff (6 percent) because of binding quotas under the Agreement on Textiles and Clothing. Moreover, assuming symmetry in preferences helps to further isolate the determinants of NAFTA's welfare effects under asymmetric rules of origin. Except in column 7, the unrestricted share of intermediate textile imports from the United States is assumed to be 30 percent, and, in line with the data, Mexicans initially export 80 percent of their apparel products to the United States. All these assumptions are described in the top part of table 6, where the corresponding row indicates the assumed values for the parameters leading to the results in the corresponding column. To ease interpretation, simulations are additive for the first five columns (the last two columns report on sensitivity analysis on the results given in column 5) so that the results of any given column are directly comparable to the results in the preceding column.

Simulations are intended to give orders of magnitude of sequentially adding the NAFTA effects detected above. Start then with the results in column 1. Giving a 10 percent preference to Mexican exporters of apparel to the United States allows them to retain 7.2 percent of the price preference, and exports to the United States increase 11 percent. Private welfare goes up by 20.1 percent, and government revenue increases by 9.6 percent. In column 2, the 10 percent tariff on the purchase of intermediate goods from the United States is eliminated. Because rules of origin have not yet been introduced, Mexican producers benefit from paying a lower price for their purchases of intermediate goods from the United States. Since they minimize costs, they also increase their share of U.S. intermediate good purchases to 32 percent, and unit costs fall 9.1 percent. Lower intermediate costs are reflected in a slightly lower increase in the unit sale price to the United States (and also to the rest of the world), and total welfare goes up even more despite the tariff revenue loss, thanks to the gains from removing a distortion.

The effects of rules of origin are added successively in columns 3, 4, and 5. In column 3, a 2 percent per unit cost is added to account for the administrative costs associated with compliance with rules of origin. This estimate is borrowed from the nonparametric estimates reported in Carrère and de Melo (2005). Not surprisingly, benefits from NAFTA for Mexican exporters decrease markedly. In column 4, the regional value content scheme is introduced. It forces Mexican producers to increase their purchase of U.S. intermediate goods 25 percent (the observed increase mentioned above). This regional value content serves as a proxy for the costs associated with exceptions and the various technical requirements that have to be met to obtain originating status. For the chosen parameter configuration and assumed preferential access, unit costs still fall, but export sales increase by only 9.8 percent, and welfare gains are almost halved from what they would be in the absence of rules of origin. Finally, in column 5, the market power and pass-through effects for U.S. producers of intermediate goods are added. Mexican firms can no longer assume a fixed price $\left(\varepsilon_Z^{US} = \infty\right)$ to

purchase U.S. intermediate goods; instead, they face an upward-sloping U.S. supply of intermediate goods, with unit costs up by 6.7 percent. Welfare gains are further reduced to less than half their estimated value in the absence of rules of origin. Arguably, this is a conservative estimate, since the data indicate that despite NAFTA, the ratio of Mexican exports of textiles and apparel to the United States barely increased 2 percent.

The last two columns give results of NAFTA, factoring in all the rules of origin effects, but starting from different parameter values. In column 6, the share of intermediate goods in apparel is increased from 40 to 60 percent. Two opposite effects—a gain from tariff reduction and a loss from paying a higher price for U.S. intermediate goods—almost cancel each other out, so that the overall effect is small. In column 7, the 25 percent increase in the share of purchases of U.S. intermediate goods is assumed to start at 40 percent (instead of 30 percent). The regional value content is more constraining, and gains from NAFTA implementation are down to a third of their estimated values in the absence of rules of origin.

IV. Concluding Remarks

This article studied Mexican access to the U.S. market under NAFTA in the textiles and apparel sector and shows that only about half the tariff preference (of about 8 percent) was retained by Mexican producers. The induced upstream effect on the price of U.S. intermediate (textile) goods used in the production of Mexican final (apparel) goods is found to be significant and rather large. The price of U.S. intermediate goods sold to Mexico is, on average, 12–13 percent higher than the price of the same goods for export to other (nonpreferential) destinations. The elimination of the tariff on imports of U.S. intermediate goods by Mexican producers thus did not result in lower intermediate goods costs. Technical requirements (a particular form of rules of origin that is prevalent in the textiles and apparel sector) alone account for a full third, or about 4 percentage points, of that price increase—a strong signal in otherwise noisy data.

On the basis of these estimates, simulations were conducted in a stripped-down model of the Mexican textiles and apparel sector, in which Mexican apparel producers can sell to the rest of the world with no conditions or to the United States under NAFTA with the condition that they increase their purchases of U.S. textile intermediate goods. The results confirm that preferential margins of the magnitude granted under NAFTA severely reduced the gains from NAFTA for Mexican exporters. Arguably, plausible parameter estimates suggest that welfare gains were easily reduced by half because of the rules associated with proving the goods' origin.

Beyond the specifics of the textiles and apparel sector under NAFTA, these results inform the debate on the usefulness of trade preferences as a development tool. Because preference margins are limited to the level of most-favored-nation

tariffs, which for industrial countries are fairly low (with apparel among the few exceptions), preferences absorbed in half by a combination of higher costs and pass-through to buyers are likely to be of limited value to developing country partners. Taken together, the results support the suspicion that rules of origin are less a development policy tool to prevent screwdriver assembly (a potentially worthy objective) and more a circuitous way of raising the profits of upstream producers by creating a captive market for them in partner countries. This is likely to be especially important in preferential trade arrangements between developed and developing countries where vertical trade (capital-intensive component manufacturing in developed countries, labor-intensive assembly in developing countries) is prevalent. The flurry of regional trade agreements may then well be a costly diversion that distracts from necessary reforms to improve the functioning of the world trading system.

SUPPLEMENTARY DATA

Supplementary data can be found at www.wber.oxfordjournals.org.

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