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Rules of Origin as Export Subsidies ^{*}

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Abstract

The paper estimates the effect of NAFTA's rules of origin (ROO) on Mexican access to the US market treating explicitly the endogenous determination of ROOs. The first equation determines Mexico's NAFTA (preferential) exports to the US as a function of tariff preference and Estevadeordal's qualitative ROO index. The second equation determines ROO strictness on the basis of a Grossman-Helpman model identifying channels through which lobbying by US intermediate-good producers leads to deep preferences and stiff rules of origin in downstream sectors. The estimates suggest that the creation of a captive market for upstream intermediate-good producers is indeed one of their political determinants.

JEL classification numbers: F10, F13, F15

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1 Introduction

With the proliferation of preferential trading agreements over the last two decades, considerable attention has been devoted to assessing their effect on market access. Notwithstanding the fact that GATT Article XXIV, para. 8(b) requires the removal of trade barriers on “substantially all trade” in Free-Trade Agreements (FTAs), in reality numerous barriers to intra-bloc trade are often left intact or even erected as part of the agreements.¹ Rules of Origin (ROOs) feature prominently among those barriers.

In principle, ROOs are meant to prevent the trans-shipment of goods imported from the rest of the world, via member states with low external tariffs, into those with higher ones. In practice, these rules often have the effect of “exporting protection” from high-tariff members to low-tariff ones, as pointed out by Krishna and Krueger (1995) and Krueger (1997).

In North-South FTAs, in particular, the combination of tariff preferences and ROOs can affect trade flows in ways that are not conducive to economic efficiency. Suppose that the production of final goods involves two stages: the capital-intensive production of components, and labor-intensive assembly. If goods are entirely produced in the North early on in their product cycle, preferential tariff reductions may accelerate the process of assembly relocation in the South, leading to what Hanson (1996) called “regional production networks”.² Suppose, however, that component manufacturing could profitably be relocated to another Northern country outside of the preferential trading bloc. Rules of origin, by forcing Southern assemblers to source a minimum fraction of their components in the area, prevent the ultimate relocation of the whole value chain in the world’s most efficient location. In other words, ROOs, when they bind, organize trade diversion by creating captive markets for relatively inefficient Northern intermediate-good producers.

While the potentially trade-diverting effect of ROOs has been widely recognized in the literature (see for instance Falvey and Reed, 2000), the recent political-economy literature has also highlighted the fact that ROOs can sometimes make preferential agreements politically feasible in circumstances where they wouldn’t be otherwise (Duttagupta, 2000; Duttagupta and Panagariya, 2002). As Grossman and Helpman (1995) showed that trade-diverting

¹See Serra et al. (1996) for a review of shortcomings in the application of Article XXIV.

²However, Hanson also shows that the emergence of vertical trade between Mexico and the United States largely predates the formation of NAFTA, as assembly plants already accounted for 53% of Mexico’s manufactured exports in 1992.

FTAs are, *ceteris paribus*, more likely than others to be politically acceptable, Duttagupta and Panagariya's result is quite consistent with ROOs acting as "trade diverters".

While the theoretical analysis of ROOs has made considerable strides since Krueger's pioneering work, their empirical analysis is still in its infancy, partly because their complex legal nature makes measurement difficult. Estevadeordal (2000) recently proposed a way to overcome this difficulty by devising a qualitative index of ROO strictness. Using the fact that most ROOs are—at least in recent agreements—expressed as a required change in tariff heading at various levels of aggregation, Estevadeordal's index takes values that increase in the level of aggregation of the required change, the idea being that a change at a more aggregate level is "wider" and hence a more stringent transformation requirement. On the basis of his index, he identified a strong negative effect of NAFTA's ROOs on Mexican market access. Using the same index, Anson et al. (2003) showed that the effect of NAFTA's tariff preferences is systematically reduced by ROOs.

Although Anson et al's results are qualitatively unambiguous, they suffer from the fact that the potential endogeneity of ROOs is not treated. If there is little doubt that, as pointed out by Estevadeordal (2000) and Sanguinetti (2003), ROOs are the result of a political bargaining process that is itself likely to be affected by trade patterns, it is not entirely clear, short of a full political-economy model, what exactly they are endogenous to. If they are endogenous to Mexican final-good exports, clearly there is a simultaneity problem. If, however, ROOs are endogenous to trade flows that are related to Mexican exports only through an indirect, nonlinear relationship, for estimation purposes the relevant system may be recursive rather than truly simultaneous.

In this paper, we take the endogeneity problem as a starting point for an exploration of the political-economy forces that are likely to shape ROOs. Although many assumptions must be made along the way, we show that in a model of endogenous ROO determination à la Grossman-Helpman (1994), the key determinant of ROOs in terms of trade flows is a product of US intermediate-good exports to Mexico and input-output coefficients. The model generates results both in terms of interpretation of what ROOs do and in terms of what the estimation strategy should be.

As for interpretative results, the key one is that whereas ROOs create captive markets for US intermediate goods, tariff preferences needed to make them acceptable to Mexican exporters along their participation constraint

constitute a transfer —albeit a modest one— from US taxpayers.³ The combination of ROOs and tariff preference is then equivalent to an export subsidy on US intermediate goods. The model thus proposes a tentative answer, in this particular context, to a question arising frequently in trade policy—namely, why inefficient indirect instruments are used to redistribute income when more direct instruments would achieve the same results at lesser welfare costs. Here, ROOs substitute for a prohibited instrument, as export subsidies would be in violation of the US's obligations under the GATT.

Our analysis of rules of origin requires a model with multiple stages of production. In contrast to Lloyd (1993), Rodriguez (2001) and Carrère and de Melo (2004) who use a multi-stage production model due to Dixit and Grossman (1982), our analysis requires only a two-stage Leontieff production technology whose analytics are very simple.

As for the estimation, the model suggests, as the key determinant of NAFTA's ROOs, a vector product of input-output coefficients multiplied by US intermediate-good exports upstream of the good to which ROOs apply. Our estimation strategy thus consists of regressing ROOs on steady-state tariff preferences (equal, at the end of the phase-out period, to the US MFN tariff adjusted for exceptions) and the upstream variable just described, the functional form being the political-economy model's first-order condition. This generates a vector of predicted ROOs which are then used in the market-access equation. As for tariff preferences, we do not model their endogeneity directly as intra-NAFTA tariffs smoothly converge to zero over a fixed phase-out period. A fuller model would recognize, as Estevadeordal (2000) did, that the length of the phase-out may itself be endogenous, but the model we use does not lend itself easily to taking this into account.

We chose NAFTA as a testing ground because it provides a laboratory experiment to test the effect of ROOs. It is the quintessential example of the North-South agreement due to the comprehensive tariff liberalization built in the agreement and the fact that member countries share borders, eliminating the need to account for distance as in traditional gravity exercises. We construct a panel dataset with information dating back to 1989 on commodity exports from Mexico to the United States under different preferential programs. The data was compiled mostly from USITC sources at the 6-digit HS

³By participation constraint, we mean that the rate of effective protection granted to Mexican final-good producers by the combination of tariff preferences and rules of origin is just zero.

disaggregation level and contains information on tariff preferences (GSP and NAFTA rates) granted by the United States to Mexico. From 1989 to 1994, Mexico's exports to the United States benefited from the Generalized System of Preferences (GSP), after which this regime was overhauled by NAFTA. The data on rules of origin comes from Estevadeordal (2000).

The results are in conformity with the model's predictions. All variables are significant—most of them at the 1% level—and have the expected signs. Tariff preferences and ROOs exert positive and negative influences respectively on Mexican exports, and the key variable influencing endogenously-determined ROOs—a product of input-output coefficients and US intermediate exports to Mexico—has the predicted sign and is significant at the 1% level.

The paper is organized as follows. Section 2 sets out the political-economy model and characterizes its equilibrium. Section 3 presents the empirical methodology and results, and section 4 concludes.

2 Politically-determined ROOs

This section uses a simple, stripped-down political-economy model to illustrate the simultaneous determination of tariff preferences and ROOs. Although the model borrows from Grossman and Helpman (1994) the appearance of a general-equilibrium model, it is best thought of as a partial-equilibrium one as interindustry linkages are nonexistent except for the vertical linkages around which the discussion is centered.

2.1 The economy

Consider a PTA formed by two small economies, North (N) and South (S). The North produces, under increasing cost, an intermediate good denoted by the subscript I and exports it to the South which uses it to assemble a final good denoted by the subscript F . Southern supply of the final good is not enough to cover the North's consumption at its tariff-ridden price, so the North also imports from the rest of the world. The South imports all its own consumption of the final good from the rest of the world and exports all its production to the North.⁴

⁴This is shown to arise endogenously in Cadot, de Melo and Olarreaga (2001).

Households in both countries consume the final good and an aggregate of all other goods, which also serves as numeraire, under identical and quasilinear preferences. Let c_F and c_0 denote respectively the quantities of final and ‘other’ goods consumed by a representative consumer in either country. The utility function is

$$U = c_0 + u(c_F) \quad (1)$$

where $u' > 0$ and $u'' < 0$.

The final good sold in the free-trade area is produced by combining value added and the intermediate good. Value added is created with intersectorally mobile labor ℓ and specific capital κ under a technology $f(\ell, \kappa)$. The technology producing the final good, into which the value-added production function is nested, is of the Leontieff type with input-output coefficient a_{IF} . Letting y_F and x_I stand respectively for the final-good output and quantity of intermediate good consumed in the process,

$$y_F = \min\{f(\ell, \kappa); x_I/a_{IF}\}. \quad (2)$$

Let p_I^* and p_F^* be respectively the intermediate and final goods’ world prices. Under free trade, given the technology postulated, the ‘net price’ out of which a Southern producer can remunerate value added (wages and profits) is

$$p^* = p_F^* - a_{IF}p_I^*. \quad (3)$$

With the stock of specific capital fixed, the technology f which generates value added displays diminishing returns on labor. The supply of value added is therefore upward sloping in its net price p^* , and economic rents accrue to owners of specific capital, who are assumed to be the industry’s residual claimants.

A similar good is sold in the rest of the world, and the marketing mix between the free-trade area and the rest of the world is determined by a Constant Elasticity of Transformation (CET) technology (see the footnote in section 3 below) which provides the functional form for the market-access equation estimated in the empirical part.

The rest of the economy uses only labor under constant returns to scale, which fixes the wage rate. Given this assumption, the model becomes a quasi-partial equilibrium one. In this setting, Southern final-good producers’ surplus under free trade, π_F^* , is a monotone increasing function of p^* :

$$\pi_F^* = p^* y_F - w_S \ell_F.$$

Letting p be the *domestic* net price, $(p - p^*)/p$ is the effective rate of protection granted to Southern producers when selling on the Northern market.⁵

The intermediate good is produced in the North with value-added only under a technology similar to f (i.e. a CRS combination of labor and specific capital). Letting y_I be its output, producer surplus is

$$\pi_I = p_I y_I - w^N \ell_I. \quad (4)$$

Finally, we will measure the intermediate good in units that make its world price p_I^* equal to one, and we will treat its supply elasticity in the North, $\varepsilon_I \equiv p_I y'_I/y_I$, as a constant.

2.2 The preferential regime

In order to keep things simple, we will treat MFN (external) tariffs on the final and intermediate goods as predetermined to the PTA and hence parametric. Northern tariffs are respectively t_F^N and t_I^N and Southern ones t_F^S and t_I^S . In order to focus on the effects of Northern tariffs and ROOs, we will set $t_F^S = t_I^S = 0$. Extensions to other cases are straightforward but add little to the analysis.⁶

The model's endogenous political-economy variables are the preferential tariff applied, as part of the PTA, on Southern exports of the final good, τ , and the regional value content of the ROO, r . Let x_I^N be the amount of intermediate good sourced in the North (as opposed to imported from the rest of the world), and let $\delta = t_F^N - \tau$ be the rate of preference (in specific form).

⁵To see this, it suffices to observe that p is unit value added.

⁶First, note that endogenous determination of MFN tariffs would yield $t_I^S = t_F^N = 0$ given that the South does not produce the intermediate good and the North does not produce the final one. However if specialization is a result of the PTA and MFN tariffs are predetermined to it (say, because they are negotiated in multilateral rounds and thus constitute valuable bargaining chips), they will not be eliminated after the PTA's formation.

Second, even if $t_F^S > 0$, its level is inconsequential. To see this, observe that if $t_F^S < t_F^N$, the South's entire output is sold in the North and the analysis is as if t_F^S was zero. If $t_F^S > t_F^N$, the South's output is sold in priority on the Southern market. But if some of it is also exported to the Northern market (which is of course necessary for ROOs to have any effect at all) then the South's output being larger than its consumption, the Southern price is 'competed down' to the level of the Northern tariff-ridden price, and the analysis proceeds as before.

The price at which Southern final-good producers —we will henceforth use the term “assemblers” for brevity— can sell in the North is

$$p_F = \begin{cases} p_F^* + \delta & \text{if } x_I^N \geq rx_I \\ p_F^* & \text{otherwise.} \end{cases} \quad (5)$$

That is, Southern producers can sell under the PTA’s preferential regime if they satisfy the ROO. If not, they sell under the MFN regime, i.e. at the world price.

Given the ROO, Southern producers selling under the preferential regime source a proportion r of their intermediate good in the North. The price of the ‘composite’ intermediate good is thus $rp_I + (1 - r)p_I^*$, and the net price faced by Southern assemblers is

$$p = p_F^* + \delta - a_{IF} [rp_I + (1 - r)p_I^*]. \quad (6)$$

2.3 The politics

The action is in the North, where the politics is described by a Grossman-Helpman game in which the intermediate producers lobby faces the government with a contribution schedule $C_i(\delta, r)$, $i = I, F$, conditioned on the policy variables of interest to it, δ and r . The function C has the ‘truthfulness’ property that

$$\frac{\partial C_i}{\partial r} \Big|_{r^e, \delta^e} = \frac{\partial \pi_i}{\partial r} \Big|_{r^e, \delta^e} \quad \text{and} \quad \frac{\partial C_i}{\partial \delta} \Big|_{r^e, \delta^e} = \frac{\partial \pi_i}{\partial \delta} \Big|_{r^e, \delta^e}$$

where the superscript e designates equilibrium values. With only one lobby, the common agency degenerates into a simple principal-agent relationship.⁷

⁷The model ignores lobbying by Northern final-good producers, if any. There are several reasons for this. First, in terms of modeling issues, competitive final-good producers would be concerned about prices only, not market shares. As the Northern MFN tariff on the final good is unchanged, their profits would be unchanged as long as the area is not self-sufficient at the Northern tariff-ridden price. Second, even if the market is not competitive, as long as the South is on its participation constraint (more on this below) Southern exports to the North are unchanged.

In terms of empirical issues, as far as NAFTA is concerned, a substantial proportion of the companies doing assembly work in Mexico for re-export into the US are either subsidiaries of US companies or non-competing subcontractors. Cases in which Mexican companies compete head on with US assemblers (either independent or vertically integrated) are, arguably, sufficiently marginal to assume that reducing such competition was *not* a key consideration for US negotiators.

Without hidden action, the principal (the lobby) is then able to appropriate the entire protection rents, and any equilibrium will have the property that the government is just indifferent between implementing the lobby's preferred policy and the default one (free trade).⁸ Put differently, the lobby's contribution just compensates the government for the efficiency loss generated by trade protection. The government determines δ and r to maximize a linear combination of welfare (with weight a) and the lobby's contribution:

$$G^N \equiv C_I(\delta, r) + aW(\delta, r).$$

The pair (δ, r) is set to leave the FTA's Southern partner on its 'participation constraint'. Given that the South's consumption of the final good is always priced at p_F^* , consumer surplus is unaffected by changes in either τ or r . Thus, the only change in Southern welfare —or any political objective function combining welfare and producer surplus— is in assemblers' profits, and the South's participation constraint is completely characterized by $p = p^*$.

2.4 Equilibrium

ROOs have the effect of segmenting the intermediate good's market in the trading bloc. Southern assemblers selling on the Northern market must comply with the ROO if they are to benefit from the preferential regime. The market on which they buy the intermediate good is then a closed-economy market where Northern supply must match the ROO-induced Southern demand. We now determine the price prevailing on that market.

Price determination With their home market unprotected, Southern assemblers sell all their output on the protected Northern market where they enjoy preferential access. Suppose that p_I is greater than p_I^* . In equilibrium, it will be. The ROO's domestic content is then binding, which means that a proportion r of the South's intermediate-good demand will be sourced 'locally' (in the North). The market-clearing condition determining the intermediate good's domestic price is thus that the local demand induced by the ROO, $ra_{IF}y_F(p)$, be equal to its supply, i.e.

$$ra_{IF}y_F(p) = y_I(p_I) \tag{7}$$

⁸This assumption about rent sharing is in conformity with the empirical observation that small contributions seem to buy 'large' policies in terms of redistributive effects (Ansolabehere et al., 2002). Any alternative assumption would imply larger contributions, which would go against the evidence.

where, as before, y_F is the South's final-good production and y_I is the North's intermediate-good production.

Let p_I satisfy (7). If $p_I \leq p_I^* + t_I^N$, the ROO is not binding, which means that the North's supply of the intermediate good is sufficient to satisfy the South's needs and more. We will henceforth disregard this case and suppose that the intermediate good's price determined by (7) is larger than its tariff-ridden price in the North.⁹

Using (3) and (6) and recalling that $p_I^* = 1$ by choice of units, the South's participation constraint can be written as

$$p_F - a_{IF}(rp_I + 1 - r) = p_F^* - a_{IF}$$

or, using (5) and simplifying,

$$\delta = ra_{IF}\Delta p_I \quad (8)$$

where $\Delta p_I = p_I - 1$. Expression (8) says that the degree of effective protection given to Southern assemblers by the combination of r and δ is zero.

The Northern government's maximization problem under the South's participation constraint and the intermediate-good market-clearing condition is

$$\begin{aligned} \max_{\delta, r} G^N &\equiv C_I(\delta, r) + aW^N(\delta, r) \\ \text{s.t.} \\ \delta &= ra_{IF}\Delta p_I \\ ra_{IF}y_F(p) &= y_I(p_I) \\ 0 \leq r \leq 1, \quad 0 \leq \delta &\leq t_F^N. \end{aligned} \quad (9)$$

As an intermediate step before solving problem (9), we now calculate two useful derivatives treating r as predetermined: dp_I/dr and $d\delta/dr$. The first measures the marginal effect of the ROO, expressed as a regional value content (RVC) r , on the intermediate good's internal price. The second measures the substitutability between the ROO's RVC rate r and the tariff preference rate δ along the South's participation constraint. Both apply only to interior solutions, i.e. when the inequality constraints (9) are not binding.

⁹In other words, using Grossman and Helpman's terminology, we assume 'enhanced protection' on the final- and intermediate-good markets.

Differentiating totally (6), (7) and (8) with respect to p_I , δ and r and rearranging gives

$$\begin{aligned} d\delta &= a_{IF}\Delta p_I dr + r a_{IF} dp_I \\ a_{IF} y_F dr + r a_{IF} y'_F dp &= y'_I dp_I \end{aligned}$$

or

$$\frac{dp_I}{dr} = \frac{a_{IF} y_F}{y'_I} = \frac{p_I}{r \varepsilon_I} > 0 \quad (10)$$

where ε_I is the intermediate good's supply elasticity —treated as constant—and

$$\begin{aligned} \frac{d\delta}{dr} &= a_{IF}\Delta p_I + r a_{IF} \frac{dp_I}{dr} \\ &= a_{IF} \left(\Delta p_I + \frac{p_I}{\varepsilon_I} \right) \quad (11) \\ &= a_{IF} \left[p_I \left(1 + \frac{1}{\varepsilon_I} \right) - 1 \right] > 0. \quad (12) \end{aligned}$$

Expression (10) shows that, as long as tariff preferences can be adjusted, the ambiguity of the ROO's effect on the intermediate good's price noted by Ju and Krishna (1998, 2000), does not apply here. The reason is that, by construction, along the South's participation constraint value-added in the final-good sector cannot go down, so (given the Leontief technology) nor can output. In other words, here ROOs cannot become so stiff as to become self-defeating because any tightening of r is met by an offsetting increase in δ .

Solving (8) for r at $\delta = t_F^N$, define $\bar{r} \equiv t_F^N/a_{IF}\Delta p_I$ as the RVC that just satisfies the participation constraint at full preferences. Ju and Krishna's argument applies in the semi-open interval $(\bar{r}, 1]$ if $\bar{r} < 1$. With homogenous firms in the South (in terms of their compliance costs), beyond \bar{r} the participation constraint is violated and the preferential regime's utilization rate falls discretely to zero.

We are now in a position to solve problem (9). Combining the inequality constraint on δ with the participation constraint gives

$$r a_{IF} \Delta p_I \leq t_F^N.$$

Letting λ and μ be two Lagrange multipliers, we have

$$\mathcal{L} = G[\delta(r), r] + \lambda(1 - r) + \mu(t_F^N - r a_{IF} \Delta p_I)$$

and the Kuhn-Tucker conditions are

$$\begin{aligned}\frac{dG}{dr} &\leq 0, \quad r \geq 0, \quad r \frac{dG}{dr} = 0; \\ 1 - r &\geq 0, \quad \lambda \geq 0, \quad \lambda(1 - r) = 0; \\ t_F^N - ra_{IF}\Delta p_I &\geq 0, \quad \mu \geq 0, \quad \mu(t_F^N - ra_{IF}\Delta p_I) = 0.\end{aligned}$$

We now construct the expression for dG/dr which will be set equal to zero under the first-order condition. It has two components: a contribution effect and a welfare effect.

Contribution effect Using Hotelling's lemma and the contribution function's truthfulness property, we have, in a neighborhood of the equilibrium,

$$\frac{dC_I}{dr} = \frac{d\pi_I}{dr} = y_I \frac{dp_I}{dr} = \begin{cases} p_I y_I / r \varepsilon_I & \text{if } r < \bar{r} \\ 0 & \text{if } r > \bar{r}, \end{cases} \quad (13)$$

and the derivative is undefined at $r = \bar{r}$ because p_I jumps down to one at that point (because the preferential regime's utilization rate falls to zero). Thus, left to itself —i.e. absent any welfare consideration— the Northern intermediate-good lobby would be willing to push ROOs to \bar{r} , the level of ROO strictness that makes Southern assemblers just indifferent between using the preferential regime or not given tariff-free access ($\delta = t_F^N$).¹⁰

Combining (13) and (11), it is apparent that the Northern intermediate-good lobby is willing to contribute in favor of 'deep' tariff preference in the downstream sector because, along the South's participation constraint, tariff preference buys stiffer ROOs which in turn are to its advantage.

Welfare effect Let m_F and m_F^* be the North's imports of final goods from the South and from the rest of the world respectively. As the North does not produce the final good, $m_F + m_F^* = c_F$. Under quasilinear preferences, Northern welfare is the sum of income —from profits, wages and tariff revenue— and consumer surplus, which by (1) comes only from consumption of the final good. Formally,

$$W^N = \pi_I + w^N \ell_I + \tau m_F + t_F^N m_F^* + u(c_F) - p_F c_F.$$

¹⁰We are grateful to Maurice Schiff for helping to clarify this discussion.

As $m_F = y_F$ (the South exports its entire final-good output to the North), $m_F^* = c_F - m_F = c_F - y_F$, so

$$W^N = \pi_I + w^N \ell_I + t_F^N c_F - \delta y_F + u(c_F) - p_F c_F. \quad (14)$$

Along the South's participation constraint, p is constant and hence so is y_F . Thus, treating p_I and δ as endogenous variables along the problem's constraints,

$$\begin{aligned} \frac{dW^N}{dr} &= y_I \frac{dp_I}{dr} - y_F \frac{d\delta}{dr} \\ &= \frac{p_I y_I}{r \varepsilon_I} - a_{IF} y_F \left[p_I \left(1 + \frac{1}{\varepsilon_I} \right) - 1 \right]. \end{aligned}$$

Using the fact that, by (7), $a_{IF} y_F = y_I / r$, this becomes

$$\begin{aligned} \frac{dW^N}{dr} &= \frac{y_I}{r} \left\{ \frac{p_I}{\varepsilon_I} - \left[p_I \left(1 + \frac{1}{\varepsilon_I} \right) - 1 \right] \right\} \\ &= -\frac{y_I}{r} \Delta p_I < 0. \end{aligned} \quad (15)$$

Combining the contribution and welfare effects gives

$$\begin{aligned} \frac{dG^N}{dr} &= \frac{dC_I}{dr} + a \frac{dW^N}{dr} \\ &= \frac{p_I y_I}{r \varepsilon_I} - a \frac{y_I}{r} \Delta p_I \\ &= \frac{p_I y_I}{r} \left(\frac{1}{\varepsilon_I} - \frac{a \Delta p_I}{p_I} \right). \end{aligned}$$

Under the first-order condition, this expression is set equal to zero, so

$$\frac{p_I}{\Delta p_I} = a \varepsilon_I. \quad (16)$$

The second-order condition requires $a \varepsilon_I > 1$, which we assume to hold.¹¹

¹¹This assumption is not innocuous. The parameter a is, in our setting, the dollar amount that the intermediate-good lobby must contribute per equivalent-dollar of welfare reduction. As contributions are typically small relative to the distortionary costs of trade policies, a is likely to be smaller than one. Then ε_I , the elasticity of supply of intermediate goods, must be larger than one. When this assumption is violated, a corner solution occurs at either $r = 0$ (no ROO) or $r = \bar{r}$.

It can be shown by algebraic manipulation that, along the first-order condition, r is a decreasing function of δ . However, the equilibrium value of r that is observed in the data is not determined just by the model's first-order condition but by its intersection with the participation constraint along which r is an increasing function of δ . Using (8) to substitute for Δp_I in (16) gives

$$r = \frac{\delta a\varepsilon_I}{a_{IF}p_I}. \quad (17)$$

Re-introducing the inequality constraints, the solution is thus

$$r = \begin{cases} t_F^N/a_{IF}\Delta p_I & \text{if } \delta a\varepsilon_I \Delta p_I/p_I \geq t_F^N \\ 0 & \text{if } \delta a\varepsilon_I/a_{IF}p_I \leq 0 \\ \delta a\varepsilon_I/a_{IF}p_I & \text{otherwise.} \end{cases}$$

With several inputs indexed by i and one output indexed by j , it is easily verified that (17) becomes

$$r_j = \frac{a\delta_j}{\sum_i a_{ij}p_i/\varepsilon_i}. \quad (18)$$

This expression will guide the empirical analysis in the section that follows.

3 Market access and ROO determination

3.1 The data

The estimation is carried out on a panel dataset covering the period from 1989 to 1994 and containing information on commodity trade and tariffs between Mexico to United States under MFN and preferential regimes. The data was compiled mostly from USITC sources at the 6-digit HS level of disaggregation. The preferential regime for Mexico was the Generalized System of Preference from 1989 to 1993, and NAFTA after 1994. The data on rules of origin comes from Estevadeordal (2000). Descriptive statistics are shown in Table 1.

Table 1
Descriptive statistics

3.2 Empirical estimation

We estimate two equations: a market-access one and a political one. Let j stand for a tariff line (at the HS6 level) and t for time measured in years. The estimated system has a peculiar structure in the time dimension. Mexican exports to the US (y_{jt}) and to the world (x_{jt}) vary over time. So does the rate of preference (δ_{jt}), as NAFTA's tariff reductions were phased in progressively over a transition period (on this, see Estevadeordal 2000). By contrast, rules of origin (r_j) were negotiated once and for all in the early 1990s. Thus, the market-access equation must be estimated on panel data whereas the political determination of ROOs must be estimated on a cross section of tariff lines with the variables suggested by the model as likely determinants of ROOs, as of the 1990s.

We measure ROOs in two alternative ways. First, we use a vector of binary variables, each marking the presence of a specific ROO instrument (change of tariff heading, technical requirement etc.). Second, we use Estevadeordal's synthetic index. Using both proxies provides a check on the construction of Estevadeordal's index, as estimated coefficients should be larger in absolute value for instruments assigned a higher value in his index.

Thus, the market-access equations to be estimated is either

$$\ln y_{jt} = \alpha_0 t + \alpha_1 \ln x_{jt} + \alpha_2 \ln \delta_{jt} + \alpha_3 r_j + u_{jt} \quad (19)$$

where x_{jt} stands for Mexican exports of good j to the rest of the world, δ_{jt} is the rate of preference granted to good j in year t under NAFTA, r_j is Estevadeordal's (2000) index of ROO strictness, and u_{jt} is an error term. Alternatively,

$$\ln y_{jt} = \alpha_0 t + \alpha_1 \ln x_{jt} + \alpha_2 \ln \delta_{jt} + \sum_{k=1}^n \tilde{\alpha}_k r_{kj} + u_{jt} \quad (20)$$

with a vector of n binary variables for the n legal forms of ROOs.

We control for serial correlation in the time dimension by time effects and for unobserved industry characteristics by fixed effects at the section level. As the estimation is carried out at the hs6 level of aggregation, we control for heteroskedasticity by using weighted least squares, the weight being Mexico's total exports. Expected signs and magnitudes in (19) are $\alpha_1 = 1$, $\alpha_2 > 0$, $\alpha_3 < 0$, and, in (20), $\tilde{\alpha}_{k+1} < \tilde{\alpha}_k < 0$ if ROO type $k+1$ is assigned a higher

value than ROO type k in Estevadeordal's index.¹²

The political equation is based on (18) in log form. As values of δ during the phase-out period were determined simultaneously with rules of origin, we instrument for δ using its steady-state value $\bar{\delta}_j$, the US MFN tariff (the latest available value is for 2001).¹³ Thus,

$$\ln r_j = \beta_0 + \beta_1 \ln \left(\sum_i a_{ij} p_i / \varepsilon_i \right) + \beta_2 \ln \bar{\delta}_j. \quad (21)$$

¹²This equation can be justified as follows. Consider a Mexican final-good exporter maximizing profits by choice of a mixture of export destinations. Let y stand for the value added of exports to the US, x for the value added of exports to the rest of the world, and let p be the relative net price in the US. Assume that the firm produces out of a fixed pool of resources R under a Constant Elasticity of Transformation technology (Powell and Gruen, 1962), i.e. $x^\alpha + y^\alpha = R$ where α is the inverse of the elasticity of transformation. The value of R is itself determined in the previous stage of a two-stage optimization problem. The second-stage problem is thus

$$\max_{x,y} x + py \text{ s.t. } x^\alpha + y^\alpha = R.$$

The FOC yield $y/x = p^{1/(\alpha-1)}$ or

$$\ln y = \frac{1}{\alpha-1} \ln p + \ln x,$$

a functional form close to (19). If this equation is roughly invariant across tariff lines, the elasticity of transformation between the US and the ROW can be retrieved from the parameter estimate on the tariff preference term, whereas the parameter estimate on exports to the ROW should be insignificantly different from one.

The interest of this formulation is that because of the curvature of the transformation surface, the export mixture is an interior solution even when the participation constraint is binding (i.e. when $p = 1$), an observation that is largely true at the tariff line (although not necessarily true at the firm level). This framework can be easily extended to a three-dimensional choice in which exports to the US can be made under either the preferential regime or the MFN one. If the choice between legal regimes for exports to the US involves no efficiency consideration, the transformation surface can be represented as

$$x^\alpha + (y_{NAFTA} + y_{MFN})^\alpha = R.$$

¹³We also tested an alternative formulation, namely $\tilde{\delta}_j = \sum_{t=0}^{\infty} \beta^t \delta_{jt}$ with $\beta = 0.9$. Results were similar.

Alternatively, noting that, by (10)

$$\frac{p_i}{\varepsilon_i} = \frac{ra_{ij}y_j}{y'_i} = \frac{y_i}{y'_i},$$

it follows that

$$\sum_i \frac{a_{ij}p_i}{\varepsilon_i} = \sum_i \frac{a_{ij}y_i}{y'_i},$$

so letting $z_j = \sum_i a_{ij}y_i/y'_i$, the equation to be estimated becomes

$$\ln r_j = \beta_0 + \beta_1 \ln z_j + \beta_2 \ln \bar{\delta}_j + v_j. \quad (22)$$

where $\beta_0 = \ln a < 0$ (if $a < 1$), $\beta_1 < 0$, $\beta_2 = 1$, v_j is an error term, and $z_j = \sum_i a_{ij}y_i/y'_i$ is proxied (with measurement errors since y'_i is unobserved) by $\sum_i a_{ij}y_i$, the sum, over all goods i upstream of j , of the product of US exports of good i to Mexico, y_i , times the share a_{ij} of good i in good j 's output.

Note that there is no endogeneity bias from the fact that z_j is a linear combination of intermediate-good exports from the US to Mexico that may be affected by final-good exports from Mexico to the US because z_j is calculated as an average for three years before NAFTA's entry into force, so the link between the two types of trade flows is tenuous at best. Thus, the system is recursive and estimated as such.

As estevadeordal's ROO index is a categorical variable which takes on integer values between one and seven, the political equation is estimated as an ordered probit. As a result, direct quantitative interpretation of parameter estimates in terms of (22) is not possible. As the model assumes that ROOs take the form of a continuous RVC whereas actual ones are combinations of discrete instruments, there is no way around this difficulty.

As a robustness check, we split the sample of Mexican exports to the US into final vs. intermediate and capital goods. As the logic of our model applies essentially to final goods exported by Mexico with intermediates imported from the US, the effect of ROOs should be stronger for the sub-sample restricted to final goods.

3.3 Results

Estimation results are shown in Tables 2 and 3.

Table 2
Regression results, ROOs and Preferential margins

Column (a) of Table 2 shows results for equation (22). The dependent variable is the log of Estevadeordal's index. The regressor called "upstream" is z_j averaged out over 1989-93. Its coefficient is negative as predicted and significant at the one-percent level. The coefficient on the log of the US MFN tariff is positive as predicted, and also significant at the one-percent level. The relatively low explanatory power of the regression is not a surprise given that it is very parsimonious, that the data is only a cross section, and that the dependent variable is itself a constructed one. Column (b) shows estimation results by weighted least squares which, although biased, yields a relatively good fit (which is useful when predicted values are substituted back into (19)).

Column (c) of table one shows an ad-hoc regression of tariff preferences on the log of the latest value of the US MFN tariff (equal to the steady-state value of NAFTA tariff preferences), the log of the Mexican MFN tariff, and the predicted value of the ROO index from equation (a). As expected, the Mexican tariff is not significant (see footnote 6 above), and tariff preferences are overwhelmingly influenced by the US MFN tariff, suggesting that the latter is a good instrument for the former.¹⁴ Although δ and r are negatively related along the model's FOC condition, the negative coefficient of the ROO index's predicted value has no direct interpretation observed pairs (r, δ) are determined jointly by the FOC and the participation constraint.

Table 3 shows estimation results for equations (19).and (20).

Table 3
Regression results, Mexican exports

Columns (d)-(h) of Table 3 report estimation results ignoring the endogeneity issue. Column (d) shows estimation results for equation (20). The

¹⁴When the predicted ROO index is generated by WLS rather than by ordered probit, the coefficient on the 1993 Mexican MFN tariff becomes statistically significant but the point estimate of the elasticity (0.007) is very small: a doubling of the Mexican tariff raises the rate of NAFTA preference on the same good by less than a hundredth of its initial value.

coefficient on the log of Mexican exports to the ROW is 0.58 (and stable across equations), so the null hypothesis that $\alpha_1 = 1$ is rejected at the one-percent level, suggesting that the transformation surface is not CET but rather of a form closer to $x^\alpha y^{2\alpha-1}$, where the elasticity of transformation is variable. The coefficient on the preference margin is positive, as expected, and significant at the one-percent level. Coefficients on ROO instruments are all significant at the one-percent level. All are negative except two: the one on changes in tariff item, the narrowest tariff classification change, and the one on exceptions. This second sign reversal is a puzzle given that most exceptions are tightening rather than relaxations of ROO requirements. Except for this, the ranking of coefficients is consistent with Estevadeordal's index, and a test of equality of coefficients rejects the null that they are all equal at the one-percent level.

Column (e) shows estimation results for the same equation but with the vector of binary variables replaced by Estevadeordal's synthetic index. The sign of the coefficient is as expected; more importantly, the explanatory power of the regression stays the same as the unadjusted R^2 is not affected (0.696 compared to 0.706, not shown in the table), suggesting that there is little loss of information involved in using the synthetic index. Column (f) runs the same regression but on final goods only (according to the BEC classification).¹⁵ As the model's logic and assumptions apply essentially to final goods, these results are particularly important. Interestingly, the coefficient on tariff preference stays positive but loses statistical significance, while the coefficient on ROOs remains highly significant and jumps up by a factor of three.

Columns (g) and (h) test for evidence of a learning curve by interacting the coefficient on ROO with year effects. The results are inconclusive and stand in contrast with those of Tumurchudur (2004) which show strong evidence of a learning curve for Central and Eastern European countries.

Finally, column (i) reports estimation results with preferential margins and the ROO index replaced by their predicted values from equations (a) and (c) in Table 2. Signs and levels of significance are unaffected, suggesting that qualitative conclusions hold irrespective of the handling of endogeneity issues; however, the magnitudes of point estimates are seriously affected.

¹⁵We used the BEC's classification rather than the WTO's because the latter classifies all goods in automobile and machinery & equipment as final ones, whereas vertical trade in those sectors is particularly important for Mexico.

suggesting that quantitative conclusions must be drawn carefully. Interestingly, the point estimates of the coefficients on preferences and ROOs both go up, suggesting that the effect of both trade-policy instruments are underestimated when endogeneity issues are ignored.

4 Concluding remarks

Two messages come out of our results. One is empirical, the other conceptual. First, at the empirical level, NAFTA's rules of origin seem to dilute the benefits generated by preferential trade liberalization, in terms of market access, for Mexico. This result, which is in conformity with the findings of the recent literature, suggests that ROOs should indeed be viewed as an economically sensitive item rather than a technical one in the agenda of bilateral trade negotiations. Moreover, the effect seems to be stronger for final goods than for intermediate ones, in conformity with what one would expect in a multi-stage production model where each stage is located according to the production stage's factor intensity and the host country's factor abundance. This result begs the question, why do Northern partners create policy instruments that put hurdles in a process that is economically efficient? One reason might be that ROOs are the price to pay for the acquiescence of Northern final-good producers threatened by Southern competition. However, many of the final-good assemblage activities undertaken by Southern 'maquiladoras' are non-competing, making this explanation less than satisfactory.

The second point of our paper is about this issue. We use a standard model of endogenous trade policy —Grossman and Helpman's common-agency model— to explore an alternative logic, namely that ROOs reflect political pressure by Northern intermediate-good producers interested in creating captive markets for their goods in the South. The logic is as follows. On the assumption that the Mexican side is on its "participation constraint", i.e. that the rate of effective protection conferred to Mexican final-good producers by the simultaneous use of tariff preferences and ROOs is just about zero, tariff preferences are the price to be paid for Mexican assemblers' acquiescence to a system which forces them to buy US intermediate goods. Seen this way, as the model shows, preferences-cum-ROOs amount to a pure transfer from US taxpayers to intermediate-good producers, i.e. to a hidden export subsidy. Because export subsidies are in violation of any country's obligations under the GATT, recourse to an indirect and inefficient substitute

instrument —ROOs— makes sense.

Empirically, the model suggests the inclusion, among the right-hand side variables of the second equation (ROO determination), of the product of input-output coefficients by US intermediate sales to Mexico. This somewhat unintuitive prediction provides a test of the approach's validity, since it is difficult to think of an alternative theoretical approach that would lead to the inclusion of that particular algebraic term. Empirical results are in striking conformity with the model's predictions. In sum, they suggest that the use of NAFTA to create a captive market for US intermediates was indeed one of the forces shaping the agreement's rules of origin.

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Figure 1: Descriptive Statistics

Variable	Observations	Mean	Std. Dev.	Min	Max
Log Mex. pref. exports to US	21056	13.091	3.090	5.533	23.003
Log Mex. exports to ROW	33943	11.817	2.963	-0.024	21.556
RoO restr. index	42457	5.056	1.298	0.000	7.000
Predicted Value RoO rest. ind.	39936	0.139	0.121	0.009	2.271
Log Roo restr. index	43639	1.538	0.406	0.000	1.946
Log pred. value of RoO rest. ind	39936	-2.373	0.955	-4.673	0.820
Log (Pref. Margin + 1)	42062	0.025	0.050	-0.150	1.504
Log (Pred. value of Pref. margin + 1)	38672	0.029	0.051	-0.047	1.180
US MFN tariff 2001	42443	0.031	0.083	0.000	3.046
Mex. MFN tariff 93	40804	0.153	0.158	0.000	2.820
Log US MFN Tariff 2001 + 1	42443	0.028	0.058	0.000	1.398
Log Mex. MFN tariff 1993 + 1	40804	0.137	0.085	0.000	1.340
Chapter Dummy	43639	0.503	0.500	0	1
Heading Dummy	43639	0.375	0.484	0	1
Sub-Heading Dummy	43639	0.040	0.196	0	1
Item Dummy	43639	0.000	0.019	0	1
Exception Dummy	42822	0.266	0.442	0	1
RVC Dummy	43639	0.434	0.496	0	1
Pref. margin*94	4991	0.021	0.037	-0.118	0.747
Pref. margin*95	4979	0.023	0.038	-0.041	0.972
Pref. margin*96	5360	0.025	0.062	-0.139	1.831
Pref. margin*97	5363	0.029	0.072	-0.080	2.777
Pref. margin*98	5370	0.030	0.082	-0.001	3.244
Pref. margin*99	5386	0.030	0.086	-0.001	3.500
Pref. margin*00	5470	0.029	0.072	-0.014	2.828
Pref. margin*01	5143	0.031	0.084	0.000	2.970

Figure 2: Regression results, ROO index and pref. margins

	(a)	(b)	(c)
Dep. var. (in log):	ROO index	ROO index	Pref. marg.
Estimation	Ord. prob.	WLS	WLS
Constant		2.06	
		<i>34.02</i>	
Upstream	-0.17	-0.30	
	<i>-11.11</i>	<i>-11.32</i>	
ln(1+US MFN tariff 2001)	1.87	0.18	0.86
	<i>6.18</i>	<i>3.21</i>	<i>302.76</i>
ln(Mexico MFN tariff 1992/1993)			0.00
			<i>0.38</i>
Predicted Value of ROO			-0.01
			<i>-9.06</i>
Observations	4'991	4'992	33'940
Pseudo R-square	0.22		
R-square adj.		0.38	0.85

Notes:

z-statistics (a) or t-statistics (b) in italics under coefficient estimate

Section/time effects not shown (time effects only in (b))

Preferential margin is $\ln[1+(\text{MFN rate} - \text{Tariff on Mexican goods})]$

Dependent variable:	(d)	(e)	(f)	(g)	(h)	(i)
	All goods	All goods	Final goods	All goods	All goods	All goods
ln(Mex. Exp. US)	7.05	7.11	8.06	8.18	7.08	3.90
Constant	<i>12.51</i>	<i>12.41</i>	<i>4.31</i>	<i>6.68</i>	<i>5.76</i>	<i>3.21</i>
ln(Mex. Exp. RoW)	0.58	0.61	0.56	0.60	0.62	0.60
	<i>103.18</i>	<i>111.04</i>	<i>53.69</i>	<i>108.73</i>	<i>112.73</i>	<i>109.90</i>
ln(preferential margin)	2.36	2.83	0.60	2.50	2.83	
	<i>11.98</i>	<i>14.21</i>	<i>1.64</i>	<i>12.38</i>	<i>14.07</i>	
Predicted ln(preferential margin)						5.53
						20.73
ln(RoO restrictiveness)		-0.40	-1.36	-0.95		
		<i>-13.17</i>	<i>-18.87</i>	<i>-14.28</i>		
Predicted ln(ROO restrictiveness)						-1.37
						-18.65
CTC dummy	-0.33					
	<i>-5.27</i>					
CTH dummy	-0.21					
	<i>-4.51</i>					
CTS dummy	-0.19					
	<i>-3.12</i>					
CTI dummy	0.38					
	<i>3.06</i>					
Exceptions dummy	0.59					
	<i>16.34</i>					
RVC dummy	-0.48					
	<i>-14.75</i>					
ln(RoO restrictiveness)*94					-0.10	
					<i>-3.69</i>	
ln(RoO restrictiveness)*95				0.21	-0.09	
				<i>-6.53</i>	<i>-3.67</i>	
ln(RoO restrictiveness)*96				0.14	-0.16	
				<i>-4.49</i>	<i>-7.01</i>	
ln(RoO restrictiveness)*97				0.20	-0.10	
				<i>-6.80</i>	<i>-4.68</i>	
ln(RoO restrictiveness)*98				0.20	-0.10	
				<i>-6.87</i>	<i>-5.17</i>	
ln(RoO restrictiveness)*99				0.23	-0.07	
				<i>-8.13</i>	<i>-3.46</i>	
ln(RoO restrictiveness)*00				0.26	-0.04	
				<i>-9.19</i>	<i>-2.04</i>	
ln(RoO restrictiveness)*01				0.24	-0.07	
				<i>-8.28</i>	<i>-3.26</i>	
Observations	19'962	19'898	6'180	19'898	19'898	19'343
Adjusted R-squared	0.71	0.70	0.80	0.70	0.69	0.70

Notes

t-statistics in italics below coefficient estimates

Year and section effects not shown

Preferential margin is $\ln[1 + (\text{MFN rate} - \text{Tariff on Mexican goods}) / (1 + \text{Tariff on Mexican goods})]$

Estimation by WLS, weight: total Mexican exports

Figure 3: Regression results, market-access equation