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Should tariff-rate quotas mimic quotas? Implications for trade liberalization under a supply management policy

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Abstract

This article compares price-equivalent import tariffs and quotas when domestic production is controlled by a marketing board with the power to restrict domestic supply through production quotas. Canada's dairy industry is supply-managed and protected by TRQs to achieve a domestic price target. TRQs are currently set to mimic the import quotas they replaced. However, they could be set to mimic tariffs instead. We provide welfare rankings between (domestic) price-equivalent quotas and tariffs under various assumptions regarding the powers of the marketing board to shed new light on liberalization in the Canadian dairy industry. When the marketing board is allowed to export, quotas can never be welfare-inferior to price-equivalent tariffs when transport costs between the two markets are insignificant. Import licensing methods have important implications for the ranking of the two trade instruments and the ranges of feasible domestic prices. If the marketing board controlled all import licenses and there was no rule preventing it from sleeping on part or all of its import licenses, the quota regime would support a small range of high feasible prices. In contrast, when the quota is a minimum access commitment, there are high prices under the tariff regime that are not feasible under the quota regime.
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1. Introduction

Focusing on tariff reductions in the early days of the GATT was most useful as industrial tariffs averaged roughly 40%. Now these tariffs average about 4% (OECD, 2003). Similarly, many quantitative barriers to trade in industrial products were eliminated. The objective set out in the late 1940s to lower tariffs on industrial goods is nearly achieved. While the agri-food sector was not totally excluded from the rounds of multilateral trade negotiations that preceded the Uruguay Round, it is fair to say that not much was accomplished prior to 1994. One of the greatest achievements of the Uruguay Round (UR) was arguably the conversion of all non-tariff barriers (NTBs) in agriculture into bound tariffs using an average price gap method over the 1986–88 base period. Unfortunately, the reference period permitted extremely high bound tariffs to be proposed. These proposed tariffs threatened historic market access levels that prevailed under the previous NTBs and were deemed unacceptable by exporters. To protect market access and further encourage liberalization, WTO members agreed to introduce tariff-rate quotas (TRQs) in many agri-food sectors to guarantee access to all importing countries' markets.

UR TRQs are two-tier tariffs set such that a first (in-quota) tariff is applied to imports as long as aggregate imports do not exceed a certain quantity or quota, while a second (over-quota) tariff is applied when aggregate imports exceed the quota. For many sensitive sectors, the quota of the TRQ is set close to past import volumes; the in-quota tariff is set at a very low (close to zero) level, while the over-quota is set at a high (prohibitive) level. These TRQs mimic the import quotas they replaced. Because import licensing procedures used to administer TRQs were not disciplined in the UR, importing countries are able to rely on questionable import license allocation methods to protect sectors expected to be adversely affected by trade liberalization (Skully, 2000).

TRQs are typically used for agricultural products that have proved resilient to previous liberalization efforts. This is the case with Canada's supply-managed industries and particularly so for the dairy industry. Supply-managed products were excluded from the bilateral Canada-U.S. trade liberalization process initiated in 1989 and TRQs on these products (or products that make use of them) had over-quota tariff rates varying between 240 and 300%. Supply-management programs restrict domestic and import supplies through production quotas and TRQs to attain domestic price targets. Canada is not alone in using supply controls to support domestic prices. For example, similar policies are used in dairy production in the European Union and Japan. The United States had supply controls for tobacco until July of 2005. Supply-management programs in Canada have been an irritant for some of Canada's trading partners, notably the United States and New Zealand. The Doha Round has created much anxiety among Canadian dairy and poultry producers, because there is a great deal of uncertainty regarding the extent and the manner with which TRQs will be liberalized. The July 2004 framework in the Doha Round calls for liberalizing both tariffs and import limits although modalities are still being discussed.[1]

In this paper, we compare price-equivalent tariffs and quotas when domestic production is restricted by a marketing board that behaves like a monopolist as in Vercammen and Schmitz (1992), and Schmitz, Furtan, and Bayliss (2002).[2] Our analysis builds on the small-country models

[1] The July 2004 framework calls for a tiered formula to reduce tariffs "with flexibilities for sensitive products" (WTO, 2004). Some stakeholders in supply-managed sectors inferred from this that the principles of supply management are not threatened by the current trade negotiations. Because substantial improvement in market access must apply everywhere, including sensitive sectors, and because the number of sensitive products may fall short of what would be desired, supply-managed sectors will not be entirely shielded from trade liberalization.

[2] There is a voluminous literature that examines the non-equivalence between tariffs and quotas under various settings. For example, Rodriguez (1974) and Syropoulos (1994) make comparisons when countries are engaged in trade wars,

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of Kaempfer, McClure, and Willett (1989), and Feldman (1993) that relied on the domestic price to anchor tariff-quota welfare comparisons when domestic production is monopolized. Feldman (1993) also entertained the possibility that a sufficiently protected monopolist could be tempted to export. Other researchers, like Bhagwati (1965), Sweeney, Tower, and Willett (1977), Larue and Lapan (2002), have proposed different variables, like the volume of imports and the share of domestic production in consumption, to anchor tariff-quota welfare comparisons. The domestic price plays a crucial role in the implementation of supply-management programs and this is why it is the variable of choice to anchor our comparisons. More specifically, supply is purposely restricted to achieve a domestic price target revised each year to account for changes in the cost of production of agricultural producers. The viability of such a policy hinges on the ability to restrict imports.

The paper is organized as follows. The next section describes how the supply management policy is implemented in the Canadian dairy industry. Section 3 investigates the case where the marketing board must contend with imports from private traders. Section 4 investigates the welfare ranking of the trade instruments when protection and the terms of trade make exporting profitable for the marketing board. The final section summarizes the main results of the paper and their policy implications.

2. Canada's dairy supply management program: market access and export subsidy issues

Canada's dairy supply management program was created in 1971. This national program is jointly administered by the federal government, through the Canadian Dairy Commission (CDC), and the provincial governments. The dairy industry is the most protected agricultural sector in Canada.[3] Basically, supply is restricted to achieve a price high enough to allow most dairy producers to cover their costs of production, which include a "fair" return on labor and capital (Schmitz et al., 2002). Domestic supply is restricted through production quotas, while imports are controlled with very restrictive TRQs. Dairy producers receive a blended price, because milk is sold at different prices in the domestic market depending on end-uses. The economic rents are capitalized in the value of the production quotas, tradable within a province between producers. An average-size farm with about 66 cows (CDC, 2006) must own production quotas worth about Can$1.9 million (U.S. 1.6 million) to have the right to market the milk it produces. The price of production quotas constitutes a formidable entry barrier.

Canadian dairy producers have vigorously lobbied to preserve the supply-management policy amidst trade liberalization initiatives and complaints from trade partners. Supply management has been a recurrent irritant in Canada-U.S. relations and tensions did not abate with the signature of the bilateral trade agreement in 1988. A few months after ratification of the agreement, a notice to importers stating that import permits would be required for any Canadian imports of ice cream

while Young and Anderson (1982) compare policy instruments under uncertainty. Some, like Larue and Gervais (2002), compare ad valorem and specific tariffs.

[3] The OECD has been tracking measures of producer support for almost twenty years. Canada's Producer Support Estimate (PSE) in 2001 for dairy, pigmeat and poultry were 50.4%, 5.7% and 2.7%, respectively. Canada is not the only country providing more support to its dairy producers. The 2001 dairy, pigmeat and poultry PSEs for the United States were 50.8%, 4% and 4.2%. For the EU, the comparable 2001 PSEs were 39.8%, 19.8% and 46.1%. Source: http://miranda.sourceoecd.org/vl=553644/cl=11/nw=1/rpsv/ij/oecdstats/16081056/v13n1/s4/p1, accessed on March 13, 2007.

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and yoghurt ignited a dispute with the United States. Importers seeking permits for any of the restricted products had to document their past import performance with respect to these products. Permits were requested for 3536 tonnes of ice cream and for 2279 tonnes of yoghurt in 1988, but permits were issued for only 349 tonnes of ice cream and for 1212 tonnes of yoghurt. In late 1989, a dispute panel concluded that Canada's restrictions were inconsistent with GATT Article XI:2(c)(i), because ice cream and yoghurt cannot be considered "like products" to raw milk. Canada did not comply, waiting to resolve the issue through the tariffication of non-tariff barriers at the end of the Uruguay Round (Barichello & Romain, 1996).

In 1995, the United States appealed to NAFTA Article 2006(4) to complain about Canada's over-quota tariffs. In December of 1996, a panel ruled that Canada did not replace its non-tariff barriers with more restrictive TRQs and that its trade barriers were consistent with its obligations under NAFTA. In 1997, the United States and New Zealand requested GATT Article XXII consultations, alleging that Canada was operating a pricing system that provided an export subsidy in excess of Canada's commitment (Janow & Staiger, 2004). On May 15 of 2003, Canada confirmed the elimination of its commercial milk export program and that it would not surpass quantities and budgetary outlays specified in its WTO schedule. In February 2007, Canada began negotiations with interested parties under GATT Article 28 to curb imports of milk protein concentrates. It also announced the launch of a regulatory process related to compositional standards for cheese. These last two initiatives signal Canada's resolve to shield its dairy industry against competitive pressures. However, it remains to be seen whether Canada will be able to prevent significant liberalization of TRQs in so-called sensitive sectors in the current WTO negotiations.

3. Supply management with private importers

We assume that the marketing board behaves like a constrained monopolist maximizing profits on behalf of agricultural producers.[4] The board controls production, but imports are purchased by private traders. Because the policy is centered on the attainment of a domestic price, our analysis is cast in the Kaempfer et al. (1989) and Feldman (1993) framework. The marketing board has a linear marginal cost, $mc = c + dq$, where q is the quantity of milk produced. For simplicity, we assume that total demand for unprocessed milk is linear such that: $p(Q) = a - b(q + L)$, where a, b, c, and d are all positive constants, $Q \equiv q + L$ denotes the total quantity purchased by processors and L stands for imports.[5] The world price is unaffected by the behavior of the marketing board and is simply a constant, ω.

The marketing board is not technologically efficient enough to supply the whole domestic market under free trade. If it has a market share varying between 0.5 and 1 under free trade, we will call it "efficient". Conversely, if its market share under free trade falls beneath the 0.5 threshold, it will be called "inefficient". As will become clear shortly, the market share under free trade plays a critical role in our analysis. The market share of the marketing board under free trade is a simple expression that can be exploited in choosing parameter values for simulation

[4] Feldman and Richardson (2001) argue that monopolies are common in developing countries. This could be because of policies, as in our case, or because it is easier for a firm to become a monopolist when the manufacturing sector is under-developed.

[5] As pointed out by a reviewer, dairy products are unquestionably differentiated products. However, these differentiated products use the same milk as an input and it follows that our demand can be regarded as one aggregating the demand for milk across uses.

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purposes:

$$\text{share}_{\text{freetrade}} = \frac{b(\omega - c)}{d(a - \omega)}. \tag{1}$$

One can easily show that when the share of the marketing board under free trade is one half, then the output of the marketing board under free trade exactly equals its output when imports are not allowed. When the marketing board is efficient (inefficient), its output is larger (smaller) under free trade than when no trade occurs.

Imports are purchased by a large number of small traders that can be considered as a competitive fringe. Accordingly, the marketing board acts as a dominant firm when there are imports. In this setting, ad valorem and specific tariffs impose price ceilings on the domestic firm and are equivalent. We will rely on the latter when analyzing tariff protection. The behavior of the marketing board is simple. Under a quota of R units, the firm exploits a residual demand function $Q^{\mathrm{R}}(p; R) \equiv Q(p) - R$. The profit-maximizing level of output is decreasing in R: $q(R) = (a - c - bR)/(2b + d)$. Therefore, we assume that the board would decrease the domestic price target and production quotas in response to an increase in imports. As R becomes larger, there will be a critical quota $R = R_{\max}$ for which profit under the quota regime is just equal to the profit under free trade. This occurs at a domestic price in excess of the world price (*i.e.*, $p|_{R=R_{\max}} = \omega + t_{\min}$) and hence at a level of output below the free trade level of output q^{ft}.[6] Consequently, there are no price-equivalent quotas for tariffs below the threshold $t_{\min}$ and $\omega + t_{\min}$ is the lowest admissible domestic price for which the quota and the tariff can be compared.[7] When the quota is zero, the marketing board is unconstrained and the domestic price reaches its highest level. This unconstrained price constitutes the highest admissible domestic price for our quota-tariff comparisons.

As long as tariffs are low enough to allow imports to enter the domestic market, the marketing board is a price-taker. Accordingly, the output path of the marketing board under tariff protection has a competitive segment along which output is rising with the tariff: $q(t) = (\omega - c + t)/d \; \forall t \in [0, t_0)$. In this domain, output and imports are jointly determined by the following two restrictions tying the marginal cost to the world and domestic prices: $mc(q) = \omega + t$ and $p(q + L) = \omega + t$. In Fig. 1, the output path is represented by the marginal cost curve between ω and $\omega + t_0$.[8] When the tariff is high enough to eliminate imports (*i.e.*, $t \geq t_0$), the domestic price exceeds marginal cost, $p(q) = \omega + t > mc(q)$, and output decreases with the tariff: $q(t) = (a - \omega - t)/b$. We refer to this segment of the marketing board's output path as uncompetitive. It coincides with the portion of the demand curve between $\omega + t_0$ and $\omega + t_{\mathrm{w}}$ in Fig. 1. As the tariff keeps increasing, it will eventually reach a critical level, t_{w}, at which the ceiling it imposes on the domestic price ceases to be binding. At that point, an increase in the tariff provides redundant protection.

When the domestic price is the variable anchoring the tariff-quota comparison, the best instrument is the one that supplies the domestic market at the cheapest cost, because the sum of domestic output and imports must be the same under both instruments. In our partial equilibrium framework, welfare is the sum of consumer surplus, $CS \equiv \int p(q + L)(dq + dL) - p(q^{\mathrm{e}} + L^{\mathrm{e}})(q^{\mathrm{e}} + L^{\mathrm{e}})$,

[6] The minimum boundary is defined by $p(q(R_{\max}) + R_{\max}) > \omega + t_{\min}$.

[7] This is the essence of Proposition 1 in Kaempfer et al. (1989). Vercammen and Schmitz (1992, p. 969) arrive at a similar conclusion when they state that "considerable import concessions could occur before the excessive producer rents are eroded away."

[8] In Fig. 1, the share of domestic output under free trade is not one half, but the illustration remains pertinent. Provided that marginal cost is increasing in output, the output adjustment path under the tariff regime has a competitive segment and an uncompetitive segment as long as the firm's market share under free trade is strictly less than one.

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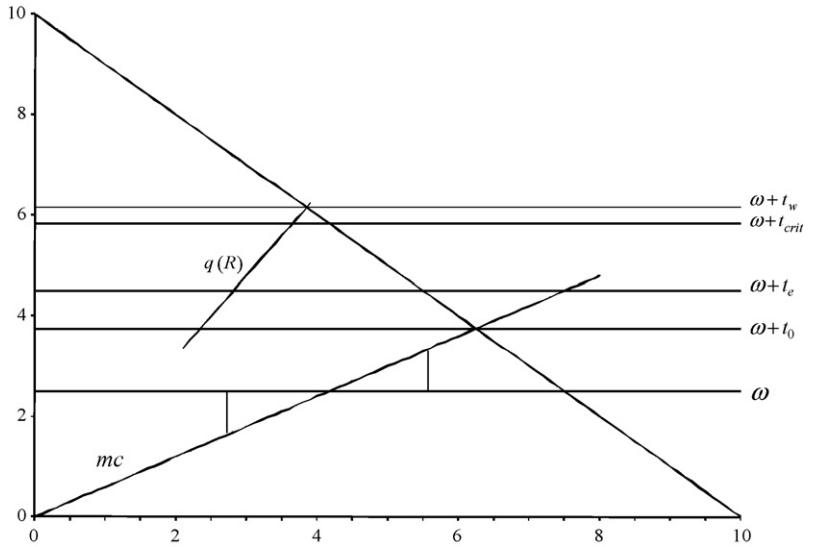

Fig. 1. The inefficiencies of quotas and tariffs when the marketing board has a market share in excess of one half under free trade.

the aggregated profit of the domestic firms, $\pi = p(q^e + L^e)q^e - c(q^e)$, and policy revenue, $\text{rev} \equiv (p(q^e + L^e) - \omega)L^e$. It should be noted that superscripts indicate that the variables are evaluated at their equilibrium values and that $c(q)$ is the cost function of the firm. Consequently, the welfare criterion is simply:

$$W \equiv \int p(q + L)(dq + dL) - c(q^e) - \omega L^e. \tag{2}$$

Lemma 1. *Defining SC_i as the sourcing costs under instrument i, a quota R (tariff t) welfare-dominates a price-equivalent tariff t (quota) if: $SC_t \equiv sL_t^e + c(q_t^e) > (<) \omega R + c(q_R^e) \equiv SC_R$.*[9]

Sourcing is efficient when the marginal cost of imports is equal to the marginal cost of producing domestically. Thus, efficient sourcing for a "small" country requires that domestic production be at the free-trade equilibrium: $\omega = c + dq = mc(q)$. One problem with the comparisons of different instruments lies in their units of measurement. A quota enlargement is equivalent to a tariff reduction, but it is not easy at first glance to relate quota enlargements and tariff reductions to equivalent domestic price reductions. Fortunately, our linear functions enable us to express the domestic price-equivalent quota in terms of the tariff. By construction, the price-equivalent quota is implicitly defined by $p(q(R) + R) \equiv \omega + t$.

Lemma 2. *The price-equivalent quota expressed in terms of the tariff is $R(t) = (a(b + d) + bc - (2b + d)(\omega + t))/(b(b + d))$. Inserting the expression for $R(t)$ in $q(R)$, domestic production under the quota can be expressed as a function of the price-equivalent tariff: $q(R(t)) = (\omega + t - c)/(b + d)$.*

The quota R is linearly decreasing in t and the production path under the quota is a straight line, as shown by the $q(R)$ path in Fig. 1. We know that sourcing costs under the tariff and quota regimes

[9] Proofs of lemmas and propositions may be found on the following website: http://www.crea.ulaval.ca/.

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will be the same at the maximum domestic price (*i.e.*, $R = 0$, $t \geq t_w$). Hence, the marginal cost of domestic output and imports are equalized at tariffs and quota supporting the maximum domestic price. We also know that at "high" tariff levels $t_0 \leq t < t_w$, $\partial q(t)/\partial t < 0$ and $(\partial q(R)/\partial R)(\partial R_t/\partial t) > 0$. Because $\partial mc(q)/\partial q > 0$, a quota enlargement from $R = 0$ implies that $mc(q(R)) < \omega$, while a tariff reduction from t_w implies $mc(q(t)) > \omega$. The inefficiency of the quota (tariff) comes from the fact that imports are too large (small). Because the marginal cost is linear, the best instrument in the neighborhood of the maximum domestic price is the one for which the change in domestic output is smallest following a given domestic price reduction.

Proposition 1. (*i*) *When domestic production is inefficient, quotas dominate tariffs at domestic prices supported by prohibitive tariffs* $t_0 \leq t < t_w$. *At domestic prices low enough to allow imports,* $p \in [\omega + t_{\min}, \omega + t_0)$, *the ranking is ambiguous, because tariffs may dominate at low prices in the neighborhood of* $\omega + t_{\min}$. (*ii*) *When domestic production is efficient, the ranking is ambiguous, because quota may dominate at intermediate domestic prices in the upper part of the* $[\omega + t_{\min}, \omega + t_0]$ *interval and in the lower part of the* $[\omega + t_0, \omega + t_w]$ *interval.*

Fig. 2 illustrates the above proposition by plotting sourcing cost differentials for four different technological assumptions. In all cases, domestic demand is $p = 10 - Q$ and the world price is $\omega = 2.5$. For the marginal cost parameterization, $mc = c + dq$, we set $c = 0$ and d according to Eq. (1) for market shares under free trade of 0.25 (thin black line), 0.5 (dark line), 0.55 (small dash) and 0.75 (long dash). The plot reveals several interesting elements. First, the range of feasible domestic prices shrinks with the level of efficiency (or market share under free trade). Intuitively, an inefficient unconstrained monopolist chooses a higher price than an efficient one (hence the higher maximum price) and earns lower profit under free trade (hence the lower minimum price). Second, quotas are better than tariffs over most feasible domestic prices when production is quite inefficient (see also Kaempfer et al., 1989). Reciprocally, tariffs are better than quotas when

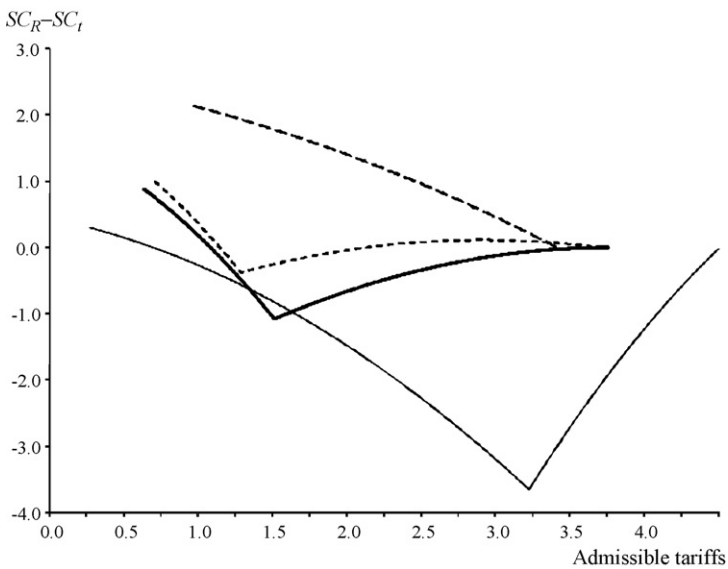

Fig. 2. Sourcing costs differentials for price-equivalent tariffs and quotas when domestic production accounts 25% (thin black line), 50% (dark line), 55% (small dash) and 75% (long dash) of consumption under free trade.

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production is efficient. Third, for some level of efficiency, e.g., when domestic production accounts for 55% of consumption under free trade given our parameters, the welfare differences between the two instruments are very small over most feasible prices. Finally, tariffs tend to be better at low domestic prices, but we cannot say that tariffs are worse or better at high prices, because the ranking is very sensitive to the technology parameters. In comparison, Cassing and Hillman (1985) showed that tariffs dominate quotas when domestic production is monopolized and the government maximizes political support. The intuition is that the domestic firm gets the same price under both instruments, but produces more under the tariff regime. When political support and revenue-seeking guide government decisions, the policy ranking is ambiguous.

As argued at the outset, the Canadian dairy sector is protected by very restrictive TRQs. This protection level and the recent negotiations under GATT Article 28 to restrict imports of milk ingredients signal a strong desire to maintain high domestic prices. We can also infer from the trends in milk production quota values that dairy producers put a very low probability on significant trade liberalization in their sector. Because the high cost of production quotas makes entry and production expansion difficult, we conjecture that Canadian dairy farms are not likely to experience major increases in size and that a productivity gap, relative to U.S. dairy farms, will remain (Romain & Sumner, 2001). This leads us to believe that their current technology is such that their market share under free trade would probably be much closer to 0.5 than to 1.

Accordingly, Canada should keep high over-quota tariffs and make "minimum access" concessions to mimic a quota. However, if the Canadian government was to change its position and impose substantial liberalization on the dairy industry, it should be transparent about it. We conjecture that with a liberalization of the dairy industry in Canada, the value of production quotas would depreciate rapidly and there would be exit by some dairy producers and significant increases in the average farm size. As a result, milk production would be more efficient and liberalization could proceed with substantial cuts in over-quota tariffs. This strategy would make domestic price reductions easier to secure and hence would provide undeniable long-run benefits. However, such as strategy would be politically risky and expensive if the government was to compensate dairy producers for their investment in production quotas. The "structural adjustment" package that accompanied the deregulation of the Australian dairy marketing system in 2000 was estimated at $Aus 2 billion (Edwards, 2003).

4. Endogenous exports

Up to now, we have assumed that the marketing board cannot export. Given our market structure, one could argue that a monopolist/marketing board would be tempted to price-discriminate. As the aforementioned trade dispute over Canada's WTO export subsidy commitments made abundantly clear, this is exactly what happened. Canadian imports of U.S. dairy products in 2004 amounted to 92.6 millions kg, while Canadian exports of dairy products to the U.S. and Mexico totalled 52.2 millions kg (AAFC, 2005). Canada also ran a negative trade balance with the European Union and New Zealand, but it was a net exporter of dairy products to Mexico, Japan, China and many other countries.[10]

[10] Canada has a supply-management program for chickens and there is cross-hauling in chicken products. Chicken imports in 2005 totalled about 107 millions of kg, while more than 69 millions of kg were exported (AAFC, 2006). South Africa, the Philippines and Russia were the most important destinations of Canadian chicken exports, while the main source of imports is the U.S., although Brazil and Thailand are also important competitors on the Canadian domestic market.

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In our analysis, imports are still marketed by a large number of small traders and the theoretical analysis is not very different from the one presented in the last section. The condition allowing price discrimination and hence exports when the marketing board is protected by a prohibitive quota or a tariff providing redundant protection is:

$$mc^{-1}(\omega - \varepsilon) > mr^{-1}(\omega - \varepsilon), \tag{3}$$

where ε is the transportation cost, $mc^{-1}(\omega - \varepsilon)$ is the quantity at which marginal cost is equal to the export price, $\omega - \varepsilon$, and $mr^{-1}(\omega - \varepsilon)$ is the quantity at which the marginal revenue function associated with domestic demand is equal to the export price. The difference between these two quantities is the maximum level of exports, barring export subsidies. This comes from the equalization of marginal revenue from domestic sales, $mr(q)$, to marginal revenue from exports, $\omega - \varepsilon$, and marginal cost, $mc(q)$. Given the linearity of the marginal cost and revenue functions, Eq. (3) boils down to $(\omega - \varepsilon - c)/d > (a - \omega + \varepsilon)/2b$. Clearly, the marketing board has to be efficient to export, but we assume that it is not efficient enough to be the sole supplier under free trade.

Under the quota, the marketing board exploits a residual domestic demand defined as total demand minus the R units imported by traders. The residual demand gets smaller and domestic price and domestic sales fall as R increases. Cross-hauling occurs under the quota regime and exports are increasing in R. However, net exports decrease with R and become negative at some point. As before, the quota regime is abandoned when the marketing board's profit at $R = R_{\max}$ is equal to its profit under free trade. Thus, for $R \in [0, R_{\max}]$, domestic production is constant at $q_R = (\omega - \varepsilon - c)/d$ and there are simultaneous imports and exports. This means that decreases in domestic sales are offset by increases in exports.

Proposition 2. *The ability to export decreases the minimum price achievable under a quota regime in relation to the case which rules out exports.*

Let t_e denote the minimum tariff supporting an equilibrium with exports.[11] Tariffs t_0 and t_w are defined as before as the lowest prohibitive tariff and the minimum tariff providing redundant protection such that $t_0 < t_e < t_w$. All three tariffs are illustrated in Fig. 1. Under very high tariffs, $t \in (t_e, \infty)$, Eq. (3) implies that domestic production is unaffected by further increases in tariffs (*i.e.*, $\partial q(t)/\partial t = 0$). Besides, exports are increasing with respect to t between t_e and t_w. For $t \in (t_0, t_e]$, $\partial q(t)/\partial t < 0$ and exports, like imports, are zero. For $t \in (t_{\min}, t_0]$, where the minimum tariff is defined by $p(q(R_{\max}) + R_{\max}) = \omega + t_{\min}$, it can be shown that $\partial q(t)/\partial t > 0$, $\partial L(t)/\partial t < 0$. To summarize, exports take place only at high tariffs; imports are observed only when tariffs are low; and there is an intermediate range of tariffs for which there is no trade.

Welfare comparisons of price-equivalent instruments are based on sourcing costs reduced by export revenues. For a given domestic price level, the dominant instrument is the one with the lowest score on $c(q) + \omega L - (\omega - \varepsilon)E$, where E and L stands for exports and imports and q is domestic production.

[11] Under the small-country assumption, a tariff imposes a price ceiling on the marketing board. Thus, the marginal revenue function for domestic sales is perfectly elastic for output levels between 0 and $p^{-1}(\omega + t)$: $mr = \omega + t$. At the upper limit, marginal revenue is discontinuous. For higher levels of output, the marketing board sells at a price below $\omega + t$ and the marginal revenue function is that of the domestic demand: $mr = \partial p(q)q/\partial q = a - 2bq$. For exports to take place, marginal revenues from domestic and export sales must equal marginal cost. When the tariff is just about to trigger exports, we must have: $a - (b/d)(\omega - \varepsilon - c) = \omega + t_e$. Rearranging, we have: $t_e = (ad - (b + d)\omega + bc + b\varepsilon)/d$.

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Proposition 3. (*i*) *If the marketing board can export and earn* $\omega - \varepsilon \ll \omega$ *on each unit exported when sufficiently protected, then tariffs weakly dominate price-equivalent quotas for domestic prices in the* $[\omega + t_e, \omega + t_w)$ *interval. In the interval* $[\omega + t_{crit}, \omega + t_e)$, *where* t_{crit} *is the prohibitive tariff at which* $q(t) = q^{ft}$, *tariffs dominate price-equivalent quotas. For domestic prices below* $\omega + t_{crit}$ *inducing output levels* $q(t) > q^{ft}$, *the ranking of price-equivalent tariffs and quotas is ambiguous.* (*ii*) *If* $\varepsilon \approx 0$, *quotas and tariffs are equivalent for* $p \in [\omega + t_e, \omega + t_w]$. *At lower prices, quotas strictly dominate price-equivalent tariffs.*

The above proposition shows that even if the market share of the marketing board is quite large under free trade, quotas are better or no worse than price-equivalent tariffs as long as goods can be imported and exported at the same price. The opportunity to export clearly improves economic efficiency and welfare because the marketing board equalizes its marginal cost of production to the world price when heavily protected, a point also made by Feldman (1993). Proposition 3 contrasts with Proposition 1 which rules out (weak) quota dominance when the marketing board is efficient enough to supply most of the domestic market under free trade. With its supply-management policy and limited market access commitments and high over-quota tariffs, it made sense for the Canadian government to fight at the WTO to maintain the ability to export. In that sense, the WTO panel decision rendered in 2002 regarding Canada's pricing scheme acting as an export subsidy was unfortunate.

5. What if the marketing board controlled the import licenses?

We now relax the assumption that import licenses under the quota are owned by competitive private traders. Instead, we assume that the marketing board controls them. Ad hoc quota allocation mechanisms are common in textile and agricultural trade and, unlike most other assets transferred from the government to the private sector, import licenses are often given away (e.g., Bergsten, Elliott, Schott, & Takacs, 1987, p. 3 and Skully, 2000). Even when import licenses are auctioned, Campos e Cunha and Santos (1996, p. 128) argue that a domestic monopolist has the incentive to buy the auctioned quota in most instances. Krishna (1999) points out that a monopoly is likely to endogenously arise when units of production capacity are sequentially auctioned. We will show that the distribution of import licenses and conditions about their uses (e.g., a use-them-or-lose-them clause) have important welfare implications.

Three cases regarding the manner in which a quota constrains the behavior of the marketing board are analyzed. It is quite common to assume that a quota acts as an upper limit on imports such that: $L(R) \leq R$, where $L(R)$ denotes actual imports. Alternatively, the quota may be a minimum access commitment such that: $L(R) \geq R$. When the latter is an inequality, it can be likened to a TRQ with a low over-quota tariff. In the third case, the actual imports are strictly equal to the quota: $L = R$. This outcome is typical of a TRQ with a very low in-quota tariff and a prohibitive high over-quota tariff. Such TRQs are not uncommon in practice. We assume that anybody willing to pay the duties under the tariff regime is allowed to import. Tariff revenues accrue to a branch of government totally separated from the marketing board. Consequently, the marketing board earns rents on imports under the quota regime, but does not under the tariff regime. We assume that the rents from imports under the quota regime are redistributed to domestic producers. Exports are ruled out throughout this section.

As in Campos e Cunha and Santos (1996), the option to import $L(R) \leq R$ at the world price under a quota regime means that the marginal sourcing cost of the firm is as

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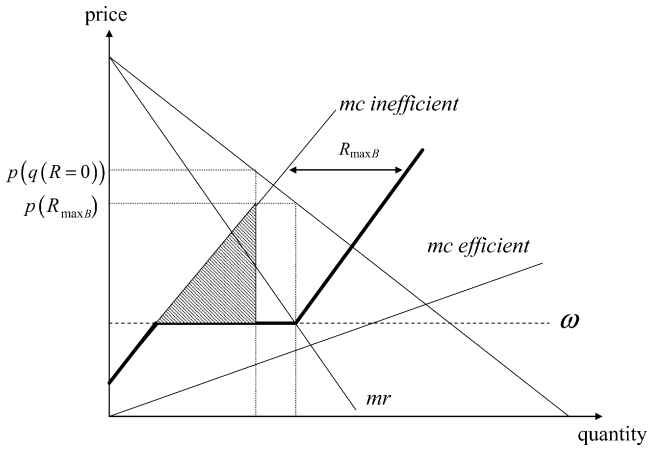

Fig. 3. Equilibrium when the marketing board can import $L(R) \leq R$.

follows:

$$msc(q+L) = \begin{cases} c + dq & \text{if } q < (\omega - c)/d,\ R > L = 0 \\ \omega & \text{if } q = (\omega - c)/d,\ R \geq L > 0 \\ c - Rd + dq & \text{if } q > (\omega - c)/d,\ R = L \end{cases}. \tag{4}$$

Because $c < \omega$, there are always some domestically produced goods consumed in equilibrium. There are some imports, whenever the marginal costs of production and import are equal. When $mc(q) > \omega$, the domestic firm is rationed by the quota. The dark line in Fig. 3 illustrates the marginal sourcing cost for different levels of output given a specific quota. If the firm is inefficient, $q^{\text{ft}} \equiv mc^{-1}(\omega) = (\omega - c)/d < (a - \omega)/2b = mr^{-1}(\omega)$, then the quota is binding, $L = R$, as R increases from 0 to $R_{\text{maxB}} = (d(a - \omega) - 2b(\omega - c))/2bd$. The domestic price is decreasing in R in the domain $[0, R_{\text{maxB}})$. For $R < R_{\text{maxB}}$, the marketing board is constrained by the quota. In contrast, increases in the quota beyond R_{maxB} are not accompanied by further increases in imports as the firm prefers to "sleep" on R–R_{maxB} units of quota. Thus, the range of feasible prices under a quota, when domestic production is relatively inefficient, is limited to $p \in [p(q(R_{\text{maxB}}) + R_{\text{maxB}}), p(q(0))]$.

Under a tariff regime, the marketing board can import at a price $\omega + t$, but its sales on the domestic market must be priced at $p \leq \omega + t$. As a result, a tariff imposes a price ceiling on the marketing board, as before. When the tariff is non-prohibitive, the domestic firm is indifferent between importing or letting traders import because no rent is earned from imports.

Proposition 4. *When the quota imposes an upper limit on imports and does not necessarily bind, $L(R) \leq R$, and domestic production is inefficient, the range of admissible domestic prices has a "high" lower bound $p(R_{\text{maxB}}) = (a + \omega)/2$. Quotas dominate price-equivalent tariffs for $p \in [p(R_{\text{maxB}}), p(0))$, where $p(0) \equiv \omega + t_{\text{w}}$. When domestic production is efficient, $L = 0 \forall R$ and the quota regime admits a single equilibrium price $p = \omega + t_{\text{w}}$ at which both instruments are equivalent.*

When the marketing board can "sleep" on its import quota, the range of feasible domestic prices tends to be small and the feasible prices are high. When domestic production is inefficient, quotas are better than price-equivalent tariffs because the marketing board exercises its option to purchase cheap imports. When the quota is large, the domestic firm elects to sleep on part of its

quota to maintain the equality between the marginal costs of domestic production and imports. This might explain why the fill rates of some TRQs used in sensitive sectors are well under 100%. When domestic production is efficient, the level of profit-maximizing domestic sales is lower than the level of output under free trade and hence it is cheaper for the monopolist to "sleep" on all its import licenses and fill the demand with home-made products. The licenses are valuable to the marketing board, even though it does not use them, because nobody else can use them. Therefore, the unique price under the quota regime is the unconstrained monopoly price. This most inefficient economic outcome arises only when a firm (a state-trading one or a private one) controls domestic production and imports and is not required to fill its import quota. Proposed reforms in import licensing procedures and state-trading regulations aim at giving incentives to fill quotas. As shown below, imposing a "use it or lose it" rule regarding import licenses significantly alters the above results.

Proposition 5. *If the domestic firm is constrained to import $L = R$ units and domestic production is inefficient, there exists a tariff t_m such that quotas dominate price-equivalent tariffs in the interval $(\omega + t_m, \omega + t_w)$. Tariffs below t_m dominate price-equivalent quotas. If domestic production is efficient, tariffs dominate for all admissible domestic prices.*

When domestic production is inefficient, the marketing board benefits from access to cheap imports and at high domestic prices it wants to import more than it is allowed. The quota is necessarily better than the price-equivalent tariff which does not allow any imports. However, there are quota levels in excess of the board's profit-maximizing level of imports which force the board to reduce too much its production. At these domestic prices, tariffs dominate price-equivalent quotas. When domestic production is efficient, the board's profit-maximizing import level is zero and tariffs dominate quotas even at high prices.

Under the minimum access commitment case, the marketing board is coerced into importing at least R units: $L(R) \geq R$. This implies that when domestic production is inefficient, the board can import the profit-maximizing level of imports even when R is small. As a result, the range of feasible prices under the quota is truncated.

Proposition 6. *When $L(R) \geq R$ and domestic production is inefficient, $L > R\ \forall R \in [0, R_{\mathrm{maxB}})$ and the quota regime does not admit domestic prices above $p(R_{\mathrm{maxB}}) = (a + \omega)/2$, unlike the tariff regime. When domestic production is efficient, the highest domestic prices under the tariff and quota regimes coincide. Furthermore, the lowest domestic price, the free trade price, is feasible under both instruments.*

In previous cases, the tariff regime could be regarded as more competitive than the quota regime, because its range of feasible prices included domestic prices in the neighborhood of the free trade price. Under a minimum access commitment and inefficient domestic production, the quota regime is more competitive because it does not support high domestic prices! This is due to the ability of the marketing board to import the quantity that maximizes its profit when the minimum access commitment is not binding. The intuition is that profits from importing accrue to the marketing board (and hence to dairy producers). Therefore, low prices not feasible (as in Proposition 1 or Kaempfer et al., 1989) when import licenses under the quota regime are controlled by private traders are now feasible.

Proposition 7. *When $L(R) \geq R$ and domestic production is inefficient, quotas (tariffs) dominate at higher (lower) domestic prices. When domestic production is efficient, tariffs dominate price-equivalent quotas for all admissible domestic prices.*

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The marketing board is best served with a minimum access commitment when domestic production is inefficient because it can compensate for its fast-increasing marginal cost with cheap imports. In fact, the board behaves like a "two-plant" monopolist because the board's sourcing cost never exceeds the world price under the quota regime. However, when the minimum access commitment binds too much, the board reduces too much domestic output and price-equivalent tariffs are better.

6. Conclusion

An important agricultural issue in the current Doha Round of multilateral negotiations is the liberalization of sensitive sectors protected by TRQs. In these sectors, domestic prices tend to be much higher than world prices and many politically pressured governments would like to exclude these sectors from significant liberalization initiatives. This is the case for the Canadian dairy industry, which relies on TRQs with prohibitive over-quota tariffs to complement production quotas in restricting supply of milk and dairy products. Canada's dairy supply-management program is explicitly built around a domestic price target which is set to allow dairy producers to cover their cost of production and earn a "fair" return on their labor and capital investment. Canada's ability to adjust its trade barriers is restricted by its obligations as a member of the WTO.

Under supply management, a marketing board is given the authority to restrict domestic supply to achieve a domestic price target. We follow previous studies (e.g., Alston & Spriggs, 1998; Vercammen & Schmitz, 1992) in assuming that the board behaves like a constrained monopolist. Currently, Canadian TRQs on milk and dairy products are set to mimic import quotas, but Canada could sets its TRQs to mimic tariffs or simply replace them by tariffs. Our trade liberalization analysis features tariff-quota comparisons for various domestic prices. The welfare ranking between the two instruments boils down to a comparison of sourcing costs, which are conditioned by the positioning of the marginal cost of domestic production and the allocation of import licenses.

The first case analyzed represents the actual situation with private traders owning import licenses under the quota. The welfare comparisons are very sensitive to technological assumptions and the level of the domestic price considered. Domestic production is considered efficient (inefficient) when the share of domestic production in consumption under free trade is larger (less) than one half. For highly inefficient (efficient) domestic production, the range of feasible prices is large (small) and the quota (tariff) dominates at virtually all feasible prices. For intermediate levels of efficiency, tariffs and quotas are quite similar, with tariffs (quotas) dominating at low and high price levels and quotas dominating for intermediate price levels. As shown by Kaempfer et al. (1989), domestic prices in the neighborhood of the free trade price cannot be supported by a quota because the profit from domestic production would be too low. Hence, the tariff could be regarded as a more competitive instrument, but in the context of the supply-management policy, the longer range of feasible prices under the tariff and the domination of tariffs at low prices are irrelevant because the policy would collapse before such prices are reached. Romain and Sumner (2001) argue that the small Canadian dairy farms suffer from a productivity gap vis-à-vis their U.S. counterparts. We infer that as long as supply management is in place, Canada is best to rely on quota increases to liberalize trade. However, phasing out supply management could induce rapid increases in farm size and in productivity which, if substantial enough, could warrant a switch in policy prescription.

We also compare quota and tariff liberalization by allowing the marketing board to export. This case is justified on the ground that a monopolist has a natural tendency to price-discriminate. As a matter of fact, Canada had put in place a pricing system to facilitate exporting, but the legality of

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this system was successfully challenged by the United States and New Zealand in a trade dispute that ended in 2003. When exporting is allowed, quotas can never be welfare-inferior to price-equivalent tariffs when transport costs between the two markets are insignificant. If transportation costs are sufficiently high, tariffs can dominate price-equivalent quotas at high domestic prices.

Finally, we asked what would be the best way to liberalize if import licenses were under the control of the marketing board. The results depend to a large extent on how the quota is administered. We consider three cases. Under the first one, the quota imposes an upper limit on imports and the marketing board is allowed not to fill the quota. When domestic production is efficient, the board "sleeps" on all quota licenses and the domestic price is always the unconstrained monopolist price. The range of feasible prices when domestic production is inefficient is larger, but remains small. The possibility of not filling the quota makes it a very uncompetitive instrument. The second case forces the marketing board to just fill the quota. Tariffs dominate except at high prices when domestic production is inefficient. The third case treats the quota as a minimum access commitment, allowing imports to exceed the quota. When domestic production is inefficient, the marketing board exercises its option to import more and behaves like a "two-plant" monopolist when the minimum access commitment falls short of the profit-maximizing level of imports. Paradoxically, the quota is a more competitive instrument than the tariff because high domestic prices that can be achieved with tariffs cannot be achieved with quotas!

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.najef.2007.07.002.

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