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Politiche dell'Unione Europea, Processi di Integrazione Economica e Commerciale ed esiti del negoziato Wto

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ROMA TRE UNIVERSITÀ DEGLI STUDI

Working Paper 08/1

(revised version, March 2009)

Prin 2007 PUE PIEC

is a Research Project on *"European Union policies, economic and trade integration processes and WTO negotiations"* financed by the Italian Ministry of Education, University and Research (Scientific Research Programs of National Relevance, 2007).

Information about the project, the partners involved and its outputs can be found at

http://www.ecostat.unical.it/anania/PUE&PIEC.htm.

Tariff Rate Quotas with endogenous mode of competition:

the case of the EU import regime for bananas[1]

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Abstract: Tariff Rate Quotas (TRQs) are among the most frequently used trade policy instruments by developed countries to limit preferential access to products from developing countries. One of the core issues in multilateral and preferential negotiations between developed and developing countries is how to liberalize agricultural trade when TRQs are in place. The paper uses a two-stage capacity constrained model, in which the mode of competition is endogenous and the constraint is flexible, to investigate the impact of TRQs and to identify the tariff equivalent. The model shows that the tariff equivalent changes according to the prevailing mode of competition under the TRQ. The model is used empirically to address the issue of the 2006 tariffication of the TRQ for EU banana imports from Latin American exporters. The results suggest that under the TRQ firms competed on quantity and that, for a wide range of parameter values, the tariff which would have left unchanged imports was higher than the one introduced by the EU.

Keywords: import quotas, oligopoly, bananas

JEL code: Q18; F13; L13.

Revised version

March, 2009

[1] I wish to thank Giovanni Anania and Francesco Aiello for helpful comments on an earlier draft of the paper. Financial support received by the "Agricultural Trade Agreements (TRADEAG)" (Specific Targeted Research Project, Contract no. 513666), and the "New Issues in Agricultural, Food and Bio-energy Trade (AGFOODTRADE)" (Small and Medium-scale Focused Research Project, Grant Agreement no. 212036) research projects funded by the European Commission, and by the "European Union policies, economic and trade integration processes and WTO negotiations" research project funded by the Italian Ministry of Education, University and Research (Scientific Research Programs of National Relevance 2007) is gratefully acknowledged.

1. Introduction

A high proportion of agricultural production and imports in developed countries is currently protected by Tariff Rate Quotas (TRQs). TRQs are two level tariffs with a limited volume of imports (the quota) subject to a lower in-quota tariff and additional imports subject to a higher out-of-quota tariff. TRQs are among the most frequently used trade policy instruments by developed countries to limit preferential access to products from developing countries. More than 15% of agricultural products imported by the EU are covered by a TRQ, while the figure in the US and Japan is slightly under 10%. Nevertheless, the extensive use of TRQs has raised many questions and several countries within the current WTO negotiations have proposed modifications to the TRQs regimes to further liberalize trade.

One controversial case is the European Union (EU) TRQs regime for bananas introduced in 1993. This regime has been at the heart of an endless international trade conflict - the so called "banana war". Within the WTO major Latin American banana exporters and the United States - which does not produce bananas, but is the home country of the most important multinational banana traders – challenged the regime (Josling and Taylor, 2003). Following the 2001 agreements reached within the WTO between the EU and the major Latin American exporters, in 2006 the EU replaced the TRQ applied to its imports from MFN countries with a "tariff-only" regime. This new regime was challenged again within the WTO by major Latin American exporters and by the US. The key issue in the current controversy on bananas is that of establishing which tariff would leave unchanged imports with respect to those under the TRQs.

Papers on the economics of TRQs assume, by and large, perfect competition (e.g. Boughner *et al*., 2000; Hraianova, De Gorter, 2005; De Gorter and Kliuaga, 2006). While this assumption reflects reasonably well many manufactured products, where imports and exports are mostly carried out by small firms, it may be unrealistic for agricultural trade, which is often dominated by few large firms. This paper considers the implications of the existence of large traders operating in the international agricultural markets; a capacity constrained model, in which the mode of competition is endogenous, is used in order to examine the effect of TRQs and the implications for establishing the tariff which leaves imports unchanged.

The literature on the non-equivalence between quotas and tariffs in non competitive markets which originated with the contribution by Bhagwati (1965), has considered different market structures and settings. Contributions assuming oligopoly have shown that when firms compete on price, strategic interactions under quotas and tariffs may be fundamentally different (e.g. Harris, 1985; Krishna, 1989). These papers, however, implicitly assume that firms' behaviour and market structure are not influenced by the trade policy.[2] Few papers have analysed import quotas under oligopoly by means of models in which the conduct of firms on the market arises endogenously and is determined by the

[2] A recent contribution by Krishna and Tan (2007) analyses, in a competitive setting, the effect of quotas and tariffs considering the impact that trade policies may have on the size of the trading industry.

trade policy. Syropoulos (1992) constructed a model where firm behaviour is endogenously determined in an infinitely repeated game and analysed the impact of quotas and tariffs on market conduct. Deneckere *et al.* (2000) developed a capacity constrained duopoly model with homogeneous products in which the existence of price leadership and the identity of the leader are endogenous and depend upon firms' costs and capacities. They show how conclusions regarding the equivalence of quotas and tariffs may differ when endogenous conduct is taken into consideration.

Capacity constrained models are the natural framework for examining the impact of quantitative restrictions under oligopoly. Unlike import quotas, under a TRQ the capacity constraint faced by firms is not rigid, as firms can always increase imports outside the quota albeit at a higher tariff. Maggi (1996) has developed a duopoly two-stage capacity constrained model in which the mode of competition is endogenous and the constraint is flexible to address strategic trade policy issues. In his paper the cost of adjusting capacity in the first period is lower than in the second period; he shows that the outcome of the game ranges from Cournot to Bertrand depending on the gap in the cost of adjusting capacity between the two periods: the greater this gap the higher the effectiveness of the capacity constraint and the closer the outcome of the game to that of Cournot.

In this paper the model by Maggi (1996) is used to model the working of TRQs and to find the tariff equivalent. The basic idea is that the existence of a TRQ introduces a capacity constraint for trading firms which is given by the number of licences they have been allocated. However, the firm can adjust its capacity over time by incurring adjustment costs: either by acquiring additional licences on the market in the first stage, or by importing out-of-quota in the second stage. The effectiveness of the capacity constraint in this paper is determined by the values of the trade policy instruments, i.e. the in quota and the out-of-quota tariffs and the initial allocation of licences. The replacement of the TRQ with a tariff, by removing the capacity constraint, may imply a change in the mode of competition. As a consequence, the tariff which leaves imports unchanged varies according to the prevailing mode of competition under the TRQ; in general terms this is higher the less competitive the equilibrium under the TRQ, i.e. the more effective the capacity constraint under the TRQ. The paper shows that the key trade policy variables – the values of the in-quota and out-of-quota tariffs and the initial allocation of licences - determine the mode of competition under the TRQ and, therefore, the value of the tariff equivalent.

The setting in this paper differs from Maggi (1996) mainly because it takes into consideration a competitive fringe supplying licences to the duopolists at increasing prices; thus, unlike most capacity constrained models, the duopolists face increasing marginal costs. A further contribution is that the model is empirically used to address the issue of the tariffication of the EU TRQ on bananas in place until 2006 for non-ACP countries. Within this framework the mode of competition can be assessed by means of observable parameters, i.e. the values of adjusting costs in the two periods; a further advantage is that, while trade policy analyses based on the conjectural variation approach assume a constant conduct parameter, here the possibility that a trade policy change may change the mode of competition is taken into account.

The prevailing mode of competition under the banana TRQ regime and the value of the tariff which would leave imports unchanged are assessed. Limited data on firms has suggested the use of a calibrated version of the model. The results show that the prevailing mode of competition under the TRQ is Cournot for a wide range of parameter values; this is because the effectiveness of the capacity constraint is very high mainly due to the high value of the out-of-quota tariff. The results also suggest that, for a wide range of values of parameters, the tariff which would leave imports unchanged is higher than the tariff introduced by the EU in 2006.

The paper is organised as follows. The next section presents the main hypotheses of the model and the various outcomes of the game. The third section addresses the issue of the tariff which leaves imports unchanged under the different outcomes. In the fourth section the empirical exercise addressing the tariffication of the EU TRQ for bananas is presented. The final section offers some concluding remarks.

2. The model

The model considers two symmetric duopolistic firms and a large number of small competitive firms importing a differentiated product in one country. The inverse demand functions in the importing country are:

$$\begin{aligned} p_1 &= p_1(q_1, q_2, q_s) \\ p_2 &= p_2(q_1, q_2, q_s) \\ p_s &= p_s(q_1, q_2, q_s) \end{aligned} \qquad (1)$$

with q_i and p_i being the quantity and the price of the product traded by the large firm *i* and q_s and p_s being the quantity and the price of the product imported by small firms.

In the importing country a tariff rate quota is in force with *Q*, *t* and *T* being, respectively, the import quota, the in-quota tariff and the out-of-quota tariff.

We assume that the government has allocated the quota on an historical basis and that licences can be transferred between operators. Most studies to date have examined the case of auction quotas (e.g. Bergsten *et al.*, 1987; Krishna, 1993) and more recently of licences-on-demand allocations (Hraianova *et al.*, 2006). Unlike these methods, the historical criteria allocate to importers the right to import a given quantity at the in-quota tariff without having to pay for the licences.

The duopolist holds q_i^0 licences while small operators hold q_s^0 licences, with $q_1^0 + q_2^0 + q_s^0 = Q$.[3] The marginal trading costs of small operators are assumed to be above those of large firms, thus, a market for licences arises. Small operators are in equilibrium when the price of the licence is equal to the

[3] The initial allocation of licences to firms is exogenous and rent-seeking activities to obtain quota rents are not considered. Hraianova and De Gorter (2005) have recently shown how rent seeking by trading firms may affect the licences market structure.

value of using it (i.e., the product price less the marginal costs). If small operators face marginal trading costs c_s, then their inverse supply of licences is: [4]

$$L(q^d) = p_s - c_s - t \tag{2}$$

with $q^d \leq q_s^0$ being the amount of licences exchanged on the market. The two large firms face identical marginal trading costs, c, which are constant and lower than c_s; due to their low marginal trading costs, they are the sole purchasers of licences and, thus, exert market power in the licence market. [5] We assume that $L' + t \leq T$ with $L' = \frac{\partial L q_i^d}{\partial q_i^d}$.

This setting reproduces the likely market structure arising when licences are allocated on the basis of historical imports; over time, traders who have reduced costs hold an amount of licences which is lower than their optimal trading capacity; hence, their willingness to purchase licences from the less efficient importers.

Profits of large firm *i* are:

$$\Pi_i = \begin{cases} p_i q_i - c q_i - t q_i & \text{if} \quad q_i \leq q_i^0 \\ p_i q_i - (c+t) q_i - L(q_i - q_i^0) & \text{if} \quad q_i^0 < q_i \leq q_i^0 + q_i^d \\ p_i q_i - c q_i - L q_i^d - t(q_i^d + q_i^0) - T(q_i - q_i^d - q_i^0) & \text{if} \quad q_i > q_i^0 + q_i^d \end{cases} \tag{3}$$

while profits of small firms are:

$$\Pi_s = p_s q_s + L q_d - (c_s + t) q_s \tag{4}$$

As already mentioned, in the first stage of the game the two firms choose capacity, i.e. they decide the quantity to trade; if this quantity exceeds their own quota, firms purchase licences on the market. By choosing capacity, firms commit themselves to import a certain volume in the second stage. In the second stage we assume that the only way to increase imports is to import out-of-quota. This assumption appears to be realistic in the context of several TRQ regimes with transferable licences; licence transactions usually occur well before the entry of the product into the importing country, as firms plan the quantity to trade in advance in order to arrange contracts with suppliers, distributors and providers of logistical services. The amount of purchased licences could thus work as a firm's commitment to trade a certain quantity in the second period. The effectiveness of this commitment depends on the cost of increasing capacity in the second stage, that is, the cost of importing out-of-quota, which is tariff T. The higher T and the higher is the effectiveness of the capacity commitment; on the contrary, if the cost of increasing capacity in second stage is equal to that incurred by firms in the first stage ($L' + t = T$), then the capacity chosen in the first stage does not work as a commitment device.

[4] Thus, the quota licence is here considered as an asset, with the price being endogenously determined once for each period and reflecting the opportunity cost of holding the asset. The behaviour of the price of the quota licence within the year has been analysed by Krishna and Tan (1996).

[5] The TRQ is here assumed to be applied to products which consumers treat as imperfect substitutes, as it is actually often the case. Therefore, licences hold by small operators can be used by large operators.

In the second stage, after observing capacity, firms compete on price. As Maggi (1996) has shown, in this setting the prevailing mode of competition and, consequently, the outcome of the game, depends upon the effectiveness of the capacity commitment; as the effectiveness of the commitment increases, the game moves from a pure Bertrand solution - when the capacity constraint is not important, firms compete on prices - to a pure Cournot outcome - when the capacity constraint is very important, firms commit themselves to import the quantity chosen in the first stage. The prevailing mode of competition, therefore, depends upon the values of t, T, and q_i^0, that is, it depends upon the value of the key instruments of the trade policy.

As usual, the game is solved backwards, by first considering the second stage decision, when firms compete on price, given the capacity chosen in the first stage. The subgame Bertrand reaction curve is a kinked curve with three branches. If $q_i < q_i^0 + q_i^d$ marginal costs are equal to $c + t$. The firm's imports are lower than the licences it holds (i.e. its own licences plus the licences acquired in the first stage). If $q_i > q_i^d + q_i^0$ marginal costs of firms are equal to $c + T$. The firm's imports are greater than the amount of licences it holds; therefore there are also out-of-quota imports. If $q_i = q_i^0 + q_i^d$, the residual marginal revenue curve crosses the marginal cost curve at its vertical segment. The relevant price combination is derived from the demand functions by setting a fixed traded quantity $q_i = q_i^0 + q_i^d$. This subgame admits a unique pure-strategy equilibrium, given by the intersection of the two reaction curves. The subgame perfect equilibrium implies that:

$$p = \begin{cases} p_i^B(c,T) & \text{if} \quad L' + t \le T < T^* \\ p_i^C(c,t,L) & \text{if} \quad T \ge T^* \end{cases} \tag{5}$$

with T^* being a critical value of the out-of-quota tariff, and p_i^B e p_i^C being the Bertrand and Cournot equilibrium prices, respectively.

With no capacity constraints ($L' + t = T$), the full game equilibrium is the outcome of a one-shot Bertrand game with long run costs equal to $c + t + L'$. When the capacity constraint is effective (T is higher than the critical level T^*) then the full game equilibrium is given by the Cournot price. The Cournot solution is identified as the outcome of a one-shot game in which firms compete on quantity and have long run costs equal to $c + t + L'$ (Figure 1).

Figure 1

When the value of the out-of-quota tariff is lower than the critical level, but greater than the first stage capacity costs ($L' + t < T < T^*$), the equilibrium price is the outcome of a one-shot Bertrand game in which firms compete on price and have long run costs equal to $c + T$. This is the equilibrium price even if firms do not import out-of-quota and incur marginal costs $c + t + L'$, which are lower than $c + T$. The basic intuition explaining this outcome is that when the cost of increasing capacity in the first stage is lower than in the second stage ($L' + t < T$), investment in capacity in the first stage

induces a higher price ($p_i^B(c,T)$) than the one that would prevail in a pure Bertrand one shot game ($p_i^B(c,t,L')$.

The critical level T^* above which the mode of competition switches from Bertrand to Cournot is defined implicitly by $p_i^B(c,T) = p_i^C(c,t,L')$.

To address the issue of the tariff equivalent it is convenient to choose a functional specification. We assume quadratic utility functions and, thus, linear demands. For sake of simplicity, we also assume that the demand for the product imported by large firms is not sensitive to changes in the quantity of the product traded by small firms. [6] Inverse demand functions are thus:

$$\begin{aligned} p_1 &= \alpha - \beta q_1 - \lambda q_2 \\ p_2 &= \alpha - \beta q_2 - \lambda q_1 \\ p_s &= \varepsilon - \delta q_s - \phi(q_1 + q_2) \end{aligned} \qquad (6)$$

with $\beta > \lambda > 0$ and $\delta > \phi > 0$.

The direct demand functions are:

$$\begin{aligned} q_1 &= a - b_1 p_1 + b_2 p_2 \\ q_2 &= a - b_1 p_2 + b_2 p_1 \\ q_s &= e - d p_s + g(p_1 + p_2) \end{aligned} \qquad (7)$$

The cost function of small firms is assumed to be linear and upward sloping: $c_s = h + fq_s$ with $f > 0$.

When large firms do not purchase any licence ($q^d = 0$), small firms import the quantity q_s^* satisfying $p_s = c_s + t$, i.e. the first order conditions resulting from the maximisation of profits (4). [7] The quantity actually imported by small operators is given by the difference between the quantity q_s^* and the amount of licences they sell to the duopolists:

$$q_s = q_s^* - q_d = \frac{\varepsilon - h - t - \phi(q_1 + q_2)}{f + \delta} - q_d \qquad (8)$$

By substituting (8) in the licence supply (2) we obtain:

$$L = (\delta + f)q^d \qquad (9)$$

The maximisation problem under Bertrand is:

$$\max_{p_1} \Pi_1 = p_1 q_1 - (c + T)q_1 \qquad (10)$$

from which the Bertrand price equilibrium $p_i^B(c+T)$ is [8]:

[6] The main implication of this simplifying assumption is that the equilibrium of the duopolists, and thus the mode of competition, does not depend on the equilibrium of small firms: equations (11), (13) and (14) do not include parameters of demand and cost functions of small firms. The removal of this hypothesis would not provide relevant additional insights on the issue of the tariff equivalent.

[7] Under the assumptions made throughout the paper, $q_s^* \leq q_s^0$. Unlike large firms, small traders face high marginal costs; the quantity they would import without a market for licences is assumed to be not greater than the amount of licences they actually hold.

[8] Details are included in the Appendix.

$$p_1^B = p_2^B = \frac{a + b_1(c+T)}{2b_1 - b_2} \tag{11}$$

The Cournot equilibrium price is obtained by solving the maximisation problem:

$$\max_{q_1} \Pi_1 = q_1 p_1 - (c+t)q_1 - Lq_1^d \tag{12}$$

from which $p_i^C(c,t,L')$ is:

$$p_1^C = p_2^C = \frac{\Delta + \Phi(c + t - 2(f+\delta)q_1^0)}{\Sigma} \tag{13}$$

with $\Delta, \Phi, \Sigma > 0$ depending upon parameters of the large firm demand and of licence supply. When parameters satisfy all constraints and $T < T^*$, $p_1^B < p_1^C$ which implies $q_1^B > q_1^C$.

The value of T^* determines the equilibrium under the TRQ. As already mentioned, T^* is identified as the tariff satisfying the identity $p_i^B(c,T) = p_i^C(c,t,L')$. From (11) and (13) we obtain:

$$T^* = \frac{(a+c)\Psi + \Upsilon(q_i^0(\delta + f) - t)}{\mathrm{N}} \tag{14}.$$

with $\Psi, \mathrm{N}, \Upsilon$ depending upon large firm demand and licence supply functions parameters.

The mode of competition in this model, thus, depends upon the key variables of the trade policy: the initial allocation of licences between small and large importers and the values of the in-quota and out-of-quota tariffs. Whether q_i^0 and t positively affect the value of T^* depends upon the value of the demand parameters.

As for the out-of-quota tariff, if this is higher than the critical value T^* then the capacity commitment is effective and firms compete on quantity, while Bertrand prevails in the opposite case. Even when the out-of-quota tariff is prohibitive and there are no out-of-quota imports, the value of this tariff influences the equilibrium under the TRQ. This result differs from the prediction of perfect competitive static models; in the latter, when there are no out-of-quota imports, the value of the out-of-quota tariff never influences the equilibrium under the TRQ (Boughner *et.al*, 2000; De Gorter and Kliuaga, 2006).

The quantity imported by small firms is the difference between q_s^* and the amount of licences purchased by large traders (8), which in turn is determined on the licence market and dependent upon the quantity imported by the large firm ($q_i^d = q_i - q_i^0$). Thus, the quantity imported by small firms also varies with the prevailing mode of competition: everything else held constant, under Bertrand (Cournot) the imports of the duopolist q_i are higher (lower); hence, the quantity imported by small traders is lower (higher).

3. The tariff equivalent of TRQs with endogenous mode of competition

A change in the trade policy instrument may affect the mode of competition. In this model a tariff only import regime means that there is no capacity constraint; firms in the first stage can increase their

capacity by sustaining the same cost as in the second stage, i.e. by paying the tariff. In other words, a tariff represents the case in which $L = 0$, $T = t$ and thus $L' + t = T$. Under these circumstances, the outcome of the game is the one-shot Bertrand solution. If t_0 is the tariff in force in the tariff-only regime, then the new equilibrium price for the duopolists is:

$$p_1^{t^0} = p_2^{t^0} = \frac{a + b_1(c + t^0)}{2b_1 - b_2} \tag{15}$$

As for the small firms, the equilibrium quantity under a tariff–only regime is:

$$q_s^{t^0} = \frac{\varepsilon - h - t_0 - 2\phi(q_i^{t^0})}{f + \delta} \tag{16}$$

Let us first examine the tariff equivalent for large firms, t_i^0, i.e. the tariff which would leave unchanged the imports of the duopolist. Although this is seldom a relevant policy issue, as in most cases governments are interested in finding the tariff that leaves unchanged *total* imports, and not only those of large firms; however, this question is relevant for the purposes of this paper, because it helps us to understand how taking into account of endogenous mode of competition and capacity constraint may provide rather unusual results on the issue of what the tariff equivalent actually is. We can distinguish two different cases.

Case (a):

If under the TRQ regime $L' + t \leq T < T^*$ i.e. there is a weak capacity constraint before tariffication, the outcome of the game is identified by the one-shot Bertrand game with costs equal to $c + T$ (equation (11)). The tariff which leaves quantities unchanged is the tariff satisfying $q_i^B(p_i^B) = q_i^{t^0}(p_i^{t^0})$. From (11) and (15) it is clear that this is equal to the out-of-quota tariff T. This is the tariff that would leave unchanged the price of duopolist as well. With import quotas, when firms compete on price, tariffs and quotas are not equivalent, as the rigid quantitative restriction induces a higher price than the one that would prevail with a tariff implying the same level of imports (Harris, 1985; Krishna 1989). However, the quantitative restriction due to the TRQ is flexible.

For each level of imports it is possible to find a tariff equivalent which is the sum of the price of the licence, the value of the in-quota tariff and the oligopsonistic rent of firms. This is shown in Figure 2 which represents the Bertrand equilibrium of Firm 1 under the TRQ regime when the firm purchases licences on the market ($q_1 > q_1^0$) and when $L' + t = T < T^*$, i.e. there is no capacity constraint. Small firms benefit from the quota rent which is equal to the price of the licences paid by the large firm; the large firm benefits from oligopsonistic and oligopolistic rents and from the quota rents generated by its own licences. After tariffication firms continue to compete *à la* Bertrand: the tariff t_i^0 includes the in-quota tariff, but also the quota rent of small operators and the oligopsonistic rent.

Figure 2

Case (b):

If under the TRQ regime $T > T^*$, i.e. there is a strong capacity constraint, before tariffication the outcome of the game is the Cournot price $p_i^C(c,t,L')$. In this case tariffication induces a change in the mode of competition; by shifting the outcome from Cournot to Bertrand it increases the degree of competition on the market. The tariff t_i^0 which leave s quantities the same as before tariffication is the one which satisfies $q_i^C = q_i^{t^0}$ which implies $p_i^C(c,t,L') = p_i^{t^0}(c,t_i^0)$, that is, the tariff which has been defined as the critical tariff T^*. Therefore, when the out-of-quota tariff is sufficiently high, the tariff t_i^0 is the critical tariff (equation (14)) above which firms compete on quantities. This tariff captures the in-quota tariff, the price of the licence, the oligopsonistic rent and part of the oligopolistic rent under the TRQ regime. This is because tariffication, by shifting from Cournot to Bertrand, implies a decrease in the oligopolistic rent of firms.

These results have a number of interesting implications. The tariff t_i^0 changes with the prevailing mode of competition under the TRQ, which ultimately depends upon the value of the out-of-quota tariff with respect to T^* and $L'+t$. As aforementioned, one important factor is the initial distribution of licences to small and large operators; a high proportion of licences allocated to small operators increases the price of licences and reduces the probability of a Cournot outcome and the tariff equivalent being T^*. The out-of-quota tariff also influences the value of the tariff equivalent, even if there are no out of-quota-imports. When T is sufficiently high ($T > T^*$) then the tariff equivalent is T^*, while if $T < T^*$ the tariff equivalent is the out-of-quota tariff. Thus, unlike previous studies on TRQs, in this model the out-of-quota tariff, by influencing the strategic interaction between firms, may be crucial in determining the tariff equivalent even when the out-of-quota tariff is prohibitive and there are no out-of-quota imports.

The tariff t^0 which leaves *total* imports unchanged is the one satisfying:

$$2q_i(p_i^*) + q_s(p_s^*) = 2q_i(p_i^{t_0}) + q_s(p_s^{t_0}) \tag{17}$$

The value of this tariff also depends on the mode of competition under the TRQ. By substituting in (17) the equilibrium quantities, two different values for the tariff equivalents are obtained:

$$t^{0B} = \frac{\mathrm{A}(a - c\mathrm{M}) + \mathrm{B}(t - \mathrm{X}q^B)}{\mathrm{B} + \mathrm{AM}} \tag{18}$$

$$t^{0C} = \frac{\mathrm{A}(a - c\mathrm{M}) + \mathrm{B}(t - \mathrm{X}q^C)}{\mathrm{B} + \mathrm{AM}} \tag{19}$$

with q^B and q^C being the equilibrium imports of the duopolist under the Bertrand and Cournot outcomes, respectively and $\mathrm{A}, \mathrm{B}, \mathrm{M}$ and X depending upon demand and licence supply parameters, as shown in the Appendix.

Under the Bertrand outcome, the equilibrium price and the quantity q^B are affected by the value of the out-of-quota tariff, and not by the initial allocation of licences; therefore, t^{0B} depends upon T and t. Hence, if the mode of competition under the TRQ is Bertrand, then the out-of-quota tariff influences the value of t^{0B}, even if there are no out-of-quota-imports. Conversely, t^{0C} is affected by q_i^0 and t, and not by T.

It is worth noting that neither t^{0C} nor t^{0B} could be the tariffs which also leave prices unchanged. The reason is that after tariffication the market share of large and small firms change; the removal of the capacity constrain shifts the duopolist toward a more competitive behaviour which implies higher imports by the duopolist and, thus, a lower market share for small firms. The price of small firms is higher than under the TRQ, while that of the duopolist is lower.

Further, as will be shown in more detail in the next section, the tariff which leaves unchanged total imports is always lower than the tariff equivalent for the duopolists: $t^{0C}, t^{0B} < t_i^0$. The intuitive explanation for this result is that the tariff t_i^0 - which is equal either to the critical tariff or to the out of-quota tariff depending whether the mode of competition under the TRQ is Cournot or Bertrand – must capture not only the in-quota tariff and the quota rents, but also oligopsonistic rents and part of oligopolistic rents. With such a high tariff, imports of competitive firms would thus be significantly lower than under the TRQ.

4. The case of the EU import regimes for bananas

A calibrated version of the model is used here to show how the mode of competition under the TRQ and the tariff equivalent can be empirically assessed within this framework. The case of the EU import regime for bananas is an illuminating example of the relevance of the issues addressed in this paper in real world trade policies and conflicts. Before 2006 two TRQs were in force, one for ACP countries and the other one for non-ACP countries; while the ACP in-quota tariff was zero, a positive in-quota tariff was applied to non-ACP countries. The out-of-quota tariffs were very high and in the whole period during which the TRQs regime was in force, there were virtually zero out-of-quota imports. Licenses, which were allocated through the historical allocation criteria, were transferable, albeit with certain restrictions, among operators. This regime was at the heart of a long standing trade dispute within the WTO (Josling and Taylor, 2003). In 2006 the EU replaced the non-ACP TRQ with a tariff while maintaining a duty-free import quota for ACP bananas. The new regime was challenged again within the WTO by major Latin American exporters and the US. A formal complaint by Ecuador in November 2006 was followed by one from Colombia, Panama and the US in 2007 [9] (WTO, 2006, 2007a, 2007b and 2007c).

Guyomard *et al.* (1999), Guyomard and Le Mouël (2003) and Anania (2006) have assessed the impact of the EU import regimes for bananas by assuming perfect competition, although various authors

[9] In December 2007 and May 2008 two WTO panels ruled against the EU tariff regime.

acknowledge the fact that the concentration ratio in this industry is very high. More than 50% of EU banana imports are concentrated in the hands of two firms, Dole Food and Chiquita. There are few empirical studies on the degree of market power in the banana trading industry which are rather old and provide contrasting results (Deodhar and Sheldon, 1995; Herrmann and Sexton, 2001). Few papers have assumed imperfect competition; Mc Corriston and Sheldon (1996) and Mc Corriston (2000) have developed a vertically-related markets model in which the extent of imperfect competition is assessed by means of the conjectural variation approach. All studies perform comparative static under the assumption that everything remains constant after the trade policy change, and thus ignore possible changes in firms' behaviour, although Deodhar and Sheldon (1995) have found evidence that the introduction of the TRQs caused the industry to behave in a Cournot manner, thereby stressing the fact that trade policy changes may affect the mode of competition.

Unlike the conjectural variation approach, the mode of competition is here assessed on the basis of observable parameters, i.e. the cost of adjusting capacity in the first and second period; comparative static is performed by allowing the mode of competition to change with the trade policy, while in studies using the conjectural variation approach the mode of competition is assumed not to change; a further advantage is that this framework, differently from the conjectural variation model, is game-theory founded (Maggi, 1996).[10]

The assumption of a symmetric duopoly with a competitive fringe and differentiated products appears to be realistic for the EU market for non-ACP bananas. Two firms, Dole Food and Chiquita, have dominated EU imports from non-ACP countries and account for similar market shares in the EU and world-wide. Both firms have been investing over time in product differentiation strategies and sell the product on the market with a well known brand. Their trading costs are roughly similar as both of them export mainly from neighbouring Latin American countries (Costa Rica, Panama and Colombia) and export to the EU through a full integrated marketing chain (UNCTAD, 2003; Read, 1986; Taylor, 2003). Several small firms import bananas without a brand from non-ACP countries. Until 2006, these small historical importers used to sell licences to the two large firms. The assumption that the quantity imported by small firms has a negligible impact on the demand for the branded products imported by large firms also appears to be realistic as for EU bananas imports.

One of the main empirical difficulties is that this model requires firms' data which are not always available. The problem of the lack of data has been dealt with in different ways. As for firms', imports into the EU from non-ACP countries have been assessed on the basis of the Chiquita's quarterly company reports for the year 2005 and other available information. [11]

[10] Criticisms of the use of the conjectural variation model in trade policy analysis can be found, among others, in Helpman and Krugman (1989).

[11] Chiquita reports the amount of imports in Europe; this includes imports coming from all sources (both ACP and non-ACP imports) and sold in all European countries (both EU and non EU). This figure has been corrected by subtracting imports of Chiquita from the Ivory Coast and imports of Chiquita into non EU countries. Both figures were estimated on the basis of market shares of Chiquita available in UNCTAD (2003) and data on countries' imports/exports provided by FAOSTAT.

Unlike other papers (e.g. Guyomard *et al*. 1999; Guyomard and Le Mouël, 2003; Anania, 2006), the EU wholesale price, instead of the CIF price, has been considered. This is because the CIF price is likely to reflect intra-firm transactions and, therefore, to be a transfer price, often manipulated by firms for fiscal purposes. The wholesale price of Chiquita bananas in the EU market and the price of other bananas without a brand are from FAO (2006). Large firms' costs have been obtained by adding up the various costs the firm incurs when trading the product from the Latin American suppliers to the EU market. These include the FOB price of the countries Chiquita exports from (i.e. Panama, Costa Rica, Colombia), the insurance, freight and other relevant costs from these suppliers to the EU borders and the cost of ripening and transportation in the EU markets. Licences allocation data are from the European Commission.

As for the elasticities, estimates of cross-price elasticity are not available in the literature, as virtually all studies assume banana to be a homogenous product. Hence, the model has been calibrated with a range of values of cross-price elasticities, corresponding to different values of the degree of differentiation. [12] Details on input data are provided in Table A1 of the Appendix.

Figure 3

Figure 3 shows the value of the critical tariff (T^*) as a function of the degree of differentiation. For values of the degree of differentiation below 0.34 the critical tariff is below the out-of-quota tariff and the outcome of the game is the Cournot one. This result is consistent with the conclusions reached by Deodhar and Sheldon (1995) who found empirical evidence of quantity competition under the TRQ regime in the mid nineties. The tariff equivalent for the duopolist is the critical tariff. Above this value for the degree of brand differentiation, the mode of competition is Bertrand and the tariff equivalent for the duopolists is the out-of quota tariff T.

The Figure shows that the tariff which leaves unchanged total imports (t^0) is always much lower than both T^* and T. Further, within a considerable range of values of the degree of differentiation the tariff equivalent is higher than the tariff introduced by the EU in 2006 (in the Figure denoted by t^{2006}, equal to 176 €/t corresponding to 221 US$/t at the 2006 average exchange rate). Within this range of parameters values, therefore, complaints by non-ACP exporters would not be justified.

Conversely, if the products imported by the two large firms are highly differentiated, then the tariff equivalent is lower than the tariff actually introduced by the EU in 2006 and complaints by non-ACP countries would indeed be justified.

Figure 4

Figure 4 reports the critical tariff as a function of the amount of licences held by large traders. If this is low enough, then the price of licences is high and the capacity constraint weak; the outcome of the

[12] The degree of brand differentiation is defined as $\rho = \frac{\lambda^2}{\beta^2}$, corresponding to the ratio between the square of the direct and cross-price elasticities. It is close to 0 (1) when the products are highly differentiated (almost homogeneous). The value of the cross-price elasticity for the bananas imported by small operators has been set equal to 15 throughout all simulations; the value chosen for this parameter does not affect the main conclusions of the paper.

game is Bertrand and the tariff equivalent for the duopolist is the out-of-quota tariff. The tariff which leaves unchanged total imports is constant - t^{0B} is not influenced by q_i^0 - and higher than the value of the tariff actually introduced in 2006.

On the contrary, when the duopolist holds a significant share of licences, then the licence price is low, the capacity constraint becomes effective and firms compete on quantity; the tariff equivalent for the duopolist in this case is the critical tariff. The tariff which leaves unchanged all imports declines with q_i^0, but it is always higher than the tariff introduced by the EU. Under the assumed value of the degree of differentiation, therefore, whatever the initial licence allocation, complaints by major Latin American exporters would not be justified. Clearly, for much higher values of the degree of brand differentiation the tariff equivalent may well become lower than the 2006 tariff if a large part of licences are allocated to large firms.

Table 1 reports the results of the empirical exercise under three different values of the degree of differentiation, corresponding to three different values of cross-price elasticities. Under the low differentiation scenario the critical tariff is higher than the out-of-quota tariff and firms compete *à la* Bertrand; the almost homogeneity of the products imported by the large firms mitigates the negative impact which the capacity constraint may have on the degree of market competition. Oligopolistic and oligopsonistic rents account for about 60% of the final price of the duopolists. As mentioned, the tariff equivalent is much higher than the tariffs introduced by the EU. As products become more differentiated, the mode of competition shifts to Cournot; prices increase and imports decrease. Almost 66% of the final price of the product imported by the large firms is given by oligopolistic and oligopsonistic rents. The tariff leaving unchanged total imports declines with the degree of brand differentiation because the imports of large firms are lower and, thus, a lower tariff is needed to maintain the same level of imports.

Table 1 shows how the tariffication of the TRQ changes the market share of large and small firms. Because of the removal of the capacity constraint, large firms increase market share at the expenses of their smaller rivals. As a consequence, the price of the product of large firms would be lower while that of small firms would increase.

Overall, the results show that the tariff equivalent for the duopolist is always higher than the value finally set by the EU. As for the tariff which leaves unchanged *total* imports, this is considerably higher than the tariff introduced in 2006 for a wide range of values of elasticities and initial licence allocations. Only under the assumption of highly differentiated products does the tariff equivalent approach and fall below the 2006 EU tariff.

These results differs from previous papers which suggest, by and large, lower tariff equivalents than those suggested by the analysis performed in this paper (e.g. Guyomard and Le Mouël, 2003; Anania, 2006). Such differences are explained mainly by two factors: a) unlike other studies, this paper takes into consideration oligopsonistic and oligopolistic rents; b) this paper takes into account the change in the mode of competition among firms and this makes the tariff equivalent higher than the one predicted by models assuming perfect competition.

5. Conclusions

This paper has used a two stage capacity constrained duopoly model, in which the mode of competition is endogenously determined and the constraint is flexible, in order to investigate the working of TRQs and their removal. The results emphasize the role played by two variables – the out-of-quota tariff and the initial allocation of licences – in determining the mode of competititon and, thus, the value of the tariff equivalent. Unlike previous studies on TRQs, the out-of-quota tariff in this model, by influencing the strategic interaction between firms, is crucial in determining the tariff equivalent even when the out-of-quota tariff is prohibitive and there are no out-of-quota imports. As for the licences allocation, this paper has considered the case of the historical allocation methods with a market for licences, under the assumption that large traders exert oligopsony power and that the supply of the licences is upward sloping. Under these circumstances, the price of the licences is lower the higher their concentration in the hands of large traders. Thus, the model suggests that a low concentration of licences in the hands of large traders prevents Cournot competition. The model also shows that the tariff equivalent changes with the mode of competition under the TRQ: this will become higher the lower the degree of competition under the TRQ. Finally the theoretical framework proposes an approach to assess the mode of competition which is based on observable variables, i.e. the costs of adjusting capacity in the first and in the second stage: in the specific case of TRQs, the mode of competition can be assessed on the basis of the price of licences and of the in-quota and out-of-quota tariffs.

The case of the non-ACP TRQ regime for banana imports to the EU is an example of a prohibitive out-of-quota tariff which, by increasing the effectiveness of the capacity commitments, has influenced firms' behaviour; the empirical exercise suggests that the tariff leaving unchanged imports is higher than the one suggested by other studies, possibly because it takes into account oligopolistic and oligopsonistic rents. This tariff is also higher than the tariff introduced by the EU in 2006 for a wide range of elasticities; the model, thus, predicts that imports after 2006 from non-ACP countries should be above (and the price below) the 2005 levels. This could help to explain the observed significant increase in imports from non-ACP suppliers since 2006. The assumption of perfect competition, when markets are dominated by large traders, may thus result in an underestimation of the TRQ tariff equivalent.

The empirical use of the model has shown its potential when addressing policy issues to which, in the presence of market imperfections, traditional perfect competition static frameworks are likely to provide distorted answers. The observed gap between the import and export price is here explained by the considerable oligopolistic and oligopsonistic rents which account for about 60% of the market price. In conclusion, the efforts to take into consideration the role of large traders in empirical analyses of trade policy may, in many circumstances, contribute to a more accurate assessment of the policy in question.

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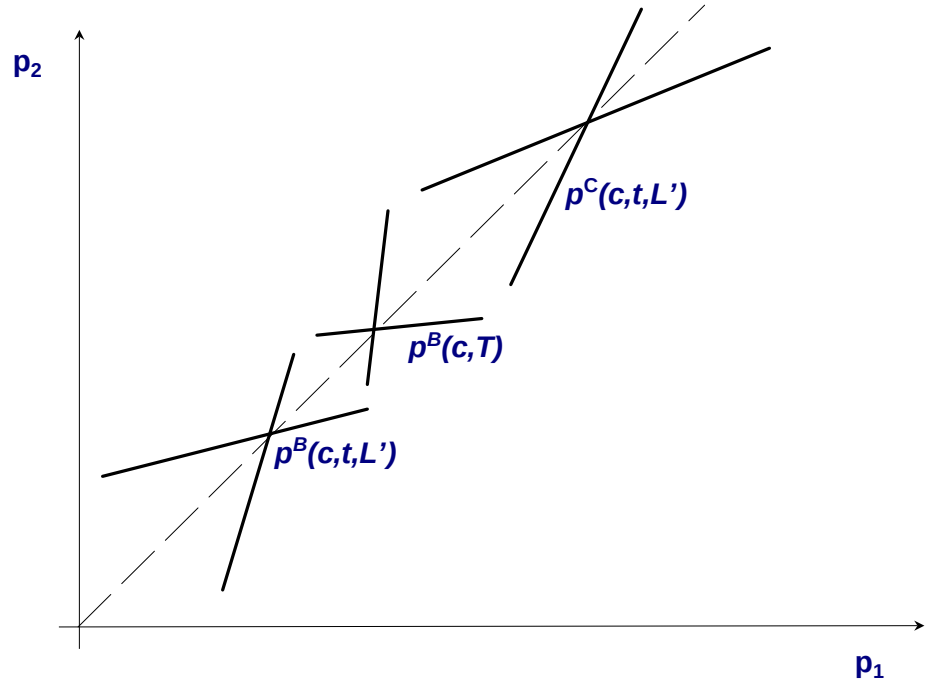

Figure 1: The full game

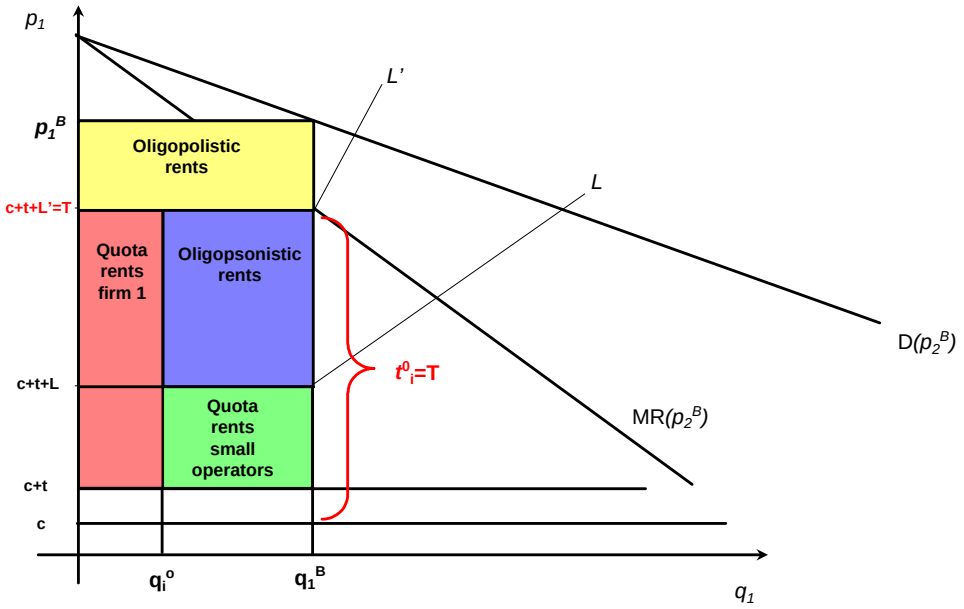

Figure 2: The tariff equivalent for the large firm under Bertrand

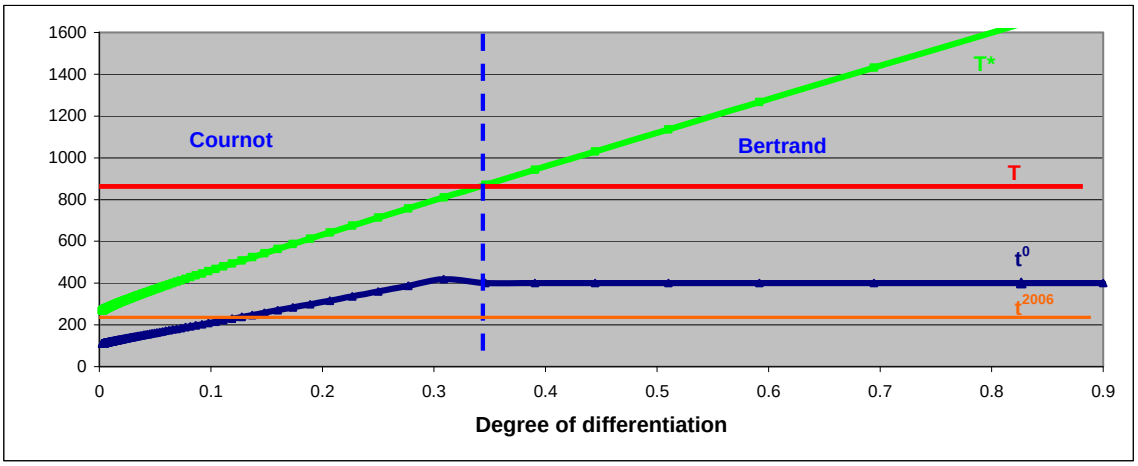

Figure 3: The tariff equivalent as a function of the degree of differentiation ($q_i^0 = 680.000$)

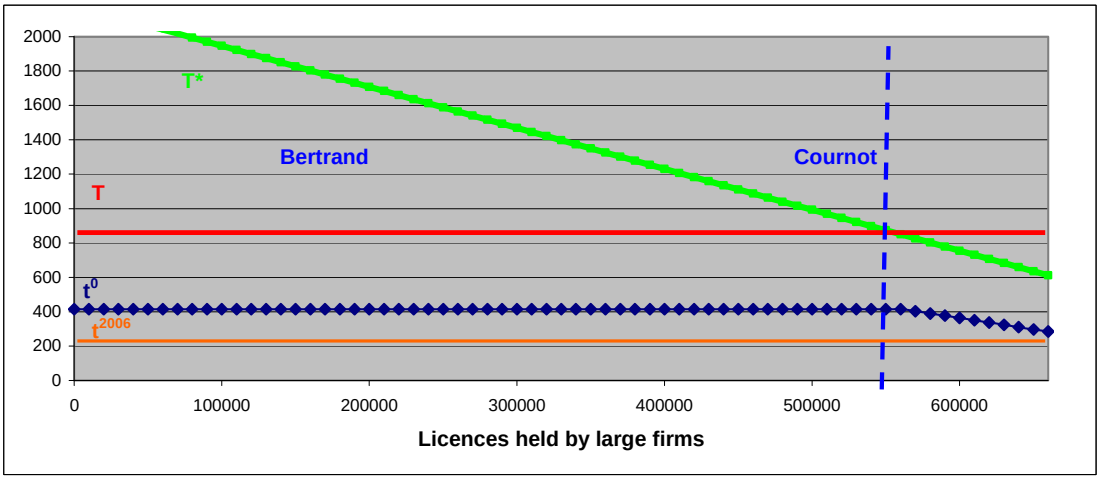

Figure 4: The tariff equivalent as a function of licences held by large operators (degree of differentiation = 0.16)

Table 1: Price, quantities, rents and the tariff equivalent

	Degree of differentiation		
	0.5	*0.16*	*0.04*
Under the TRQ			
Critical tariff (T^*)	*1,136*	563	351
Large firm price (p_i)	*2,133*	2,285	2,233
Large firm quantity (q^i)	*781,379*	707,296	700,239
Small firms price (p_s)	*1,139*	1,117	1,119
Small firms quantities (q_s)	*1,084,768*	1,081,233	1,080,896
Total imports ($2\,q_i+q_s$)	*2,647,527*	2,495,825	2,481,374
Licence price (L)	*362*	166	147
Oligopolistic rent	*787*	1,454	1,439
Oligopsonistic rent	*484*	*72*	*54*
Tariff equivalent (t^0)	*402*	258	150
Under t^0			
Large firm price (p_i^{t0})	*1,787*	2,094	2,121
Large firm quantity (q_i^{t0})	*879,363*	773,726	745,510
Small firms price (p_s^{t0})	*1,480*	1,386	1,314
Small firms quantities (q_s^{to})	*888,800*	948,373	990,353
Total imports ($2\,q_i^{t0}+q_s^{t0}$)	*2,647,527*	2,495,825	2,481,374
Oligopolistic rent	*885*	1590	1532

Note: Bertrand in italics

Appendix

The Bertrand price

The maximisation problem under Bertrand is:

$$\max_{p_1} \Pi_1 = p_1 q_1 - (c+T) q_1$$

First order conditions are:

$$a - 2b_1 p_1 + b_2 p_2 + b_1 (c+T)$$

which yields the reaction curve:

$$p_1 = \frac{a + b_2 p_2 + b_1 (c+T)}{2b_1}$$

Because firms are symmetric, the reaction curve of firm 2 is identical to that of firm 1. The Bertrand price equilibrium $p_i^B (c+T)$ is:

$$p_1^B = p_2^B = \frac{a + b_1 (c+T)}{2b_1 - b_2}$$

The Cournot price

Reaction curves under Cournot are the outcome of the following maximization problem:

$$\max_{q_1} \Pi_1 = q_1 p_1 - (c+t) q_1 - L q_1^d$$

given that $q_1^d = q_1 - q_1^o$ and $L = (\delta + f) q^d$, first order conditions are:

$$\alpha - 2\beta q_1 - \lambda q_2 - (c+t) - 2(\delta + f) q_1 + 2(\delta + f) q_1^0 = 0$$

which yield:

$$q_1 = \frac{\alpha - \lambda q_2 - (c+t) + 2(f+\delta) q_1^0}{2(\beta + f + \delta)} \qquad (20)$$

From (6) and (7):

$$\alpha = \frac{a(b_1 - b_2)}{b_1^2 - b_2^2}, \ \beta = \frac{b_1}{b_1^2 - b_2^2} \text{ and } \lambda = \frac{b_2}{b_1^2 - b_2^2}$$

from which:

$$\frac{\alpha}{2\beta + 2(f+\delta)} = \frac{a(b_1 + b_2)}{2(b_1 + (f+\delta)(b_1^2 - b_2^2)} \text{ and } \frac{\lambda}{2\beta + 2(f+\delta)} = \frac{b_2}{2(b_1 + (f+\delta)(b_1^2 - b_2^2)} \qquad (21)$$

By substituting in equation (20) direct demand functions and parameters (21) the following reaction curves in the prices space are obtained:

$$p_1 = \frac{(b_1 + Z) a + (b_1^2 - b_2^2)(c + t - 2(f+\delta) q_1^0) + b_2 p_2 (b_1 + Z)}{2b_1^2 - b_2^2 + b_1 Z}$$

$$p_2 = \frac{(b_1 + Z) a + (b_1^2 - b_2^2)(c + t - 2(f+\delta) q_2^0) + b_2 p_1 (b_1 + Z)}{2b_1^2 - b_2^2 + b_1 Z}$$

with $Z = 2(f+\delta)(b_1^2 - b_2^2)$

The Cournot equilibrium price $p_i^C(c,t,L')$ is thus:

$$p_1^C = p_2^C = \frac{\Delta + \Phi(c + t - 2(f+\delta)q_1^0)}{\Sigma}$$

with $\Delta = (b_1 + Z)a$, $\Phi = (b_1^2 - b_2^2)$ and $\Sigma = 2b^2{}_1 - b_2{}^2 + b_1 Z - b_2(b_1 + Z)$.

Given that $b_1 > b_2$, then Z, Δ, Φ and Σ are all greater than zero.

The critical tariff

The critical tariff is identified as the tariff satisfying the identity $p_i^B(c,T) = p_i^C(c,t,L')$. From (11) and (13) we obtain:

$$T^* = \frac{(a+c)(b_2^2 + b_1 Z) + (4b_1{}^2 - 2b_1 b_2(b_1 - b_2) - 2b_2{}^2)(\delta + f)q_i^0 - (2b_1{}^2 - b_1 b_2(b_1 - b_2) - b_2{}^2)t}{b_1(b_1 - b_2)(2b_1 + b_2 + Z)}$$

which can be written as :

$$T^* = \frac{\Psi + c\mathrm{K} + (t - 2(f+\delta)q_i^0)\Upsilon}{\mathrm{N}}$$

with $\Psi = (b_2^2 + b_1 Z) > 0$, $\Upsilon = 4b_1{}^2 - 2b_1 b_2(b_1 - b_2) - 2b_2{}^2$ and $\mathrm{N} = b_1(b_1 - b_2)(2b_1 + b_2 + Z)$

As $b_1 > b_2$, Ψ, N are always greater than zero; Υ may or not be positive depending on the relative values of b_1 and b_2.

The tariff equivalent

By substituting all equilibrium quantities in (17), the closed form expressions for the tariffs which leaves unchanged imports are the following:

$$t^{0B} = \frac{2(b_1 K((b_1 - b_2)a - c) + (2b_1 - b_2)((\delta + f)q_i^0 - \phi q_i^B - t))}{2b_1{}^2 K - b_2 - 2b_1(b_2 K - 1)}$$

$$t^{0C} = \frac{2(b_1 K((b_1 - b_2)a - c) + (2b_1 - b_2)((\delta + f)q_i^0 - \phi q_i^C - t))}{2b_1{}^2 K - b_2 - 2b_1(b_2 K - 1)}$$

with $\mathrm{K} = \delta + f - \phi > 0$. By denoting with $\mathrm{A} = 2b_1 K > 0$, $\mathrm{B} = (2b_1 - b_2) > 0$,

$\mathrm{X} = 2(\delta + f + \phi) > 0$ and $\mathrm{M} = (b_1 - b_2) > 0$, the two tariffs can be written as in (18) and (19).

Table A1. Input data *(US$ per ton; tons)*

Calibration:		*Source*
Demand elasticity large firms	*1.0*	Anania (2006), Guyomard *et al* (1999)
Demand elasticity small firms	0.7	
Supply elasticity small firms	1.5	
Cross price elasticity large firms Cross price elasticity small firms	*1.1 - 20* *15*	*Assumed*
Total non-ACP imports *(a)*	2,757,223	Eurostat-Comext
Quantity imported by each large firm *(b)*	875,773	Chiquita Brand Int. (2006)
Price large firm	1,800	FAO (2006)
Quantity imported by small firms	1,005,677	*a - 2b*
Price small firms	1,270	FAO (2006)
Other data		
Trading costs large firms (*c*)	500	Fruitrop, various issues
Licence allocated to each large firm	680,000	EU Commission
In quota tariff (*t*)	93	
Out-of-quota tariff (*T*)	846	