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THE VALUE OF DAIRY QUOTA UNDER A COMMERCIAL EXPORT MILK PROGRAM

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The Value of Dairy Quota Under a Commercial Export Milk Program

Abstract

This paper argues that under a commercial export milk program the market value of quota will be determined by the spread between the domestic market price and the export price rather than the conventional wisdom that it is determined by the spread between the domestic milk price and the marginal cost of production. Under this new economy it was argued that ultimately the market price of dairy quota will be priced independently of firm marginal costs, which implies that low cost (or high margin) producers will not hold an economic advantage in bidding for quota over higher cost producers. Regression results are consistent with the hypothesized positive relationship between quota values and the difference between domestic and export milk price. The average export price has generally increased over time and is approximately equal to the marginal cost for an average producer. The results have implications for the WTO challenge. New Zealand and US feel the domestic program acts as an export subsidy by cross-subsidizing production of commercial export milk. The results here suggest that the prices for the filled export contracts are approximately the marginal cost of production for the average producer, and not lower as suggested by the challenge. Export contracts were found to have higher price risk than domestically produced milk. The risk is compounded by the short-term nature of most export contracts. The increase in risk for the CEM implies that it is unlikely many farmers will greatly diversify into CEM contracts unless the uncertainty is reduced.

INTRODUCTION

The value of the right to produce milk under supply-management is an important issue for both individual producers and the dairy sector as a whole. A single decision-maker needs to determine the appropriate amount to bid for quota, and this bid value responds to a number of economic variables. An increase in domestic price, a decrease in marginal costs, expectations about future growth in cashflow, and lower costs of capital are all economic variables that could lead to an increase in quota bid prices. Quota prices should also be sensitive to international markets. For example, Lariviere and Meilke (1999) show how economic rents to milk producers would decrease with a reduction in tariffs, increased access to the Canadian milk market, and reducing or eliminating export subsidies. As economic rents per unit of output falls, so too will

the price of dairy quota (e.g. Forbes, Hughes and Warley (1982), Mochini and Meilke (1988), Barichello (1996), and Chen and Meilke (1998)).

The institutional regulations surrounding milk production can also have an impact on the value of dairy quota. Prior to 1995, domestic dairy quota was priced according to the ability of lowest cost producers to pay. Under this regime the value of quota would generally equal the present value of the difference between the efficiency output point of average cost and marginal cost and the market price of milk. The introduction of an export class (5e) milk pricing structure by the Canadian Dairy Commission in 1995 and of a commercial export milk program in 2000 has changed considerably the way quota for domestic milk production is valued. In essence a dairy producer of any size can now opt to fill up to 100% of dairy production through export contracts. Under the older regime, there was no available alternative for dairy farmers to market their milk outside of provincial milk marketing boards. In the absence of marketing alternatives, dairy milk quota provided the right and obligation to produce and sell milk into the domestic market at a regulated price, which is in excess of industry marginal costs. Under the new commercial export milk program (CEM) the definition of dairy quota has changed considerably. With the emergence of a parallel marketing alternative to domestic fluid and industrial milk, dairy quota no longer provides the right and obligation to produce milk, but instead the right to collect a price premium for marketing milk domestically rather than marketing the same milk under an optional export contract. No studies have examined how the availability of export contracts outside production quotas will affect the price of quota.

The purpose of this paper is to examine how dairy quota is valued when dairy farmers have the option to export. We argue that the program changes are not trivial. In the first section of the paper it is demonstrated that the value of quota now depends only on the spread between

the domestic board price and the export price rather than the spread between domestic prices and marginal costs. We show that some farmers may have the ability to pay more for quota as in the old regime but then argue that if the market is efficient, the ability to bid a higher price, under the new regime, is largely irrelevant. Using a mean variance portfolio model it is shown how risk and returns can influence the producer's decision to balance production for domestic and/or export markets. An analysis of monthly export prices, domestic Ontario milk prices, and Ontario quota prices confirms the theory. The paper concludes with a discussion on the implications of the introduction of export contracts within the supply management regime of the dairy sector. The results also have implications for the basis of challenge by New Zealand and the US as to the compliance of the commercial milk export program with Canada's Uruguay agreements to export subsidy levels.

THE ECONOMIC VALUE OF QUOTA

As with any other capital asset, the value of quota will equal the present value of the anticipated cashflow arising from the rights of production that it confers. Along with this right comes certain obligations, which include a continual balance of butterfat percentage and volume of milk produced. In the following section it is assumed that the quota value reflects fully the obligation to deliver a certain quantity of butterfat with no allowance for penalties associated with over or under production. We will demonstrate how incremental cashflows, and consequently the value of quota, differ under a supply management system with and without the availability of export contracts and in the presence of uncertainty.

Quota Values in the Absence of the CEM

Prior to the commercial export market (CEM), annual incremental cashflows from dairy production on a per litre basis (A_{DM}) were covered by

$$(1) \quad A_{DM} = \text{Max} [P_d - MC - Q_A, 0]$$

where P_d is the domestic price of milk under supply management, MC is the marginal cost of producing milk, and Q_A is the amortized value of quota on a per hectoliter (hl) basis. Since a dairy farmer could only sell on the domestic market, a farmer choosing to produce for this market would receive an annual net return per litre of $P_d - MC - Q_A$ or the farmer would not produce any milk if the incremental cashflows were negative. Equation (1) places a maximum on the amortized value of quota, ($Q_A \leq P_d - MC$) and subsequently the amount a farmer would bid for quota.

To illustrate the influence of production costs on the bid price for quota, consider the case in Figure 1 with two producers having different marginal cost curves, MC_1 and MC_2 . Both producers face the same domestic price P_d and for simplicity both produce at S^* . The maximum amount they are willing to pay for an extra unit of quota is $P_d - MC_1$ for producer 1 and $P_d - MC_2$ for producer 2. The maximum amortized value of quota under supply management, Q_A^{DM*} , is the difference between the domestic price and the producer's individual marginal cost. Neither producer would purchase quota if the amortized value at its present market price (Q_A^{Mkt}) is such that $Q_A^{Mkt} > Q_A^{DM*} = P_d - MC$. To summarize, producer i has two choices when producing only for the domestic market (DM):

$$\text{buy quota if} \quad P_d - MC_i = Q_{A_i}^{DM*} \geq Q_A^{Mkt}$$

$$\text{stay at } S^* \text{ (or sell quota) if} \quad Q_A^{Mkt} > Q_{A_i}^{DM*} = P_d - MC_i.$$

Farmers with lower marginal costs such as producer 2 in Figure 1 are able to out-bid producers with higher marginal costs such as producer 1. We will assume that farmers do not sell quota if $Q_A^{Mkt} > Q_{A_i}^{DM*}$ but rather keep at S^* due to the influence of quota appreciation. Canadian dairy farmers tend to sell either all their quota if they are exiting the industry or none at all so the assumption of keeping production constant is appropriate for a dairy producer continuing to farm.

Quota prices are presently settled in Ontario on a bid-ask basis once a month with the final price equating supply and demand. During each month individual farmers desiring quota place a bid with the exchange (the maximum price at which they are willing to buy) while those selling quota set ask prices (the minimum price at which they are willing to sell). Both buyers and sellers state the amount and type of quota they are willing to buy or sell. Note that there will be a distribution of bid prices with the maximum bid price determined by the producer with the lowest marginal cost.

The quota exchange then ranks and accumulates the quantity and price of quota available for sale and the quantity and price of quota to be purchased. The market-clearing price is the price at which the quantity offered for sale equals the quantity bid upon. Since supply equals demand all offers to purchase at or above the market clearing price and all offers to sell at or below the market-clearing price are satisfied. To illustrate, assume there are 3 sellers selling one unit of quota at prices of 15, 20 and 22 and there are 4 buyers with bid prices of 10, 15, 20 and 35. The top bid price (35) is matched with the lowest bid price (15) to begin and the process continues until the bid and ask prices are equated.¹ In this example, two units of quota will be sold in the market with a unit each sold by the two sellers with the lowest ask prices and a unit

each bought by the two buyers with the highest bid prices. Both units of quota are exchanged at a price of 20. In essence, the market-clearing price is dictated by the willingness of producers to pay for quota, and producers with lower marginal costs are better positioned to bid a higher price than those producers with higher marginal costs.

Quota Values in the Presence of the CEM

Under the previous regime, dairy producers had no (or limited) options to produce milk for markets other than the domestic market implying a zero opportunity cost associated with not producing for the domestic market. This has changed. Cashflows under the new regime (A_{CEM}) are:

$$(2) \quad A_{CEM} = \text{Max} [P_d - MC - Q_A, P_e - MC].$$

where P_e is the export price of milk. To illustrate this change, consider the case of Figure 2 which introduces the export price, P_e , to Figure 1. Prior to CEM, the farmer would buy additional rights to produce milk provided $P_d - MC$ (i.e. Q_A^{DM*} in Figure 1) was greater than the amortized value of quota at its current market price (Q_A^{Mkt}) as discussed previously. The maximum they would be willing to pay for quota (Q_A^{Max}) would vary by individual producer depending upon their marginal costs. With the CEM, the current producer has three mutually exclusive choices that can be summarized as:

buy quota if	$P_d - MC - Q_A^{Mkt} > P_e - MC > 0$, or
buy an export contact if	$P_e - MC > P_d - MC - Q_A^{Mkt} > 0$, or
stay at S^* (or sell quota) if	$P_d - MC - Q_A^{Mkt} < 0$, $P_e - MC < 0$.

¹ Some producers needing quota will submit a bid price significantly higher than the expected clearing price knowing that their high bid will not influence the eventual equilibrium price but will ensure them a purchase (Doyon, Grant and Brinkman, 2000).

Note it is still assumed that a continuing dairy producer stays at a domestic quota level/production of S^* even if the incremental returns under both domestic and export production are negative due to the expectation of growth in quota value and the real option value to remaining in dairy.

Provided the returns to producing domestically and for commercial export are both positive, the choice between buying quota or agreeing to an export contract depends on comparing the incremental cashflows from the two options. The same farm can be active in both markets although most participants in the CEM have quota and few rely exclusively on the export market (Stoneman, 2001). The difference between producing for the export market ($P_e - MC$) and the domestic market ($P_d - MC - Q_A^{Mkt}$) can be written on a \$/hl basis as

$$(3) \quad B = P_d - P_e - Q_A^{Mkt}.$$

The basis (B) between producing for the domestic or export market is defined by equation (3) and is independent of costs of production. This wedge between the domestic and export prices governs the value of quota. The basis will take on a positive value if $P_d - Q_A^{Mkt} > P_e$ which implies that the market price of quota is lower than its opportunity cost. With a positive basis, the producer will increase supply by purchasing quota and no production will shift to the export market. However, if $B < 0$, then the value of quota exceeds its opportunity cost and the farmer will do better by producing additional milk for the export market.

In equilibrium neither a positive or negative basis can exist except in a transitory state. A positive basis suggests that producers will bid up the price of quota until marginal benefits of holding quota fall to zero. Thus, the maximum amortized value of quota (Q_A^{CEM*}) for a producer is the value of Q_A such that net returns from expanding production for domestic demand through additional quota, or for the international market through an export contract, are the same, $P_d -$

$MC - Q_A^{Mkt} = P_e - MC$. Thus, $Q_A^{CEM*} = P_d - P_e$, which is the same for both producers in Figure 2.

If the basis is negative, those holding quota will sell it, increasing supply, and reducing its price.

In equilibrium all arbitrage opportunities are exploited when

$$(4) \quad Q_A^{CEM*} - P_d - P_e = 0.$$

Equation (4) states that in equilibrium the market price of quota depends on the spread between the domestic milk price and the export price, rather than the marginal cost of production. This means that the bid price for quota is independent of scale, as discussed in Figure 2, and that the bid price, and the bidding process no longer favours dairy producers with a comparative advantage in size or scale economies.

The Effect of Export Prices on Quota Bid Prices

The above theory suggests that there are two mutually exclusive formulations for calculating the bid price for quota. Using a general approach to asset capitalization (see Baker *et al*, 1990) the bid price formulas are given by

$$(5) \quad QV_{DM} = \{365 (P_d - MC) / (bf\% \times 100)\} / (r - g)$$

for milk produced for the domestic market and

$$(6) \quad QV_{CEM} = \{365 (P_d - P_e) / (bf\% \times 100)\} / (r - g^*)$$

for milk sold under an export contract. The numerators convert the bid price from a \$/hl basis to a \$/kg butterfat/year basis and convert cash flow in terms of \$/hl to a \$/kg b.f. basis. Dairy quota provides the right to produce 1 kg/day for 365 days. If for example $bf\% = 3.5\%$ then each hectoliter of milk produces 3.5 kg of butterfat which means that 3.5 units of quota are required to produce 1 hl of milk. The discount rate would be the same in both cases but there is the possibility that anticipated growth in the respective spreads would differ. In the short run

differences in growth (g) would be attributable to temporal changes in marginal costs and export prices but in equilibrium there is no reason to anticipate that they would differ since marginal costs would always set the lower boundary for export prices.

The two formulations are mutually exclusive since equation (6) would dominate (5) when $P_e > MC$ and equation (5) would dominate or be at least equal to (6) when $P_e \leq MC$. Changes in anticipated growth will increase the quota values since the spread between the domestic price and marginal costs or export prices will increase. Holding domestic prices constant, the growth rate becomes negative and the value of the quota will fall as export prices increase at a rate greater than marginal costs. Assuming equivalent growth rates in the long run, quota values will decrease as the costs of capital increase, but further discussion on capital costs is beyond the scope of this paper.

Risk And The Optimal Milk Marketing Choice

The previous sections discussed how the CEM model could affect the market price of dairy quota, but did not provide insight into how farmers would choose between producing milk for the export market and/or owning quota and producing for the domestic market. Facing different price risks the problem can be viewed in the context of portfolio diversification. In this section, the objective is to provide some base-line comparative statics in a normative framework for a representative producer with a negative exponential utility function and a constant absolute risk aversion, α .

From the first major section of the paper, deterministic, incremental cashflows from producing domestically are $P_d - MC - Q_A$ while the returns to shipping under a commercial export contract is $P_e - MC$. In this section, returns are stochastic and expected revenue for domestic and

export production are given by $E[P_d]$ and $E[P_e]$ respectively. Defining the proportion of total milk production shipped to domestic processors as λ , the remainder $(1-\lambda)$ is shipped under export contracts. Expected profits are then given by

$$(7) \quad E[\Pi] = \lambda(E[P_d] - Q_A^{Mkt}) + (1-\lambda) E[P_e]$$

since marginal cost cancel out and its variance is given by

$$(8) \quad \sigma_{\Pi}^2 = \lambda^2 \sigma_d^2 + (1-\lambda) \sigma_e^2 + 2 \lambda(1-\lambda) \sigma_{de}$$

where σ_d^2 and σ_e^2 are the variance of marginal profits when shipping domestically and for export respectively and σ_{de} captures any covariance between the domestic and export market prices.

The model assumes for simplicity that quota is perfectly divisible and total milk production is fixed so we can look at the problem in terms of a single unit of production (e.g. per hectoliter).

If it is optimal for an individual producer to increase quota production then profits increase by the per unit price less the amortized value of quota purchased. If quota production is reduced, then the export price substitutes for the domestic price and the amortized value of quota is returned to the producer upon sale. Expected utility under the above assumptions is then given by

$$(9) \quad EU(\Pi) = \lambda(E[P_d] - Q_A) + (1-\lambda) E[P_e] - \frac{\alpha}{2} [\lambda^2 \sigma_d^2 + (1-\lambda)^2 \sigma_e^2 + 2\lambda(1-\lambda) \sigma_{de}]$$

The optimal proportion to ship under domestic quota is λ^* which is obtained by differentiating (9) and solving for λ when $\partial EU(\Pi)/\partial \lambda = 0$. It is

$$(10) \quad \lambda^* = \frac{(P_d - Q_A - P_e) + \alpha(\sigma_e^2 + \sigma_{de})}{\alpha \sigma^2}$$

where

$$(11) \quad \sigma^2 = \sigma_d^2 - \sigma_e^2 - 2 \sigma_{de}.$$

Examining the first order conditions of (11) with respect to the price spread reveals that

$$(12) \quad \partial \lambda^* / \partial (P_d - P_e) = \frac{1 - \partial Q_A / \partial (P_d - P_e)}{\alpha \sigma^2}.$$

In general $\partial \lambda^* / \partial (P_d - P_e)$ will be positive which means that the proportion of milk entering the export market $(1 - \lambda^*)$ will decrease as domestic prices rise relative to export prices. But there are two effects. The first is a pure price effect and its value is $1/\alpha \sigma^2$ holding quota values constant. However, since an increase in the spread could also cause a rise in the price of quota, the total effect is somewhat dampened. If the quota effect over-reacts then it may be possible to observe a decrease in domestic production. This would unlikely be sustainable and in the longer run the value $\partial Q_A / \partial (P_d - P_e)$ will likely be less than 1.

In terms of risk aversion

$$(13) \quad \frac{\partial \lambda^*}{\partial \alpha} = - \frac{(P_d - Q_A - P_e)}{\alpha^2 \sigma^2}.$$

If the numerator in (13) is positive this suggests, in a mean variance framework, that the risk associated with $P_d - Q_A$ is greater than that associated with P_e . Consequently λ^* , the proportion of milk produced for the domestic market will decrease. The opposite is true if $P_e > P_d - Q_A$.

More interestingly is the effect of risk on λ^* . To examine this, define

$$(14a) \quad \frac{\partial \sigma}{\partial \sigma_d} = \frac{\sigma_d - \rho \sigma_e}{\sigma}, \text{ and}$$

$$(14b) \quad \frac{\partial \sigma}{\partial \sigma_e} = \frac{\sigma_e - \rho \sigma_d}{\sigma}$$

where ρ is the correlation between domestic and export prices. Then

$$(15) \quad \frac{\partial \lambda^*}{\partial \sigma_d} = -2 \frac{[(P_d - Q_A - P_e) + \alpha \sigma_e^2][\sigma_d - \rho \sigma_e]}{\alpha \sigma^2}.$$

The effect of increasing domestic milk price variance on the proportion of milk shipped under domestic quota is ambiguous. The first bracketed term in (15) will be positive if the spread in marginal profits between producing under domestic quota and under an export contract $\{(P_d - Q_A) - P_e\}$ is greater than $\alpha\sigma_e^2$. If domestic and export prices are either negatively correlated or uncorrelated, then the second bracketed term is positive and $\partial\lambda^*/\partial\sigma_d < 0$. The correlation between domestic and export prices is slightly negative at -0.19 based on price data in Table 2. Under these conditions the result states that as domestic price uncertainty rises relative to export prices, there will tend to be a decrease in production for the domestic market. If the price series are positively correlated then $\partial\lambda^*/\partial\sigma > 0$ for $\sigma_d/\sigma_e < \rho$, $\partial\lambda^*/\partial\sigma_d = 0$ for $\sigma_d/\sigma_e = \rho$, and $\partial\lambda^*/\partial\sigma_d < 0$ if $\sigma_d/\sigma_e > \rho$. A positive correlation suggests that increased volatility in the domestic market will be matched by a correlated rise in volatility in the export market. This latter effect would generally dampen the overall impact of a change in σ_d . It follows by a similar argument that $\partial(1-\lambda^*)/\partial\sigma_d > 0$ so that a marginal increase in risk in domestic prices will cause an increase in production for export markets.

The effect of an increase in export price variability provides a symmetrical (and equally ambiguous) result to that presented above. In this case $\partial\lambda^*/\partial\sigma_e > 0$ and $\partial(1-\lambda^*)/\partial\sigma_e < 0$. As above, the total effect is either exacerbated or dampened by negative or positive correlations.

EMPIRICAL RESULTS

Export Contracts

Export contracts for milk have been offered to producers in Ontario and Quebec since August 2000 and in Manitoba since December 2000. Characteristics of the contracts for Ontario are provided in Table 1 up to November 2001. The monthly volume of all contracts offered by

processors has been relatively constant for 2001 at around 400,000 liters per month. During the initial periods of the CEM, processors offered significantly more contracts, particularly in the November 2000 to January 2001 period when a small number of processors made very large requests. For example, Nestle Canada requested 20 million liters per day at \$33.4658 per hectoliter in November 2000. This request did not represent an expectation to fill a specific amount but rather it was a signal to the market that Nestle would accept all available production at the given price. Similar activities occurred in December and January with other processors.

Producer participation in the CEM has been increasing. Since February 2001, dairy farmers have accepted an average of approximately 30% of the contracts made available by processors. The volume filled under export contract now represents about 2% of Ontario's current production.

The average price of filled export contracts has ranged from a low of \$29.05 in July 2000 to a high of \$37.90/hl in October 2001. The theoretical model hypothesized that a producer will enter into a commercial export contract if the incremental cashflows from doing so are greater than buying additional quota to supply domestically ($P_e - MC > P_d - MC - Q_A^{Mkt}$). Thus, the increase in export price has been matched by increased producer participation in the CEM as expected. In addition, the relationship between export price and marginal costs and the firm's decision to enter into an export contract. Using the historical record from the Ontario Dairy Farm Accounting Project over the years 1995 through 2000 it was found that the cash conversion ratio (net operating cashflow/\$ of milk sales) was approximately 70%. On a cash flow basis, this implies that the spread between prices received and marginal costs is approximately 30%. Applying this value to a base domestic price of \$55/hl gives an approximate value for marginal

costs of \$38 and the spread between price and cost is \$17². According to theory, if farmers are going to supply milk to processors for export then the export price must at least cover marginal costs on a cash basis. Throughout 2001 the export price has risen and is approaching the roughly estimated average marginal cost of production.

Domestic/Export Milk Prices and Quota Values

One of the major findings of the theoretical model is that the market price of quota will become more dependent on the spread between the domestic milk price and the export price, rather than the marginal cost of production as the export price rises relative to costs. To determine if such a relationship has started to emerge, the price spread and quota values are compared. Table 2 lists the domestic and export prices, price spread and quota price for each month from August 2000 to November 2001. As the spread decreases it is expected from theory that quota prices will fall. In most months, an increase in the price spread is accompanied by a corresponding increase in the price of quota. This is especially true in the January to March 2001 period. Thus, it appears that the hypothesized positive relationship between the price spread and the price of quota developed in the theoretical model is beginning to appear in Ontario.

² The increased spread in prices excludes the amortized cost of quota. Assuming a 20 year horizon, at a 8% discount rate, the amortization factor is 9.818. The amortized value of quota at \$20,000 is then \$2,037 per year. At 3.5% butterfat this provides the right to produce 104.28 hl of milk per year or approximately \$19.58/hl. Since the \$16.34 spread occurs before amortization, then it is evident that with an opportunity cost of \$19.58/hl the spread between domestic and marginal costs is all but exhausted if not negative. When the opportunity cost of holding quota is considered, export prices in the mid \$30 range compares directly with current domestic prices.

Uncertainty and Quota Values

Trade challenges have altered the form of the export milk program in Canada and continue to pose a risk to its existence. The creation of milk class 5(e) by Canada in 1995 was challenged by New Zealand in 1997 as a violation of Canada's export subsidy commitments made in the Uruguay Round Agreement. The US joined the NZ challenge in 1998 and the WTO Dispute Settlement Panel ruled in their favour on May 17, 1999. Canada then created the CEM in an attempt to become compliant with the Panel's report and the subsequent ruling by the Appellate Body, which upheld the Panel's initial decision. NZ and the US again filed a complaint against the form of the CEM in February 2001 (WTO, 2001a). A second Dispute Panel ruled in July 2001 that CEM program was not compliant with Canada's Uruguay commitments putting the future of the program in jeopardy. Canada again appealed to the Appellate Body and this time the Panel's decision was overturned. However, the report did not state that the CEM was WTO legal suggesting that future challenges are likely.

The theoretical model suggests that increased uncertainty in the export market will cause an increase in quota prices as farmers move to the safety of the domestic market. The WTO ruling masques some of the relationships hypothesized in the theory section, but the total relationships can be investigated by simply regressing the value of quota against the price spread and including a dummy variable to capture the months of uncertainty between July and November 2001 regarding the WTO ruling. The results of the regression (t stats in parantheses) are

$$\text{Quota Value} = \$13,599 + 191.6 * \text{Price Spread} + 1,458.7 * \text{WTO} \quad \text{Adj RSquare} = 0.12$$

(4.79) (1.77) (1.99)

The results are consistent with the a priori positive relationship hypothesized between the price spread and the value of dairy quota. A \$1 increase in the price spread represents a \$1 decrease in the export price relative to the domestic price so the positive sign is correct. All other things held constant, a \$1 increase in the export price will reduce the price of quota on average by \$191.6/kg³.

Likewise, the dummy variable on the WTO ruling is significant and positive. The WTO Dispute Settlement Panel ruling in July 2001 increased uncertainty and ambiguity about the future of the CEM program and the export prices that the CEM program could offer. The result clearly indicates that there was a reversion back to domestic and conventional quota valuation.

Our theory supports the positive effect of the WTO ruling on domestic quota values in two forms. The first is that a successful NZ and US challenge on the CEM would either reduce or eliminate export pricing in Canada. As export prices fall, the spread between the domestic and export prices rises and theory indicates that quota values should subsequently rise. In addition, our theory suggests that an increase in uncertainty about the export price will decrease the amount of milk shipped for export and the increased supply of milk would need to be shipped domestically. This in turn would increase the demand for domestic quota and prices would rise. The WTO ruling clearly indicates that such a response exists. Over the period July-November 2001, quota prices rose in direct response to the WTO ruling by about \$1,458/kg.

In general, export prices are transitory and unpredictable. Without any ties to a cost of production formula that can smooth profit margins, export prices will be volatile relative to

³ In equation (12) and its subsequent discussion, we suggested that the derivative $\partial Q_A / \partial (P_d - P_e)$ would be less than 1. From the regression, the change in quota value is \$191.6. Assuming that holding period of quota is 20 years and the discount rate is 8%, the present value annuity factor that converts this to annuity value is 9.818. The amortized value is therefore \$19.515 ($191.6/9.818$). The quota provides the right to produce 365 kg bf or 104.28 hl in one year. Dividing \$19.515 by 104.28 results in a value less than 1 (\$0.187/hl) as suggested following equation (12).

domestic prices. From Table 2 the standard deviation in export prices is 2.41 compared to 1.69 for domestic prices. This represents a 42% higher degree of price risk. A similar result is found in the volatility of the percentage changes in the Table 2 prices. In addition, many export contracts are for durations of 3 months or less which creates even further risk and ambiguity. As discussed above, one needs only to look at the impact of the July 2001 WTO Panel judgment in favour of the NZ and US challenge to see that an increase in uncertainty or ambiguity about export prices will have a significant impact on quota prices. Given the relationships above, and the option to produce milk for the domestic or export markets, it is unlikely that farmers will greatly diversify into CEM contracts as long as the price risk relative σ_e/σ_d is high. On the other hand, as CEM matures, processors may be able to offer extended forward contracts-to-deliver or export price options. Such contracts will reduce uncertainty and this could encourage some farmers to move away from fluid milk production for the domestic market.

DISCUSSION AND CONCLUSIONS

This paper argues that under a commercial export milk program the market value of quota will be determined by the spread between the domestic market price and the export price rather than the conventional wisdom that it is determined by the spread between the domestic milk price and the marginal cost of production. Under this new economy it was argued that ultimately the market price of dairy quota will be priced independently of firm marginal costs, which implies that low cost (or high margin) producers will not hold an economic advantage in bidding for quota over higher cost producers. Regression results are consistent with the hypothesized positive relationship between quota values and the difference between domestic and export milk price.

The average export price has generally increased over time and is approximately equal to the marginal cost for an average producer. It is unlikely that the export price will fall below the marginal costs of production for sustained periods of time since farmers would no longer enter into export contracts. The data supports this finding. A more complete model of quota pricing in equilibrium would set the marginal costs of production as a (lower) boundary condition to the export price. Under this scenario setting the export price equal to marginal production costs would result in equivalent pricing models.

The effect of risk on the portfolio choice of producing milk for the domestic or export markets was also illustrated. Export contracts were found to have higher price risk than domestically produced milk. The risk is compounded by the short-term nature of most export contracts. The increase in risk for the CEM implies that it is unlikely many farmers will greatly diversify into CEM contracts unless the uncertainty is reduced. Not only does the CEM have greater price risk, but has faced greater policy risk regarding its future viability. The study found that during the time period of the successful NZ and US challenge to the WTO Dispute Settlement Panel, quota values increased due to the potential reversion back to conventional quota valuation and higher risk.

The results have implication for the WTO challenge. New Zealand and US feel the domestic program acts as an export subsidy by cross-subsidizing production of commercial export milk. The results here suggest that the prices for the filled export contracts are approximately the marginal cost of production for the average producer, and not lower as suggested by the challenge. In addition, the difference between the export price and the domestic price is close to the marginal cost of quota for an average producer.

We speculate, but leave for further research, that under conditions of risk the export price under a continued CEM program would oscillate between, and be bounded by, the domestic marginal production costs as a lower boundary and the U.S. base formula price as an upper boundary. The BFP price will likely form an upper boundary since (in equivalent currencies) an export price in excess of the BFP price would encourage U.S. processors to increase exports until the market equilibrates. In fact, the price data in Table 2 shows that the average price has been trending upwards towards \$40/hl which is very close to the U.S. BFP when converted to Canadian dollars. Since BFP futures price volatility would include the jointness between demand and supply it is probably more variable than marginal costs. Furthermore, we would conjecture that because there are more degrees of freedom associated with export markets than domestic markets the actual volatility of export prices would be greater than the U.S. BFP prices. Consequently, we believe that a rigorous analysis of uncertainty in milk prices would reveal that the spread between the domestic price and export price would be significantly more volatile than the spread between domestic prices and marginal costs. In our model this increase could be represented by a higher discount rate for the CEM regime than the original regime and this in turn would actually cause a reduction in the quota bid price. The implication of this, in a positivist sense, is that dairy producers will generally maintain a significant investment in quota.

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Price of
Milk

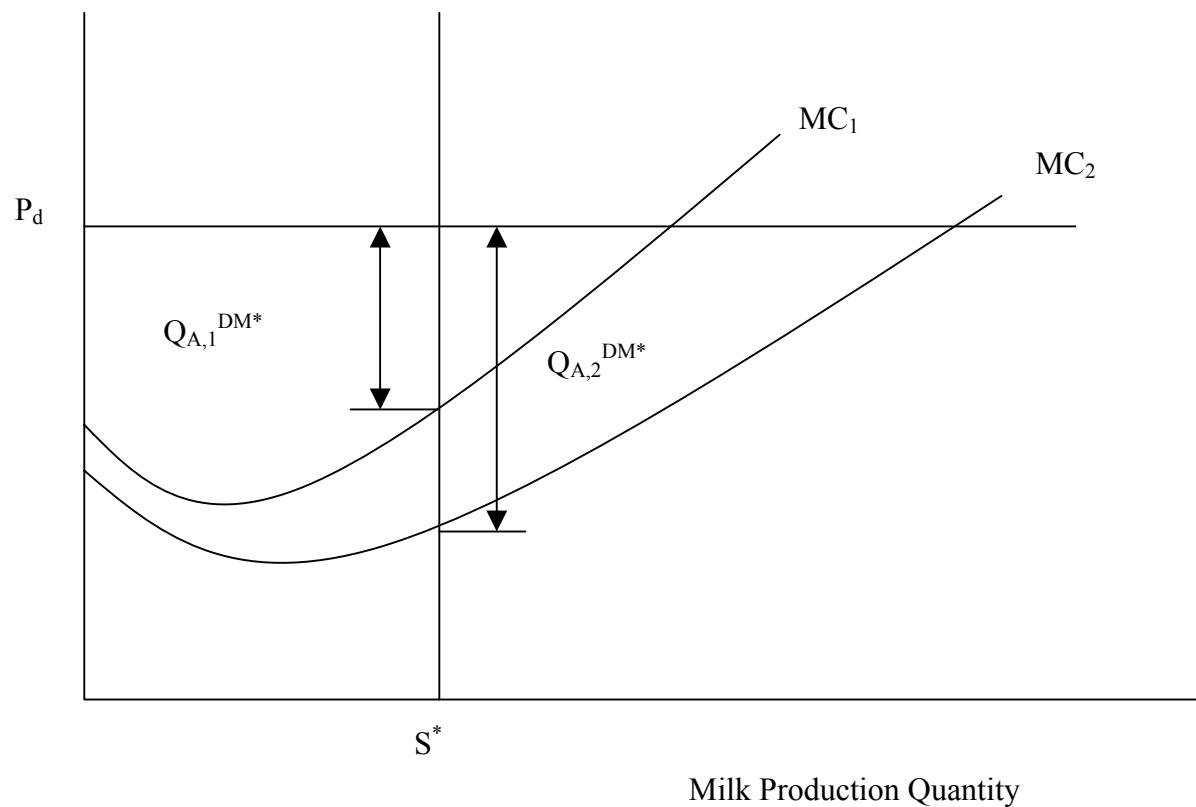


Figure 1: Maximum Amount (Q_A^{DM*}) Producers with Differing Marginal Cost Curves (MC) would Pay for Quota

Price of
Milk

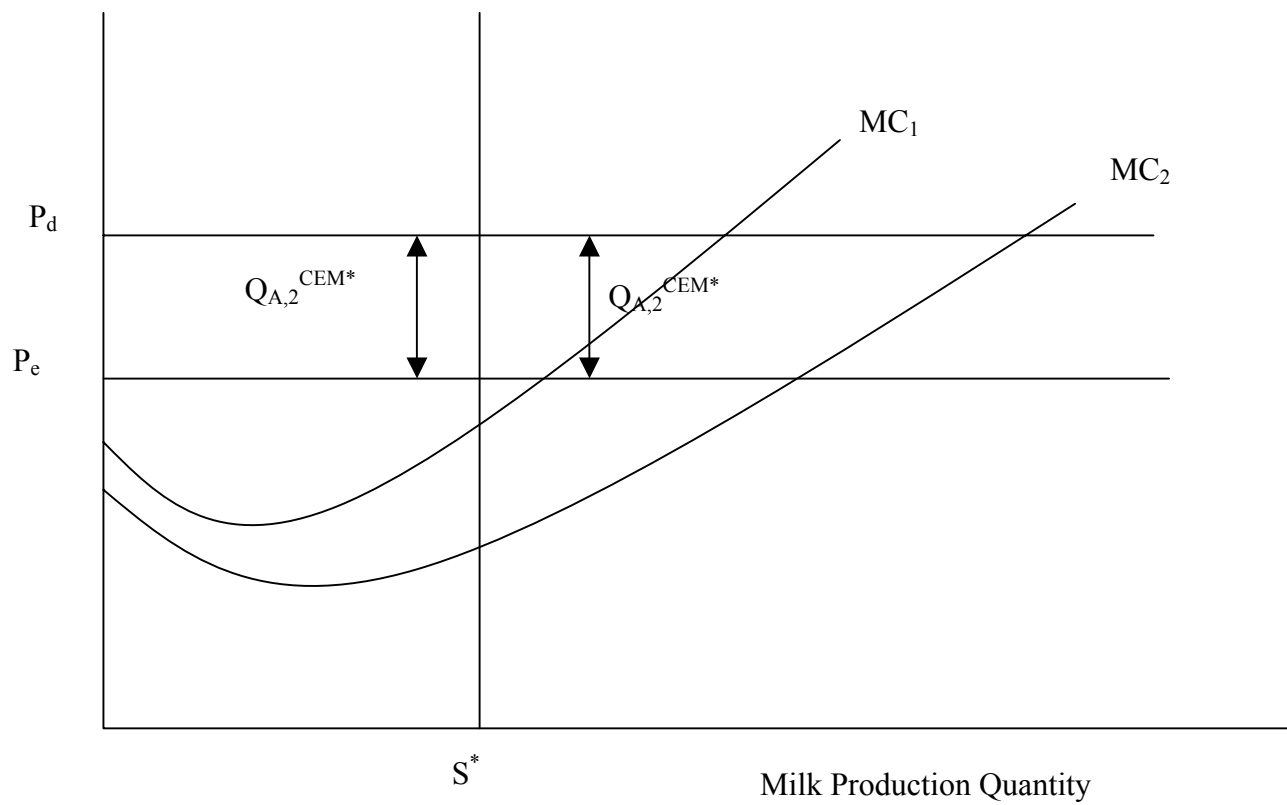


Figure 2: Effect of Export Contract at Price P_e on Maximum Amortized Value of Quota ($Q_{A,2}^{CEM*}$)

Table 1. Characteristics of Optional Export Contracts for Milk in Ontario

Date	Total Standard Volume Posted (l)	Total Standard Volume Contracted (l)	Percentage Filled (%)	Average Standard Price (\$/hl)	
				Posted	Contracted
July/2000	71,699,707	10,878,808	15.17	26.5821	29.0545
August	53,035,117	3,780,024	7.13	28.8296	31.9109
September	45,949,993	2,420,347	5.27	29.4668	33.2457
October	603,038,290	3,911,791	0.65	32.7310	35.0029
November	41,077,196	3,562,297	8.67	29.3043	32.8507
December	3,682,518,801	6,782,204	0.18	29.3220	31.2530
January/2001	3,687,640,652	9,406,413	0.26	29.3275	30.8224
February	59,602,259	12,262,314	20.57	28.7928	30.3721
March	19,439,935	10,549,802	54.27	29.2981	29.6786
April	26,456,104	10,075,590	38.08	29.5386	29.9658
May	78,279,774	8,038,822	10.27	29.7637	30.7499
June	51,415,783	7,058,895	13.73	31.8828	33.0079
July	36,798,287	6,923,997	18.82	33.3310	34.2882
August	28,197,173	7,143,025	25.33	34.6147	35.7694
September	32,870,968	5,636,988	17.15	35.6289	37.1647
October	14,239,907	6,421,060	45.09	36.1289	37.9049
November	21,247,702	14,446,736	67.99	33.8032	34.7617
Average			1.51	31.0792	32.8120

Table 2. Relationship Between Domestic Prices, Export Prices, and Quota Values

Month	Domestic Price (\$/hl)	Export Price (\$/hl)	Price Spread (\$/hl)	Quota Price (\$)
July/2000	54.47	29.0545	25.4155	17,129
August	54.77	31.9109	22.8591	17,999
September	56.36	33.2457	23.1143	17,101
October	58.15	35.0029	23.1471	18,522
November	58.41	32.8507	25.5593	20,301
December	59.69	31.2530	28.4370	19,900
January/2001	56.29	30.8224	25.4676	19,000
February	59.54	30.3721	28.9179	19,256
March	59.50	29.6786	29.8214	19,499
April	57.40	29.9658	27.4342	18,501
May	57.90	30.7499	27.1501	17,997
June	58.41	33.0079	25.4021	17,901
July	55.84	34.2882	21.5518	18,759
August	56.28	35.7694	20.5106	20,000
September	56.17	37.1647	19.0053	19,499
October	58.68	37.9049	20.7751	18,100
November	57.66	34.7617	22.8983	18,999