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NÚMERO 18

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THE BASIC ECONOMICS OF RULES OF ORIGIN

Introduction

This paper* studies certain aspects of rules of origin. Rules of origin are nothing but regulations used to identify the country of origin of the goods of international trade. Every country requires rules of origin for multiple purposes such as the collection of statistical data, the elaboration of market studies, the application of preferences in government procurements, the establishment of labeling rules, the assignment of export quotas, the application of antidumping tariffs, etc. However, this paper concentrates on the rules of origin that are employed to determine the eligibility of a product to receive a certain tariff treatment, such as a "most favored nation" (MFN) tariff treatment under the General Agreement on Tariffs and Trade (GATT) or a preferential tariff treatment under a preferential international trade agreement.[1]

In the context of preferential trade agreements, rules of origin play a fundamental role since they constitute the mechanism used by the participants in an agreement to prevent third countries from taking advantage of the negotiated benefits through "trade triangulation".[2] However, it is pertinent to note that the rules of origin of a preferential trade agreement do not necessarily prevent assembly processes from receiving preferential tariff treatment. Such processes may receive tariff preferences if they substitute third-country inputs for regional inputs.

In recent years, the definition of rules of origin has turned out to be a very important issue, due to the growing use by many industries of inputs from all over the world. This internationalization of production has made the establishment of a dichotomy between "originating" and "non-originating" products a difficult and controversial issue.

The essential aspect of the rules of origin of a preferential agreement is that they limit the use of third country inputs. However, the basic concern of the country that is negotiating the agreement is the effect of rules of origin on the use of domestic inputs. How do rules of origin affect the use of these inputs? We try to answer this question by developing a partial equilibrium model of a firm that can export to

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[1] Examples of international preferential agreements of trade are: the Generalized System of Preferences or GSP (which was created by some developed countries in order to give preferential tariff treatment to imports from certain developing countries) and the US-Canada and US-Israel free trade agreements.

[2] By "trade triangulation" we mean the process through which a third country circumvents the tariffs that the participants in the preferential agreement individually maintain on the imports of that third country. Through this process, the third country's product achieves participant origin by complying with the applicable rule of origin.

one of the member countries of a bilateral free trade zone from two plants: one which is located outside of the area and another located in the other member country of the free trade area. The rule of origin is the requirement that must be met by the plant located inside the area so that its exports enjoy a preferential tariff treatment.

In practice, rules of origin place limits on the use of third country inputs for a product to be eligible to receive tariff preference. Due to this reason, the model developed in this paper assumes, for simplicity, that the inputs originating in the two countries of the free trade area are identical from the firm's point of view and that these inputs are treated symmetrically by the rule of origin. The model also assumes that the limitation that the rule of origin imposes on the use of third country inputs has a very simple form. Although the formulation of rules of origin is usually more complex, this approach captures the essential common aspects of the rules actually used.

The topic of rules of origin in the context of preferential trade agreements has not been the object of analysis in the theoretical bibliography. In fact, the economics of performance requirements is in its infancy. However, the topic of local-content requirements is a very closely related topic that has been the subject of considerable theoretical discussion. Analyses of content protection schemes are provided by Wonnacott and Wonnacott (1967), Munk (1969) (for automobile industries in Latin America), Corden (1971), H. G. Johnson (1972) (in the case of the Canadian auto industry), Grossman (1982), and Mussa (1984). However, none of these papers covers a situation in which the content requirement is imposed on a foreign-owned firm alone. Our paper tries to help to fill the vacuum in the literature of performance requirements applied to foreign firms.

The model presented in this paper presents characteristics that express the particularities of the rules-of-origin analysis. Unlike the studies of content protection, the model: *a)* considers inputs originating in the free trade zone as perfect substitutes and allows smooth substitution between regional and third-country inputs, *b)* assumes that the main goal of the third-country producer in the model is to produce in one of the countries in the free trade zone and export to another country of that zone, *c)* establishes that the penalty for not complying with the rule of origin is a tariff on the final product, and *d)* studies the possibility which the third-country firm has of transferring all its production resources to its home plant in the case the free-trade-zone plant has to face excessively restrictive rules.

This paper is composed of six sections. In the first, the fundamental elements of the model are presented. In the second, the effects of the rule of origin in the case of perfect competition are analyzed; in the following section, the conditions that regulate the decision of the domestic plant to operate or not with the rule of origin regime are presented, and in the fourth, the case of monopoly is studied. In the fifth section, we provide numerical examples that illustrate the results of the previous sections and, lastly, some final considerations are presented in the conclusions section.

The main result in the case of perfect competition is that a more restrictive rule of origin has two contrary effects on the use of domestic inputs. On the one hand, it tends to increase it by requiring a more intensive use of them. On the other hand, it tends to decrease it as the marginal cost of the domestic plant rises, inducing a decrease in the scale of operation. In the case of monopoly the conclusion is that a stronger rule has four effects on the use of domestic inputs: the two effects of perfect competition, plus two other effects: an effect which magnifies the impact that the increase in the marginal cost of the domestic plant has on the level of production, and an effect derived from a change in the value of the marginal product of inputs from outside the area. These two last effects result from the fact that the monopolistic firm may transfer production between the plants.

1. The Model

A Japanese firm has the monopoly of product x in the United States. The firm exports to this country from two plants, one located in Mexico (plant 1) and another one located in Japan (plant 2). The first plant has the following production function:

$$x_1 = F(M_1, M_1^*)$$

where

x_1 : production of the Mexican plant,
M_1 : quantity of Mexican inputs used by the Mexican plant,

and

M_1^* : quantity of Japanese inputs used by the Mexican plant.[3]

We assume that the production function of the Mexican plant is concave, continuously differentiable and homogeneous of degree α,[4] so that in can be rewritten in the following way:

$$x_1 = f(m_1) \cdot M_1^{*\alpha}$$

where $m_1 \equiv M_1/M_1^*$.

We additionally assume that the Mexican inputs are internationally tradable and are perfect substitutes of the inputs imported from the United States. In addition, unlike Horst (1971), we assume that the tariffs paid to import inputs are

[3] Note that we are therefore assuming, as in Mussa (1984), smooth substitution between domestic and third-country inputs. This differs from Grossman (1982), who assumes perfect substitution between imported and domestic inputs.

[4] This assumption generalizes that of Mussa (1984), who assumes linear homogeneity.

reimbursed to the Japanese firm by the Mexican government through the mechanism of "duty drawback". Therefore, the profits obtained by the Japanese firm from its sales in the United States of its Mexican plant's production are given by:

$$\pi_1 = p(1 - t^x) \cdot x_1 - M_1 \cdot q_1 \,(1 + t_L^m \phi_L) - M_1^* \cdot q_1^* \,(1 + t_N^m \phi_N)$$

where

t^x : tariff paid in the United States on the Mexican exports,
q_1 : international price of the Mexican inputs,
q_1^* : international price of the Japanese inputs,
t_L^m : tariff paid in Mexico on imports of United States inputs,
t_N^m : tariff paid in Mexico on imports of Japanese inputs,
ϕ_L : one minus the *drawback* rate of tariffs paid on United States inputs,
ϕ_N : one minus the *drawback* rate of tariffs paid on Japanese inputs.

We assume that imports of U.S. inputs are subject to a preferential tariff treatment in Mexico, so that

$$t_L^m \phi_L < t_N^m \phi_N$$

On the other hand, the production function of the plant located in Japan is given by

$$x_2 = G(M_2^*) = M_2^{*\beta}$$

where M_2^* is the quantity of Japanese inputs used by the Japanese plant.

Therefore, the profits that the Japanese firm obtains from its sales in the United States of its Japanese plant's production are equal to:

$$\pi_2 = p(1 - t_N^x) \cdot x_2 - q_1^* M_2^*$$

where t_N^x is the tariff paid in the United States by the exports of Japan (most favored nation tariff).

Finally, the demand in the United States for the product of the Japanese monopoly is given by:

$$p = p(x) = p(x_1 + x_2) \qquad p' < 0$$

Consider now the effects of a rule of origin of the following type:

$$If\ \ m_1 \begin{Bmatrix} \geq \theta \Rightarrow t^x = t_L^x < t_N^x \\ < \theta \Rightarrow t^x = t_N^x \end{Bmatrix}$$

where t_L^x is the preferential tariff paid in the United States on Mexican products that satisfy the rule of origin.[5] That is, if the Mexican plant uses a proportion of Mexican inputs to Japanese inputs greater than or equal to θ, then it has the right to pay the preferential tariff t_L^x in the United States, which is of course less than the most favored nation tariff t_N^x. In the opposite case, it pays this last rate.[6] The effects of this rule of origin on the selection of inputs by the Mexican plant are analyzed in figure 1.

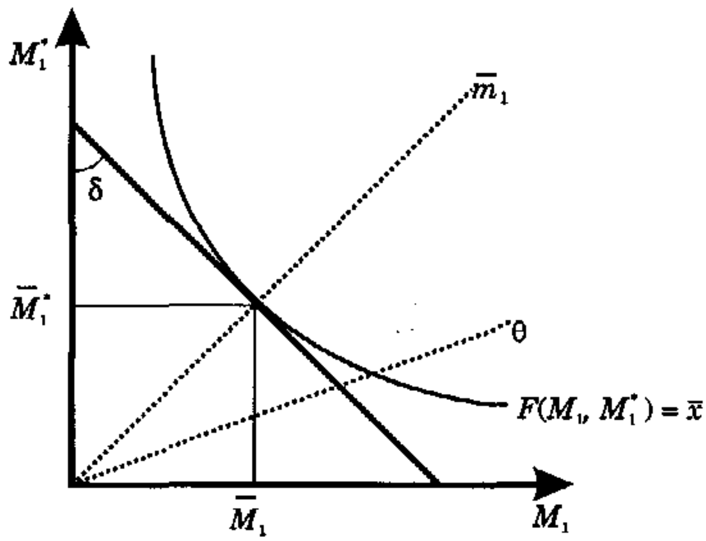

Figure 1

[5] Note that we assume, as Grossman does for the content requirement (pages 585-581), that the expression for the rule of origin is in terms of physical units. Mussa argues (page 7) that it is more common to state content requirements in terms of share of domestic inputs in the value of the final product. Even though this may be true, our assumption of a physical ratio reflects the existing difference between the rule of origin and content protection analyses. We believe that a rule of origin must be expressed in terms of physical units in order to capture at the same time change in tariff classification and value added restrictions.

[6] That is, we suppose (as in Mussa (1984) and unlike Grossman (1982)) that the penalty for not complying with the rule is a tariff on the final product. In the context of his model, Mussa shows (pages 9, 10) that this policy is superior to other policies that increase the ratio of domestic to imported inputs.

Let $\overline{M}_1$ and $\overline{M}_1^*$ be the levels of Mexican and Japanese inputs used by the Mexi-can plant when there are no rules of origin. Let $\overline{m}_1$ be the corresponding quotient. Evidently, for values of θ less than $\overline{m}_1$ (that is, for combinations of inputs that are above and to the left of the line $\overline{m}_1$), the rule of origin will be redundant and the Mexican plant will use a higher ratio of Mexican inputs than it is required to use in order to enjoy the preferential tariff t_L^x. However, values of θ greater than $\overline{m}_1$ do restrict the choice of inputs of the Mexican plant, forcing it to use a higher ratio of Mexican inputs per unit of the Japanese input.

The analysis of the effects of more restrictive rules of origin will be easier if we consider first the case in which the Japanese firm operates in the market as a perfect competitor. This analysis is developed in the following section.

2. *The Effects of Rules of Origin under Perfect Competition*

If the Japanese firm functions as a perfect competitor, the profit maximization problems associated with its two plants are independent. In that case, assuming that the Mexican plant chooses to operate under the rule of origin regime, its optimization problem, when the rule of origin is restrictive, consists of choosing the level of Japanese inputs which maximize the following profit function:[7]

$$\pi_1 = p(1 - t_L^x) \cdot f(\theta) \cdot M_1^{*\alpha} - \left[q_1(1 + t_L^m \phi_L)\theta + q_1^*(1 + t_N^m \phi_N)\right] M_1^*$$

where we temporarily assume that α is less than one, in order to assure the existence of an optimum under perfect competition.[8] The condition of maximization consists of equating the value of the marginal product with the price of the input:

$$p(1 - t_L^x) \cdot f(\theta) \cdot \alpha M_1^{*(\alpha-1)} = q_1(1 + t_L^m \phi_L)\theta + q_1^*(1 + t_N^m \phi_N)$$

In order to determine the effects of an increase in θ on the use of Mexican inputs M_1, we differentiate the first order condition with respect to M_1^* and θ and we make use of the expression:

[7] The Mexican plant's choice between operating or not in accordance with the rule of origin is examined in the following section.

[8] Note that we are assuming that the Japanese firm takes as given the price p of output. This assumption is valid because the rule of origin that applies to firms operating in the United States (and selling there their product) is not equal to the FTA rule. The rule of origin of these firms is decided solely in the United States by the customs authorities.

$$dM_1 = M_1^* d\theta + \theta dM_1^*$$

to obtain the derivative of M_1 with respect to θ:

$$\frac{dM_1}{d\theta} = \Gamma_1 + \Gamma_2$$

where:

$$\Gamma_1 = M_1^* \left[\frac{1}{1 + \theta\varphi(\theta)} \right] \geq 0$$

$$\Gamma_2 = M_1^* \left(\frac{1}{1-\alpha} \right) \left[\frac{\theta(\varphi(\theta) - \delta)}{(1 + \theta\varphi(\theta))(1 + \theta\delta)} \right] \leq 0$$

$$\varphi(\theta) \equiv \left(-\frac{dM_1^*}{dM_1} \right) \Bigg|_{x=\bar{x}}$$

$$\delta \equiv \frac{q_1(1 + t_L^m \phi_L)}{q_1^*(1 + t_N^m \phi_N)}$$

The total effect of an increase in θ on the use of Mexican inputs can be decomposed into two parts. The first part (expressed by the term Γ_1) reflects the direct effect of the rule of origin on the proportion of Mexican inputs that must be used in the Mexican plant. As can be observed, the size of this effect depends crucially on the slope of the isoquant $\varphi(\theta)$. If this slope is infinite (that is, if the isoquant in figure 1 is vertical in the initial equilibrium), the increase in θ will not increase the use of Mexican inputs. On the other hand, if the isoquant is horizontal in the initial equilibrium, the increase of θ will increase M_1 in the same proportion. In general, this direct effect is non-negative.

On the other hand, the second term Γ_2 reflects an effect of scale derived from the increase of the marginal cost caused by an increase of θ.[9] This effect basically depends on two factors. The first is the difference between the slopes of the price line, δ, and of the isoquant, $\varphi(\theta)$, caused by the introduction of a more restrictive rule of origin. This difference reflects the technological inefficiency caused by the rule of ori-

[9] Both Grossman (1982) and Mussa (1984) find a similar effect in the case of a content protection policy.

gin, and clearly tends to increase when the rule of origin becomes more stringent, reducing the optimal scale of operation of the Mexican plant. In the second place, the effect of scale depends on the size of the parameter of returns to scale, α. The greater α is, the greater is the decrease of the scale of the Mexican plant resulting from an increase of θ. In general terms, this effect of scale is non-positive.

Summarizing, a more restrictive rule of origin has two opposite effects on the use of Mexican inputs: on one hand, it tends to increase it by requiring a relatively more intense use of these inputs. On the other hand, it tends to reduce it because the increased marginal cost of the Mexican plant results in a decrease of the scale of operation. However, starting from an initial equilibrium where the rule of origin is exactly non-restrictive at the margin (that is, from the point $m_1 = \overline{m}_1$ of figure 1), an increase of θ increases the level of M_1 without ambiguity. This is true because, in that initial situation, the slopes of the price line and of the isoquant coincide ($\delta = \varphi(\theta)$), canceling in this way the negative scale effect.[10]

Also, due to the assumption of symmetry between Mexican inputs and U.S. inputs, it is possible to conclude that more restrictive rules of origin are actually redundant when their implementation is accompanied by a simultaneous reduction of tariffs on inputs imported from the area of preferential trade. Such reduction causes a decrease in the slope of the price line, δ.

Intuitively, it is clear that the behavior of the derivative of M_1 with respect to the rule of origin will depend mainly on the elasticity of substitution between the Mexican and Japanese inputs (σ). If this elasticity is "big", the inefficiency generated by the rule of origin (expressed by the difference between the slopes of the price line and the isoquant) will increase at a lower rate when the rule of origin is more restrictive. In addition, the direct effect of the rule of origin on the use of Mexican inputs will be greater relative to the scale effect. This result can be verified by checking the second derivative of M_1 with respect to θ:

$$\frac{d^2M_1}{d\theta^2} = \frac{dM_1^*}{d\theta}\,\frac{(1-\alpha)+\theta[\varphi(\theta)-\delta](1+\theta\delta)^{-1}}{[1+\theta\cdot\varphi(\theta)](1-\alpha)}$$

$$+\frac{M_1^*}{[1+\theta\cdot\varphi(\theta)]^2(1-\alpha)}\cdot\left[\alpha\cdot\varphi(\theta)(1-\frac{1}{\sigma})-\delta\cdot\frac{(1+\theta\cdot\varphi(\theta))^2}{(1+\theta\delta)^2}\right]$$

10 This agrees with both Mussa and Grossman. However, Mussa also shows, in the context of his model, that increases in the content requirement above the marginally effective level increase the equilibrium level of the domestic input provided that the price elasticity of demand is less than a critical value.

where the derivative of the use of Japanese inputs with respect to θ is clearly non-positive, since both the direct effect and the effect of scale of a more restrictive rule of origin affect the use of these inputs negatively:

$$\frac{dM_1^*}{d\theta}=-\frac{M_1^*}{\theta}\left[\frac{\theta\cdot\varphi(\theta)}{1+\theta\cdot\varphi(\theta)}\right]+\frac{M_1^*}{\theta}\cdot\frac{1}{1-\alpha}\cdot\left[\frac{\theta(\varphi(\theta)-\delta)}{(1+\theta\cdot\varphi(\theta))(1+\theta\delta)}\right]<0$$

It is easy to verify that in the special case where the elasticity of substitution is constant and infinite, the second derivative of M_1 with respect to θ will be negative $\left(\frac{d^2M_1}{d\theta^2}<0\right)$. In the more general case (and perhaps empirically more possible case) where the elasticity of substitution is reduced when the rule of origin becomes more restrictive (expressing decreasing possibilities of substituting Japanese inputs with Mexican inputs), the derivative of M_1 with respect to θ decreases at increasing rates. The behavior of this derivative is described in figure 2.

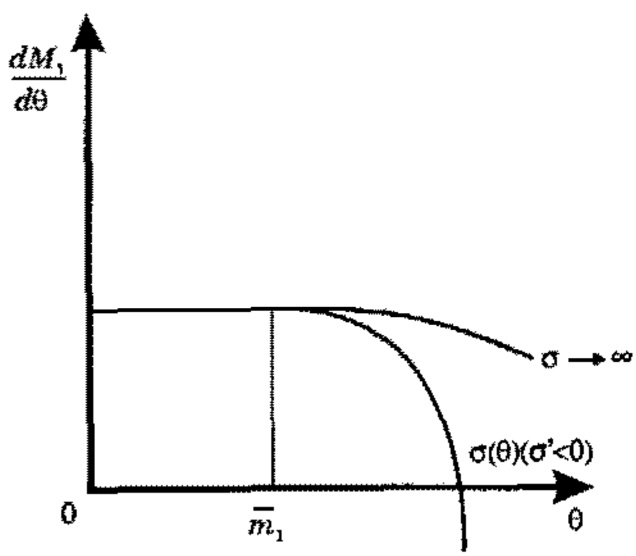

Figure 2

3. Selection of Operation Depending on the Rule of Origin

From the above discussion it is clear that the level of preferences that the exports of the Mexican plant may achieve does not affect the value of the derivative of M_1 with respect to θ. However, this level does determine the decision of the Mexican plant regarding compliance with the rule of origin. This decision depends on the comparison of profits that can be obtained under two situations:

complying with the rule of origin and exporting under preferential conditions, or exporting without tariff preferences, but without complying with the rule of origin. Figure 3 compares the profits that can be obtained in each situation.

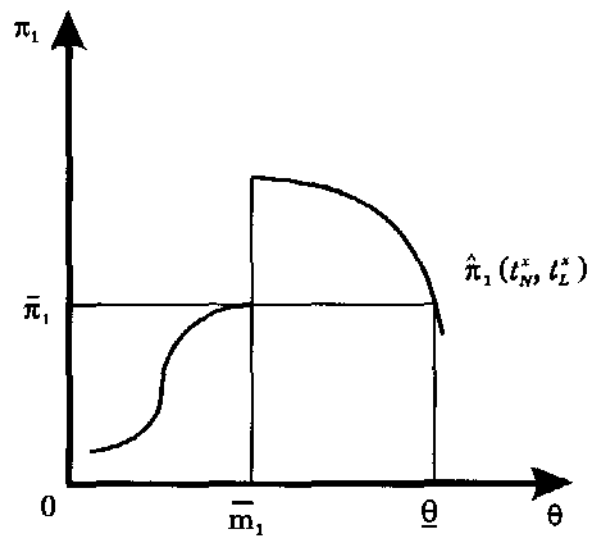

Figure 3

$\bar{\pi}_1$ corresponds to the maximum attainable level of profits that the Mexican plant can achieve without complying with the rule of origin and without receiving tariff preferences on its exports. This level of profits is the result of using the proportion of inputs $\overline{m}_1$. For rules of origin that require values of θ greater than $\overline{m}_1$, the Mexican plant can obtain two levels of profits: if it does not satisfy the rule of origin it obtains $\bar{\pi}_1$, and if it satisfies the rule of origin it obtains the profits indicated by the curve $\hat{\pi}_1$. In the right-hand neighborhood of $\overline{m}_1$, this curve shows a discontinuity as a result of the tariff preference obtained by exporting to the United States when the rule of origin is satisfied. For greater values of θ, the curve continuously declines, as a result of the technological inefficiency introduced by the rule of origin:

$$\frac{d\hat{\pi}_1}{d\theta} = \frac{p \cdot f(\theta) \cdot \alpha M_1^*}{\theta}\left[\frac{\theta(\varphi)\theta) - \delta)}{(1 + \theta \cdot \varphi(\theta))(1 + \theta\delta)}\right] < 0$$

The behavior of the curve $\hat{\pi}_1$ limits the possibilities of manipulating the rules of origin in order to induce a greater use of Mexican inputs. The value of θ cannot be increased above the level $\underline{\theta}$ which generates a level of $\hat{\pi}_1$ equal to $\bar{\pi}_1$, without completely eliminating the incentive to comply with the rule of origin. Evidently, this limit value $\underline{\theta}$ is an increasing function of the quotient t_N^x/t_L^x. This implies that if in the initial equilibrium the exports of the Mexican plant are not subject to a tariff in the United States, a more restrictive rule of origin will not affect the use of Mexican inputs.

On the other hand, it is evident that *changes* in the level of the tariff preferences that can be achieved by the exports of the Mexican plant which comply with the rule of origin do affect the demand for Mexican inputs (given that the Mexican plant finds it convenient to comply with the rule of origin). A smaller tariff on the Mexican exports which go to the U.S. increases the value of the marginal product of Mexican inputs and increases their use.

Consequently, if we start from an initial equilibrium without distortions, the simultaneous imposition of a restrictive rule of origin and an increase in the tariff preferences on Mexican exports (an increase sufficiently large to make compliance with the rule of origin profitable) increases the use of Mexican inputs as a result of two effects: the direct effect of the rule of origin —which requires a greater proportional use of Mexican inputs— and a positive effect of profitability resulting from the decrease of tariffs on Mexican exports.

4. *Effects of Rules of Origin on a Monopoly with Two Plants*

When the Japanese firm has a monopoly in the U.S. market the production decisions of each of its two plants are no longer independent, since a change in the production of one of them affects the marginal income derived from the production of the other.[11] In this case the sum of the profits obtained from the Mexican and Japanese plants (when the rule of origin is restrictive) is equal to:

$$\pi = \pi_1 + \pi_2$$

$$\pi = p(x_1 + x_2) \cdot (1 - t_L^x) \cdot x_1 - \left[q_1 (1 + t_L^m \phi_L)\theta + q_1^* (1 - t_N^m \phi_N)\right] M_1^*$$

$$+ p(x_1 + x_2) \cdot (1 - t_N^x) \cdot x_2 - q_1^* M_2^*$$

where

$$x_1 = F(M_1, M_1^*) = f(\theta) \cdot M_1^{*\alpha}$$

[11] Horst (1971) also addresses the problem of a multinational firm's transfer of production between plants in two countries. However, our specification is different from that of Horst. One of the main differences is that Horst assumes that the multinational can sell its product in either country.

$$x_2 = G(M_2^*) = M_2^{*\beta}$$

and where α and β can be greater than one. Profit maximization requires the fulfillment of the following two first order conditions with respect to M_1^* and M_2^*:

$$f(\theta) \cdot \alpha M_1^{*(\alpha-1)} \cdot R_1 = q_1 (1 + t_L^m \phi_L)\theta + q_1^* (1 - t_N^m \phi_N)$$

$$\beta M_2^{*(\beta-1)} \cdot R_2 = q_1^*$$

where R^i ($i = 1, 2$) is the net marginal income derived from increasing one unit of the production of plant i, keeping constant the production of the other plant:

$$R^1(x_1, x_2) = (1 - t_L^x)[p + p' \cdot F(.)] + p'(1 - t_N^x) \cdot G(.)$$

$$R^2(x_1, x_2) = (1 - t_L^x)p' \cdot F(.) + (1 - t_N^x)[p + p' \cdot G(.)]$$

Note that R^1 and R^2 differ only due to the difference between the most favored nation tariff on the product of the Japanese plant and the preferential tariff on the product of the Mexican plant.

In order to study the behavior of the Mexican inputs M_1 when the rule of origin changes, we now differentiate the first order conditions with respect to M_1^*, M_2^*, and θ, and we make use of the expression:

$$dM_1 = M_1^* d\theta + \theta dM_1^*$$

in order to obtain the derivative of M_1 with respect to θ:

$$\frac{dM_1}{d\theta} = \Gamma_3[\Gamma_1 + \Gamma_2] + \Gamma_4$$

where

$$\Gamma_3 = -R^1 M_1^{*-1} \Delta_1 (1 - \alpha)$$

$$\Gamma_4 = \left\{\Delta_1 \cdot R_{x_1}^1 + \Delta_2 R_{x_2}^2\right\} \cdot f(\theta) \cdot \alpha M_1^{*(\alpha-1)} \cdot \Gamma_1$$

$$\Delta_1 = \frac{\dfrac{dR^2}{dM_2^*} - (1-\beta)R^2 M_2^{*-1}}{\left(\dfrac{dR^2}{dM_2^*} - (1-\beta)R^2 M_2^{*-1}\right)\left(\dfrac{dR^1}{dM_1^*} - (1-\alpha)R^1 M_1^{*-1}\right) - \dfrac{dR^1}{dM_2^*}\dfrac{dR^2}{dM_1^*}} < 0$$

$$\Delta_2 = \frac{-\dfrac{dR^1}{dM_2^*}}{\left(\dfrac{dR^2}{dM_2^*} - (1-\beta)R^2 M_2^{*-1}\right)\left(\dfrac{dR^1}{dM_1^*} - (1-\alpha)R^1 M_1^{*-1}\right) - \dfrac{dR^1}{dM_2^*}\dfrac{dR^2}{dM_1^*}} > 0$$

When the firm has a monopoly in the U.S. market, the total effect of an increase of θ on the use of Mexican inputs can be decomposed in four parts.[12] The first two are the direct effect (Γ_1) and the effect of scale (Γ_2) present in the case of perfect competition. The two additional effects (Γ_3 and Γ_4) are effects of reallocation of the production between the Mexican and the Japanese plants. These tend to one and zero respectively as the conditions of monopoly converge towards perfect competition.

The term Γ_3 (which multiplies the direct effect and the effect of scale, Γ_1 and Γ_2) amplifies the effect of an increase in the marginal cost of the Mexican firm on the level of production of the same plant and depends fundamentally on Δ_1. The denominator of Δ_1 must be positive due to the second order conditions of maximization. These conditions are satisfied if one or both plants have increasing marginal costs. They are also satisfied if one or both plants have decreasing marginal costs, but at a lower rate than the decrease in marginal incomes (in such a way that the curve of marginal costs is always above of the curve of marginal incomes of the corresponding market). On the other hand, the numerator of Δ_1 represents the (negative) difference between the rates of increase of the marginal income and the marginal cost of the Japanese plant. The term Δ_1 is in general non-positive, so that Γ_3 will be positive.

On the other hand, the term Γ_4 expresses the effect on the use of Mexican inputs derived from the effect of the increase in θ upon the value of the marginal product of the Japanese inputs . The term in brackets in the expression for Γ_4 measures the net change of the marginal incomes of the two plants and depends on Δ_1 and Δ_2

[12] In his model, Mussa (1984) shows that the consequences of content protection are not affected by monopoly in the domestic final product market or monopsony in the domestic input market. This is because Mussa, unlike the present paper, does not study the case in which the foreign firm has non-domestic plants.

(where Δ_2 captures the effect of an increase in the production of the Japanese plant due to an increment in the marginal cost of the Mexican plant). On the other hand, the term that multiplies the brackets is equal to the product of (minus) the marginal product of the Japanese inputs used in the Mexican plant (keeping θ constant) and the direct effect of the rule of origin on the use of such inputs. The term Γ_4 can be positive or negative. It will tend to be a positive number when *a)* the result of the increase of the marginal costs of the Mexican plant is a larger concentration of production in this plant than in the Japanese plant, and *b)* the preferential tariff t_L^x becomes greater with respect to the most favored nation tariff t_N^x.

Therefore when the firm is a monopoly, the U.S tariff rates on the exports of Mexico and Japan affect the derivative of M_1 with respect to θ and the decision of satisfying (or not) the rule of origin as well. This decision now depends on the comparison of the sum of the obtainable profits of the two plants if the rules of origin for the Mexican plant are satisfied or not. As in the case of perfect competition (figure 3), when the rule of origin is satisfied, the sum of the profits of the two plants continuously decreases as the rule of origin becomes more restrictive, expressing the inefficiency created by the restriction to the use of Japanese inputs. This imposes a limit on the possibility of increasing θ as a way of promoting the use of Mexican inputs.

5. *Examples*

In order to illustrate the economic concepts of the last sections we will now proceed to two numerical examples: one in which the firm is a perfect competitor, and another in which it is a monopolist.

Perfect Competition

Suppose the Japanese firm is a perfect competitor in the U.S. market. Let $F(M_1, M_1^*) = M_1^a M_1^{*b}$, $a = .25$, $b = .25$, $q_1 = 50$, $q_1^* = 40$, $t_L^m \phi_L = .05$, $t_N^m \phi_N = .1$, $p = 18\,000$, $t_N^x = .15$ and $t_L^x = 0$. For these parameter values, table 1 compares the equilibrium values of *a)* profits, *b)* Mexican inputs, and *c)* Japanese inputs of the Mexican plant when the firm operates out of the trade agreement with the corresponding values of these variables when the firm decides to join the agreement. Also, it shows the equilibrium values of these variables and the change in the equilibrium value of the Mexican inputs when the rule of origin changes in its range of interest (that is, the range where the rule is not so low to be redundant and not too big to discourage the participation of the Japanese firm in the trade agreement). Figure 4 depicts the behavior in table 1 of profits as the rule of origin changes, and it compares them with the out-of-agreement profits. Figure 5 does the same for the Mexican inputs.

Table 1

$\overline{m}_1$ =.8381; $\overline{\pi}_1$=6.0882(10^5)

	$M_1=(10^3)$	$M_1^*(10^3)$	$\pi_1(10^5)$	ΔM_1
Non-FTA	5.7983	6.9184	$\overline{\pi}_1$ =6.0882	—
FTA			$\hat{\pi}_1$	
$\theta=\overline{m}_1$	8.0253	9.5756	8.4265	—
θ=.9381	8.4637	9.0221	8.4132	438.40
θ=1.3	9.5286	7.3297	8.2275	502.40
θ=1.7	10.1120	5.9481	7.9258	583.40
θ=2.0	10.3190	5.1597	7.6880	207.00
θ=3.0	10.3660	3.4554	6.9626	47.00
θ=4.6	9.8041	2.1313	6.0850	-561.90
θ=7.0	8.8592	1.2656	5.2079	-944.90

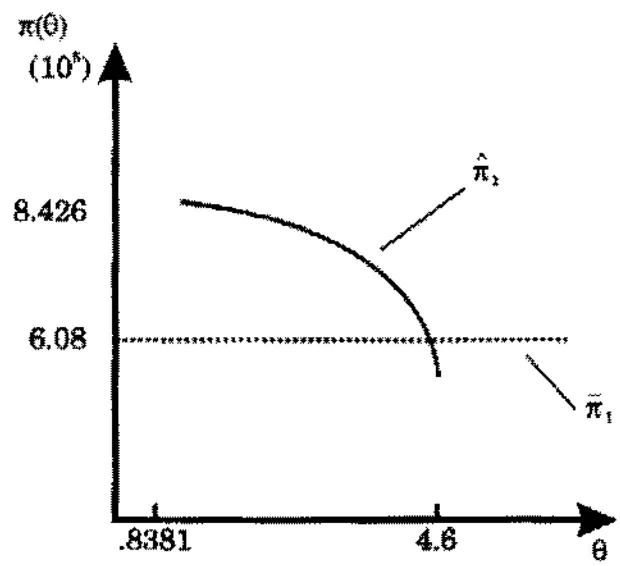

Figure 4

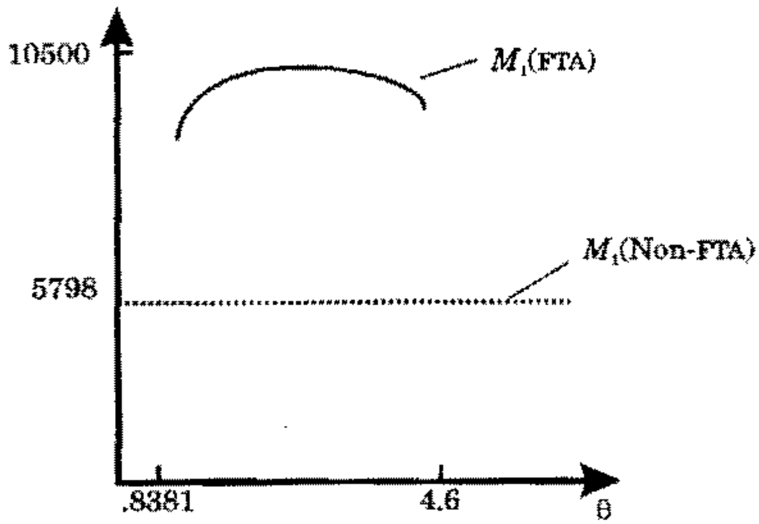

Figure 5

In table 2, a similar analysis to the one in table 1 is done for two different levels of returns to scale. This shows that, when the degree of homogeneity $\alpha = a + b$ increases, the way in which the rule of origin affects the equilibrium amount of Mexican inputs changes. On the other hand, each θ's range of interest when parameter values are changed is computed in table 3. This table also shows the minimum and maximum levels that the Mexican inputs and the profits of the Mexican plant reach over such ranges of θ.

Table 2

	a	+	b	=.25	a	+	b	=.75
	M_1	M_1^*	$\pi_1(10^4)$	ΔM_1	$M_1(10^8)$	$M_1^*(10^8)$	$\pi_1(10^9)$	ΔM_1 10^6
			$\bar{\pi}_1$	—			$\bar{\pi}_1$	—
Non-FTA	124.36	148.39	3.9176		1.8591	2.2183	6.5070	
FTA			$\hat{\pi}_1$				$\hat{\pi}_1$	
$\theta=\bar{m}_1$	154.46	184.29	4.8655	—	3.5616	4.2496	12.4650	—
θ=938	163.07	173.83	4.8629	8.6100	3.7442	3.9912	12.4060	18.26
θ=1.3	186.33	143.33	4.8269	23.2600	4.0313	3.1010	11.6030	28.71
θ=1.7	202.72	119.52	4.7671	16.3927	3.9700	2.3353	10.3730	-6.13
θ=2.0	211.13	105.56	4.7190	8.4100	3.8121	1.9061	9.4667	-15.79
θ=3.0	226.58	72.56	4.5656	15.4420	3.1408	1.0469	7.0319	-67.13
θ=4.6	234.43	50.96	4.3651	7.8560	2.2688	.4932	4.6939	-87.20
θ=7.0	235.00	33.57	4.1444	.0018	1.5018	.2145	2.9427	-76.70

Table 3

Benchmark: a =.25, b =.25, q_1 =50, q_1^* =40, $t_L^m\phi_L$ =.05, $t_N^m\phi_N$ =.1, p =18000, t_L^x =0

	θ		$\hat{\pi}_1$		M_1	
	Min	Max	Min/θ(10^5)	Max/θ10^5	Min/θ10^3	Max/θ(10^4)
base	0.8381	4.6000	6.0882	8.4265	8.0253	1.0366
a=.20	0.6705	3.9000	2.8088	3.7744	2.6144	0.3712
a=.30	1.0057	5.3000	16.2050	23.2550	29.5290	3.6018
b=.20	1.0476	6.9000	2.7641	3.7143	3.2158	0.4088
b=.30	0.6984	3.5000	16.5270	23.7150	25.0950	3.2973
q_1=40	1.0476	5.8000	6.8068	9.4212	11.2160	1.4569
q_1=60	0.6984	3.9000	5.5577	7.6923	6.1050	0.7930
q_1^*=30	0.6286	3.5000	7.0300	9.7301	9.2670	1.2038
q_1^*=50	1.0476	5.8000	5.4454	7.5369	7.1780	0.9324
$t_L^m\phi_L$=.025	0.8585	4.8000	6.1620	8.5287	8.3205	1.0809
$t_L^m\phi_L$=.075	0.8186	4.5000	6.0170	8.3280	7.7469	1.0063
$t_N^m\phi_N$=.05	0.8000	4.4000	6.2314	8.6248	8.2141	1.0670
$t_N^m\phi_N$=.15	0.8762	4.9000	5.9543	8.2413	7.8489	1.0196
p=17000	0.8381	4.6000	5.4305	7.5163	7.1584	0.9298
p=19000	0.8381	4.6000	6.7834	9.3888	8.9418	1.1616
t_L^x=.05	0.8381	3.4000	6.0882	7.6049	7.2428	0.9408
t_L^x=.10	0.8381	2.3000	6.0882	6.8255	6.5005	0.8444

The behavior of ΔM_1 when θ varies over its range is shown in table 1. When θ starts to increase with respect to the value $\bar{m}_1$=.8381, the direct effect is bigger than the effect of scale so that ΔM_1 is positive. But as θ keeps on growing, the latter effect becomes larger relative to the former, causing ΔM_1 to decrease until it becomes negative. Even if this is the case, the rule of origin θ may keep on increasing until it becomes greater than $\bar{\theta}$ (whose value is less than 4.6), where the profits π_1 of the Mexican plant are smaller than the level $\bar{\pi}_1$. This forces the plant to operate out of the free trade agreement.

On the other hand, table 2 shows the greater decrease in the scale of the Mexican plant as the rule of origin increases, due to a greater level of the returns to scale parameter α. In this table $\alpha = a + b$ changes from .25 to .75 and the proportion a / b is maintained constant. Clearly, ΔM_1 decreases more rapidly as α increases. This only reflects the fact that the effect of scale tends to (minus) infinity as α converges to one. Also note how the equilibrium levels of Mexican inputs and profits of the plant increase considerably as returns to scale become larger.

The unambiguous increase in the level of Mexican inputs M_1 caused by a small increment of the rule θ with respect to its non-restrictive level $\overline{m}_1$ is shown in tables 1 and 2. The converse decrease in the equilibrium amount M_1^* of Japanese inputs used in the Mexican plant when the rule of origin θ becomes more restrictive is also illustrated in this table, as well as in table 2. As we studied in section 2, the amount of inputs M_1^* must diminish as the rule of origin becomes more stringent since both the direct effect and the effect of scale negatively affect the use of these inputs.

The comparison between the two possible situations in which the Mexican plant can obtain profits is exemplified in tables 1 and 2. For the non-restrictive level $\overline{m}_1$, the amount of profits $\hat{\pi}_1$ achieved with tariff preference is much larger than the amount of profits $\bar{\bar{\pi}}_1$=6.0882(10^5) obtained without any preference but without complying with the rule of origin. As θ increases with respect to the value $\overline{m}_1$, $\hat{\pi}_1$ continuously decreases due to the technological inefficiency introduced by the rule of origin until θ is greater than $\underline{\theta}$. At this point the level of profits is lower than $\bar{\bar{\pi}}_1$, eliminating any incentive to comply with the rule of origin (see figure 4). On the other hand, observe how in both tables 1 and 2 the values of the Mexican inputs M_1 achieved by complying with the rule of origin are larger than the corresponding value obtained without participation in the trade agreement over all the range of θ (see figure 5).

The way in which the interval of feasible rules of origin varies as parameter values are changed is shown in table 3. As studied in sections 1 and 3, θ must be greater than the non-restrictive quotient, $\overline{m}_1$, of Mexican to Japanese inputs so as not to be redundant. It must also be less than θ to avoid having inside-of-agreement profits $\hat{\pi}_1$ lower than $\bar{\bar{\pi}}_1$, implying a lack of participation by the Japanese firm in the free trade agreement. Table 3 shows that the feasible interval of θ and, hence, the possibility of variation of the rule of origin increases as the share a of Mexican inputs, the international price q_1^* of Japanese inputs, the net result $t_N^m \phi_N$ of the policies of tariffs and duty drawbacks for Japanese inputs, and the ratio t_N^x / t_L^x of preferential to non-preferential tariffs to exports are greater. It also shows that this interval decreases as the share b of Japanese inputs, the price q_1 of Mexican inputs, and the net result $t_L^m \phi_L$ of the policies of tariffs and duty drawbacks for U.S. inputs becomes larger. These results only reflect that as the marginal product of Mexican or U.S. (Japanese) inputs increases (decreases) or the marginal cost of such inputs decreases (increases), the feasible set of possible choices for the rule of origin expands. It also reflects that this set may also be larger if the tariff preferences of the agreement are improved.

Also, it is interesting to point out in table 3 an illustration of the relationship, studied in section 3, between the ratio t_N^x/t_L^x and θ. As t_L^x decreases from .10 to .05 this ratio increases and θ changes from 2.3 to 3.4, widening the policy possibilities with respect to the rule of origin. Also, with this variation of t_L^x, the equilibrium amount of Mexican inputs increases. These are results that agree with the benefits brought by raising the level of tariff preferences for the Mexican exports to the United States.

Table 3 also illustrates the ranges of variation of the equilibrium quantities of Mexican inputs M_1 and profits π_1 of the Mexican plant as parameter values change with the Japanese firm operating under the rule of origin regime. As expected, these ranges increase as the shares a and b of the Mexican and Japanese inputs, the international price p of the final product, and the ratio t_N^x/t_L^x of preferential to non-preferential tariffs to Mexican exports are greater. The ranges diminish as the international prices q_1 and q_1^* of the Mexican and Japanese inputs and the net results $t_N^m \phi_N$ and $t_L^m \phi_L$ of the policies of tariffs and duty drawbacks for Japanese and U.S. inputs increase.

Monopoly

Now suppose the Japanese firm has the monopoly of the product x in the United States. Let $F(M_1, M_1^*) = M_1^a M_1^{*b}$, $G(M_2^*) = M_2^*$, a=.25, b=.25, q_1=10, q_1^*=50, $t_L^m \phi_L$=0, $t_N^m \phi_N$=0, t_N^x=.25, and t_L^x=0. Assume that the demand in the United States for the product of the Japanese monopolist is given by $p(x_1 + x_2) = 1 - x_1 - x_2$. For these values, table 4 compares the rule-of-origin-regime equilibrium values of *a)* total profits, *b)* profits of the Japanese and Mexican plant, *c)* Japanese and Mexican inputs used in the Mexican plant, and *d)* production of the Mexican plant with the corresponding values of these variables when the firm operates without the restriction of such regime and without receiving tariff preferences. It also shows the equilibrium values of these variables and the change in the equilibrium value of the Mexican inputs when the rule of origin changes in its range of interest. Figure 6 depicts the behavior in table 4 of profits as the rule of origin increases and compares them with the profits obtained without complying with the rule regime. Figures 7 and 8 offer an equivalent illustration for the Mexican inputs and the production of the Mexican plant respectively.

Table 4

$\overline{m}_1$=19.0735; $\bar{\pi}$=818.3161

	M_1	M_1^*	$F(M_1, M_1^*)$	π_1	π_2	ΔM_1	$\pi = \pi_1 + \pi_2$
				$\bar{\pi}_1$	$\bar{\pi}_2$		$\bar{\pi}$
Non-FTA	.3578	.0188	.2862	2.7472	815.5689	—	818.3161
FTA				$\hat{\pi}_1$	$\hat{\pi}_1$		$\hat{\pi}$
$\theta=\overline{m}_1$	.8943	.0469	.4525	4.0569	819.6341	—	823.6911
θ=19.2	.8938	.0466	.4516	4.0490	819.6127	-.0021	823.6617
θ=19.5	.8926	.0458	.4496	4.0303	819.5624	-.0012	823.5927
θ=20	.8904	.0445	.4462	3.9996	819.4799	-.0022	823.4795
θ=25	.8644	.0346	.4158	3.7233	818.7347	-.0260	822.4580
θ=35	.8059	.0230	.3691	3.2999	817.5894	-.0585	820.8893
θ=55	.7060	.0128	.3085	2.7531	816.1045	-.0999	818.8577
θ=62.5	.6758	.0108	.2924	2.6076	815.7081	-.0302	818.3157

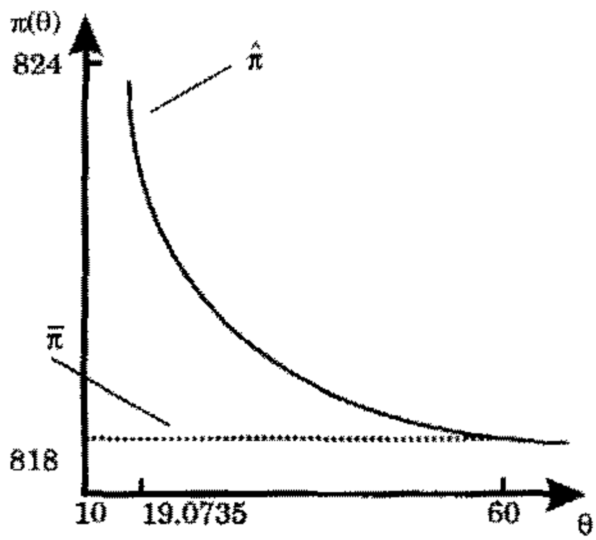

Figure 6

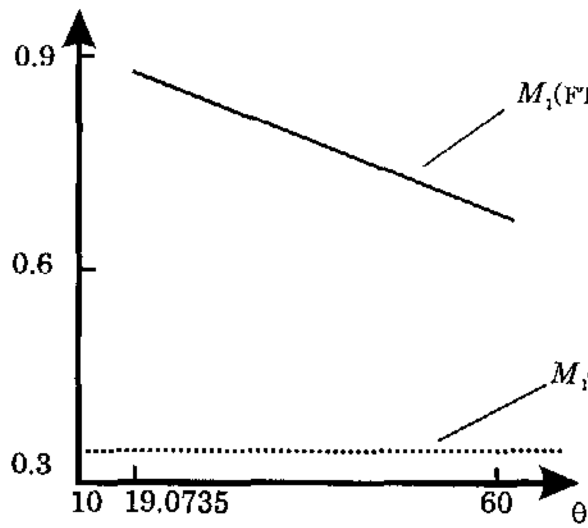

Figure 7

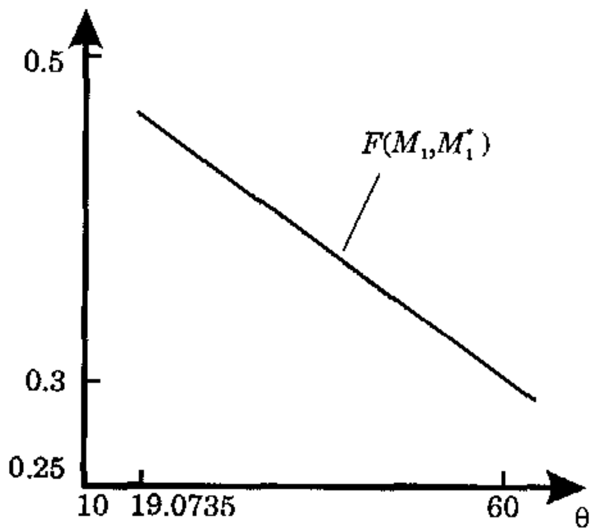

Figure 8

In table 5 an analogous analysis to the one done in table 3 is performed for the monopoly example. This table shows the ranges of θ when parameter values are changed. It also states the minimum and maximum levels that the profits of both plants and the Mexican inputs and production reach over such ranges of θ.

Table 5

benchmark: $a = .25$, $b = .25$, $q_1 = 10$, $q_1^* = 50$, $t_L^m \phi_L = 0$, $t_N^m \phi_N = 0$, $t_L^x = 0$, $t_N^x = .25$

	θ		M_1		F		$\hat{\pi}_1$		$\hat{\pi}_2$	
	Min	Max	Min/θ	Max/θ	Min/θ	Max/θ	Min/θ	Max/θ	Min/θ	Max/θ
base $t_L^x=0$	19.073	62.5	.6760	.8943	.2926	.4525	2.6078	4.0569	815.70	819.63
$t_L^x=.10$	19.073	48.4	.7368	.8959	.3256	.4529	1.7910	2.5023	816.52	822.15
$a=.20$	4.0000	21.3	.5304	.7538	.4063	.5316	4.6461	6.0976	818.50	821.56
$a=.30$	68.343	208.9	.4603	.7702	.1717	.3013	1.0997	1.9427	812.74	815.92
$b=.20$	37.252	129.8	.6939	.9295	.3206	.4693	3.6571	5.3731	816.39	820.04
$b=.30$	11.004	37.6	.6365	.8280	.2627	.4388	1.6898	2.8454	814.98	819.29
$q_1=8$	90.949	290.7	.5482	.8938	.1793	.3061	1.5932	2.7316	812.93	816.04
$q_1=12$	5.3231	21.9	.5889	.6875	.3735	.5052	3.3385	4.5373	817.69	820.92
$q_1^*=40$	4.0000	19.9	.4969	.6460	.3724	.4984	2.7095	3.6446	520.80	523.26
$q_1^*=60$	68.340	220.0	.5740	.9175	.1967	.3331	2.0769	3.5304	1176.0	1180.0
$t_L^m \phi_L=.05$	13.555	45.4	.6872	.8397	.3196	.4774	2.8529	4.2838	816.37	820.24
$t_N^m \phi_N=.05$	20.027	66.0	.6582	.8728	.2846	.4416	2.5380	3.9580	815.05	819.36
$t_N^x=.20$	19.073	53.6	.7124	.8951	.3119	.4527	2.1275	3.1020	764.11	767.56
$t_N^x=.30$	19.073	73.5	.6370	.8935	.2726	.4523	3.0839	5.1469	874.73	879.74

The behavior of ΔM_1 in table 4 exemplifies the core of the monopoly case. Even though there is a big increase in the equilibrium quantity M_1 of Mexican inputs when the firm complies with the rule at $\overline{m}_1$ (due to tariff preferences), the value of M_1, unlike the case of perfect competition, continuously decreases as θ becomes bigger (see figure 7). This is due to the presence of the new effects Γ_3 and Γ_4 of reallocation between the two plants characteristic of the monopoly case. These effects are such that, as the rule increases, production is transferred in increasing proportions from the Mexican to the Japanese plant. This production transfer is reflected in table 4 by the decrease of the production $x_1 = F(M_1, M_1^*)$ of the Mexican plant (see figure 8) and the difference in the amount of profits π_2 generated by the Japanese plant and the profits π_1 of the Mexican plant. Even a small increment in the rule of origin with respect to its non-restrictive level $\overline{m}_1$ may not always positively affect the demand for Mexican inputs. This is because in this example, even when Γ_2=0 at $\overline{m}_1$, Γ_4 (whose value must be negative) is greater than $\Gamma_3 \times \Gamma_1$ so that ΔM_1 is always negative as θ increases.

The comparison between the total profits $\pi = \pi_1 + \pi_2$ that the firm can obtain from its two plants under the two possible rule-of-origin regimes is also illustrated in table 4. When the value of θ is equal to $\overline{m}_1$, the FTA profits $\hat{\pi}_1$ are considerably bigger than the non-FTA profits $\overline{\pi}$ due to tariff preference. However, $\hat{\pi}_1$ continuously decreases as θ becomes bigger due to both technological and reallocation effects (see figure 6). The firm will continue to comply with the rule of origin until θ is greater than $\underline{\theta}$ (whose value is less than 62.5), where $\hat{\pi}_1$ will be less than $\overline{\pi}$. On the other hand, observe in table 4 how the values of the Mexican inputs and of production of the Mexican plant under FTA participation are larger than such values under non-FTA operation (see also figures 7 and 8).

The manner in which the interval of feasible rules of origin changes with parameter variations is illustrated in table 5. This interval raises with increases in *a)* the share a of Mexican inputs in the Mexican plant, *b)* the international price q_1^* of Japanese inputs, *c)* the net result $t_N^m \phi_N$ of the Mexican policies of tariffs and duty drawbacks for Japanese inputs, and *d)* the non-preferential tariff to exports t_N^x. The interval becomes smaller with decreases in *a)* the share b of Japanese inputs in the Mexican plant, *b)* the price q_1 of Mexican inputs, *c)* the net result $t_L^m \phi_L$ of the policies of tariffs and duty drawbacks for U.S. inputs, and *d)* the preferential tariff to exports t_L^x. These results, which are identical to the corresponding ones for the example of perfect competition, establish again that the amplitude of the feasible set of possible choices for the rule of origin increases as the marginal product of Mexican or U.S. (Japanese) inputs becomes larger (smaller), the marginal cost of such inputs decrease (increase), and the FTA tariff preferences are improved.

The ranges of variation of the equilibrium quantities of the Mexican input, the production of the Mexican plant, and the profits of the two plants as parameter values change and when θ is in the set $\{\theta / \overline{m}_1 \leq \theta \leq \underline{\theta}\}$ are shown in table 5.

6. Conclusions

The objective of the model developed in this paper is to analyze the effects of so-called "rules of origin" or "rules of preference", in the context of preferential trade agreements. In such a context, rules of origin limit the use of inputs of countries that are not members of the agreement (or "third countries") as a condition for eligibility for tariff preferences.

More precisely, this paper analyzes the effects of the application of rules of origin on the use of inputs originating in the zone of preferential free trade. With this purpose, we developed a model of partial equilibrium of a firm that can export to one of the countries which participates in a free trade zone from two plants: one located out of the zone and the other located in the other country of the free trade zone. The rule of origin is the requisite that must be complied with by the plant located in the zone for its exports to have preferential tariff treatment.

The model considers two extreme cases: one in which the firm sells the product of both plants in a perfectly competitive market, and other in which the firm has a monopoly over the product. In both cases, one of the most important elements that determines the effects of the rule of origin is the substitutability of the inputs originating in "third countries" with the inputs of the free trade region. If they are imperfect substitutes, an increasingly restrictive rule of origin can provoke technological inefficiency, reflected in an increase in the marginal cost of the firms. If the firms wish to comply with the rule of origin they must diminish their use of third country inputs below the optimum without distortions.

Under perfect competition, the production decisions of the plants are independent. In this case the main result of the model is that a more restrictive rule of origin has two opposite effects on the use of inputs of the free trade zone: on one hand, it tends to directly increase such use by requiring a larger ratio of regional inputs to third-country inputs; on the other, it tends to reduce such use, by augmenting the marginal costs of the plant located in the free trade zone and therefore inducing a decrease in the scale of operation. The model concludes, however, that starting from a situation without distortions, the use of inputs originating in the zone increases as the rule of origin becomes "slightly" more restrictive.

When the firm operates as a monopolist, the production of the plants are no longer independent. In this case, it is concluded that a more restrictive rule of origin has four effects in the use of inputs of the free trade zone: the two effects that were mentioned in the case of perfect competition, plus two more: an effect which multiplies the effect of the increase in the marginal cost of the plant located in the free trade zone upon the level of production, and an effect derived from the change in the value of the marginal product of the inputs which do not originate in the free trade zone, whose sign cannot be determined *a priori*. Both effects result from the possibility of reallocation of production of the monopolistic firm between its two plants.

The above considerations suggest a *minimal* (or at least careful) policy regarding rules of origin. As Corden (1971) points out for content protection policies, the rules should not be restrictive in real terms, forcing national firms to use a less than optimal amount of third country inputs.

In the process of searching for less conservative rules, a question arises: under which circumstances can the application of restrictive rules be justified? The model suggests that the cost caused by the technological inefficiency derived from the rules of origin is justified, at least, in three scenarios.

The first scenario is when the increase in the costs of the firm which complies with the rule does not imply an increase in the social costs. This could happen, for example, when the shadow price of the Mexican inputs is less than the market price.

The second is when there are major possibilities of substitution between third-country inputs and inputs from the free trade zone.

The third scenario is when the application of the rule goes together with a "sufficiently large" decrease of the tariffs for national products. This decrease should be such that it propitiates a "large increase" in the profits of national firms. This could take place both when the preferential trade agreement "creates trade" (implying that the profits of national firms also represent benefits for all the world), as well as when it "deviates trade" (implying that the profits of national firms represent a transference from firms of other countries and from the government of the trading partner).

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