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The Economics of a Regulated Dairy Market: An Empirical Analysis of Factors Determining the Values of Fluid Milk Quota

Michele Veeman and Xiao-yuan Dong

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Department of Rural Economy
Faculty of Agriculture, Forestry,
and Home Economics
University of Alberta
Edmonton, Canada

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by

Michele Veeman and Xiao-yuan Dong

The authors are, respectively, Professor, Department of Rural Economy, University of Alberta and Assistant Professor, Department of Economics, University of Winnipeg.

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The Economics of a Regulated Dairy Market: An Empirical Analysis of Factors Determining the Values of Fluid Milk Quota[1]

Abstract

Based on the hypothesis that tradeable marketing quotas may be analysed as an economic input in the production process of regulated firms, the standard capital asset pricing model is adapted to assess the impact of expectations of quota rents on Ontario fluid milk quota values. The analysis provides estimates of the marginal impacts on quota values of two variables postulated to proxy the rent that arises from the highly regulated market for this product. The results are consistent with expectations from economic theory for a divisible capital asset. It appears that the regulated marketing system for fluid milk has enabled appreciable returns from improvements in milk production technology and administered prices to be appropriated by producers. Milk production technology advances, proxied by average herd size, and increases in administered prices for milk evidently contribute to increased quota values. An experiment to assess the impact of reductions in milk prices on quota values is reported. The results of the study indicate that, following a 1 percent change in producers' price levels for milk, Ontario fluid milk quota values change by some 0.36 percent immediately and by some 6 percent over a longer-term period of about four years.

[1]We express appreciation for helpful discussion with Carol Desbiens and Marcel Huot regarding appropriate measures of technological change in dairy production; they noted to us the merit of use of herd size as a proxy variable for this purpose.

Introduction

The paper reports on an analysis of factors determining the value of the tradeable licenses, marketing quotas, that serve the dual purpose of restricting production and providing producers with a share of the relatively high-priced market returns for milk. An understanding of the economic factors underlying quota values is of importance for several reasons. Some economists analysing supply management programs have noted that since these values reflect the expected net benefits of the regulations of these programs, monitoring them provides useful indications of the extent of excess profits generated by the programs. For example, such information could be usefully employed in the regulation of prices for these products. Economists have also used evidence of quota values to impute transfers associated with these programs (see, for example, Grubel and Schwindt 1977; Arcus 1979; Barichello 1981; and Veeman 1982). From time to time there has also been extensive debate in agricultural economics literature relating to the possible impacts of various hypothesized influences on the magnitude of quota values for Canada's supply managed products (for example, see Forbes, Hughes and Warley 1982; Johnson et al 1982; Veeman 1982a; Moschini 1984; and Lermer and Stanbury 1985). Some of the debates on quota value have relied on theoretical postulates alone, rather than theory and empirical analysis. This study is an attempt to analyse empirical evidence regarding major influences suggested by economic theory to determine quota values for a supply-managed farm product, Ontario fluid milk, for which considerable data are available. We postulate that quota may be analysed as a factor of production in the production processes of regulated firms, specifically as a capital asset. Thus, a capital asset pricing model is adapted and applied to assess the impact on quota values of expected rent from holding quota to market the

supply-managed product.

In view of possible long-run implications of regional and multilateral trade agreements on the extent of protection afforded the Canadian supply-managed sectors, we also explore the potential impacts that changes in producers' returns might have on fluid milk quota values. To this end, we report on an experiment to assess the effect on quota values that would ensue if milk prices were to fall by specified amounts. Thus, we assess the impact on quota values of reductions in milk prices of the order of 15 percent and 36 percent, since reductions in levels of protection of this order of magnitude were proposed during the multilateral negotiations of the Uruguay Round of the General Agreement of Tariffs and Trade (GATT).

Background: The Regulatory Environment

Milk production is restrained through the allocation of licences or quotas that limit individual producers' marketings of milk to be consumed in fluid form to levels that, in aggregate, are consistent with regulated prices. This regulation has been a major function and purpose of provincial milk marketing boards since the first of these bodies was established more than 30 years ago. In contrast, regulation of the traditional industrial milk products of standard cheese, butter and skim milk powder, products that are less perishable and have, therefore, tended to be traded across provincial boundaries or in international markets (at considerably lower prices than for more perishable dairy products) has occurred at the federal level. Regulation of industrial milk products has largely been through the agency of the Canadian Dairy Commission (CDC) since its inception in 1967.

Producer-level prices for milk consumed in liquid form ("fluid" or Class I milk) are

typically specified on cost-based indexes or formulae that include cash costs of specified farm operations, imputed labour costs (increasingly based on farmers' records of "time charts" costed at the industrial wage rate), imputed returns to capital invested and a "management return". Achievement of "target returns" for shippers of industrial milk, specified in essence on the basis of surveyed and imputed costs along the lines outlined above, involve the support of wholesale prices of dairy products by quantitative restrictions on dairy imports; provision for domestic market clearing operations by the CDC; and supplementation of producers' returns by subsidy payments made directly to producers. The latter component constitutes a decreasing proportion of the target return. The consequent necessary restriction of production and marketing of milk for industrial uses is achieved through use of market-sharing quotas and related levies, established nationally by the Canadian Milk Supply Management Committee (a body that is chaired by the CDC) and administered locally by provincial milk marketing boards.

Prices charged by provincial boards to processors differ by use-class of milk, with highest prices for milk consumed in fluid form or as fluid cream.[2] Progressively lower prices apply for milk destined for consumption as cottage cheese, yoghurt, or processed foods; specialty cheeses; and cheddar cheese. Butter, casein, milk powder and evaporated milk constitute the lowest price classes to which milk surplus to other uses has traditionally been diverted.

Fluid milk was originally differentiated from industrial milk on the basis of freshness, sanitary standards, and producers' commitment to year-round continuity of supply. In earlier

[2] For example 6 milk classes and 4 sub-classes, each with varying prices, were applied by the Ontario Milk Marketing Board in 1993.

years, the price discrimination by use-class of milk translated to considerable differences in revenue between two types of milk shippers, those shipping to fluid markets and those shipping industrial milk. Today the typical Canadian dairy farm ships both fluid and industrial milk from the same farm operations and access to higher priced fluid markets is based on the farmer's holdings of fluid or Group I quota.[3] Producers' average revenue for sales covered by Group 1 quota reflects pooled milk returns across the various classes for which "fluid" milk is utilized within each specific area-wide pool. Holdings of market share quota provide access to the relatively lower-priced industrial milk market, which yields appreciably higher market returns than in the highly distorted world markets for dairy products. Holdings of market share quota also give producers access to direct subsidy payments.

Not surprisingly, the increased net returns (rents) associated with this regulated system of supply management for milk and dairy products is evidenced as considerable capital values of producers' marketing quotas and by considerable importers' rents on the relatively minor imports of processed dairy products that are provided for by specified import quotas. Data on rents to importers are sparse but are outlined in documents relating to a recent inquiry into the allocation of import quotas by the Canadian International Trade Tribunal. Data on dairy farmers' marketing quotas are more readily available. In earlier years the capital values associated with marketing quotas were obscured by extensive restrictions on their exchange. In more recent years, restrictions on quota transactions have been considerably reduced in some

[3] Some dairy farms continue to ship only industrial milk, but the proportion of these is declining. Increasing integration of fluid and industrial shippers has been due in part to the increasing diversion of "skim off", that is, milk fat diverted to industrial milk uses as consumption of lower fat milks has replaced that of "standard" or higher fat milk.

provinces. For example, in Ontario and British Columbia, quota exchanges are operated by the provincial milk boards.

The longest-established quota exchange is operated by the Ontario Milk Marketing Board, which lifted the major restrictions on trading fluid and industrial milk quotas in March 1980, subsequent to an analysis of quota policies and practices by Lane and MacGregor (1979) (Winslow 1980). The board operates monthly computer-based auctions of Group I Pool and market share quota. A considerable volume of quota is transferred on the exchange. The Ontario Milk Marketing Board reported in 1993 that in the preceding year some 8.0 percent of Group I Pool quota and 8.3 percent of provincial industrial milk quota, or market-sharing quota (MSQ) was transferred among producers. Similar to other years, some 57 percent of this was transferred to members of farmers' immediate families, thus bypassing the exchange. Most of the remainder was transferred on the exchange[4] (OMMB 1993).

The Theoretical Model

We hypothesize that quota may be treated as an economic input in the production process of regulated firms. Consequently, we adapt the standard capital asset pricing model to assess the impact of expectations of quota rents on quota values, based on a dynamic structure of expected rents. In terms of the classic asset value capitalization model, the value of milk quota can be

[4] An assessment of 15% of transferred quota is removed upon transfer, except for transfers to immediate family members; this tax on traded quota has been used to provide the relatively small quantities of Group I quota issued gratis to industrial producers who qualified for "graduated entry". The Board has also suggested that the tax enables it to remove quota from the system in order to maintain the payout percentage to Group I quota holders for higher priced Class I and II milk within their Group I pool(s) (OMMB 1991).

formulated as the present value of the future stream of expected net returns:

$$P_t = \sum_{s=0}^{\infty} \frac{R^*_{t+s}}{(1+i)^s} \qquad \textbf{(1)}$$

where P_t = the real value of fluid milk quota (per hectolitre of daily fluid quota);
R_t^* = the expected return from holding a hectolitre of daily fluid milk quota at period *t*; and
i = the long-run expected discount rate which is assumed to be constant over time.

If it is expected that equilibrium net returns are constant in the long run, expression (1) simplifies to:

$$P_t = \frac{R_t^*}{i} \qquad \textbf{(2)}$$

From the capitalization formulation in (2), a dynamic regression equation for quota values is postulated, as follows:

$$p_t = \alpha_0 + \alpha_1 r_t^* + u_t \qquad \textbf{(3)}$$

where p_t and r_t^* denotes the natural logarithms of P_t and R_t^*, respectively, u_t is a random disturbance which follows an ARMA process, and α_o and α_1 are unknown parameters. It is assumed that an adaptive expectations process applies to r_t^*, as follows:

$$r_t^* - r_{t-1}^* = (1 - \lambda)(r_t - r_{t-1}^*) \qquad \textbf{(4)}$$

where λ is the coefficient of expectation ($0< \lambda < 1$), and r_t denotes the logarithm of current net returns from holding quota at period t. It is assumed that current expectations of net returns, r_t^*,

are adjusted by a proportion of the discrepancy between current values of r_t and previous expectations r_{t-1}^*. We also assume that dairy farmers are more concerned with percentage changes than absolute changes in quota values, and thus apply a logarithmic form of the expectations process. Equation (4) can be simplified as:

$$r_t^* = \frac{(1-\lambda)}{(1-\lambda L)} r_t \qquad \textbf{(5)}$$

where L is the lag operator, defined for any variable, say, Z such as that $L^j Z_t = Z_{t-j}$. Substituting (5) into (3) gives

$$p_t = \alpha_0(1-\lambda) + \alpha_1(1-\lambda) r_t + \lambda p_{t-1} + u_t - \lambda u_{t-1} \qquad \textbf{(6)}$$

Accurate data on quota rents are not readily available. For example, quota rental is disallowed, according to the policy of the board (OMMB, 1993). However, economic theory and *a priori* information suggests the importance of two proxy measures of quota rent. One of these is the regulated price of the major output, milk. Economic theory and observation of the prevalence, pervasiveness, and importance of technological change to agricultural returns suggests that measures of technological change should be viewed as a second proxy measure of quota rent. Both these factors are expected to influence the derived demand for quota. All other things being equal, increases in the levels of regulated prices are expected to lead to outward shifts in a farmer's marginal value product, moving the derived demand for quota to the right. Since we expect that profit-motivated producers will adopt cost-reducing technology, a similar influence is expected from improvements in technology, through the upward shifts in marginal physical product that are expected, other things being equal, to result from the adoption of

available new farm-level technologies. Thus, the two variables used as proxies of net returns, R_t, are producers' average returns per hectolitre of milk, denoted by X_t, and T_t, a measure of technological change.

We considered three possible measures of milk production technology. One such possible indirect measure is the series of estimated milk sold per cow compiled by OMMB. However, consistent monthly data on milk sold per cow are not available. The series consists only of annual observations and its definition was changed by OMMB for July 1990 and subsequently. Further, output sold per cow may itself periodically be affected by quota constraints and may not fully reflect actual or potential output per cow. A second alternative that we considered was use of a time trend as a proxy for milk production technology; we note that time trend alone explains 67.7 percent of the total variation in milk sold per cow from 1984 to 1993. However, trend is not necessarily an accurate measure of milk production technology at a particular point in time. The third possible proxy for technological change in milk production that we considered, and the variable that we chose for this purpose, was herd size, expressed as the average number of cows per production unit. This variable is only available on an annual basis; we consider it to be the most appropriate available measure of dairy production technology, since many such technologies appear to be dependent on herd size. Examples include milking parlour design, use and type of bulk tanks, and use of genetic improvement services such as artificial insemination, sire selection and herd recording services.

Our initial observations of the pattern of quota prices, indicated in Figure 1, showed that these appeared to be unusually low during the first few months of 1990. We hypothesize that this may be associated with the adoption, in December 1989, of an adverse GATT panel ruling

on the legitimacy of Canada's import quotas for ice cream and yoghurt. To take into account the possible pessimistic changes in expectations of rent that may have arisen from this GATT panel ruling (since its possible impact could be expected to loosen quantitative restrictions on imports of these and related processed dairy products), dummy variable D_t is introduced into the model. D_t is equal to one for the periods from January 1990 to May 1990 and zero otherwise. In view of the pessimism expressed as a result of the ruling, as expressed in hearings of the Committee on Agriculture (1990), we expect the estimated coefficient on D_t to be negative.

Thus we propose the estimating model:

$$p_t = \beta_0 + \beta_1 D_t + \beta_2 x_t + \beta_3 T_t + \lambda p_{t-1} + u_t - \lambda u_{t-1} \qquad \textbf{(7)}$$

where $\beta_0 = \alpha_0(1-\lambda)$. Parameter β_1 measures the impact of the postulated structural change in expectations during early 1990 on quota values, and β_2 is interpreted as the short-run elasticity of quota values with respect to milk prices, X_t. Parameter β_3 is the coefficient of the measure of technological change, T_t. λ is the coefficient of expectation, as defined before, and x_t is the natural logarithm of X_t.

The Data and Estimation Procedure

Since the data series on "Ontario producer gross returns for fluid and industrial milk marketings under quota" was not available before August of 1984, the model of quota values in (7) was estimated with monthly data starting in August of 1984 and ending in July of 1993. The quota price series are the market-clearing prices of Group I (i.e. fluid) milk quota, in dollars per litre, sold through the Ontario Milk Marketing Board's quota exchange. Ontario producer "gross

returns for fluid and industrial milk marketings under quota, in dollars per hectolitre," is used as a measure of producer-level prices of milk. Average dairy herd size in Ontario is used as the measure of technological change in milk production. Data on these variables are all from the Ontario Milk Marketing Board, *Dairy Statistical Handbook*. Both quota value and producer gross return series are deflated by the consumer price index (1981=100).[5]

Ordinary least squares are not an appropriate method for the estimation of equation (7) since the explanatory variable p_{t-1} is correlated with the error term. Consequently, the maximum likelihood method was applied, using the Berndt, Hall, Hall and Hausman algorithm provided by the computer package of RATS (version 3.11). Details of the estimation procedure are given by Harvey (1990) and Judge *et al* (1985).

The model was initially estimated assuming that the disturbance term u_t represents a white noise process. The results are as follows (t-statistics are in brackets):

$$\begin{aligned} \hat{p}_t = & \underset{(-10.23)}{-2.23} - \underset{(-4.31)}{0.04D_t} + \underset{(5.61)}{0.18x_t} + \underset{(10.64)}{0.45T_t} + \underset{(72.73)}{0.97p_{t-1}} - \underset{(72.73)}{0.97u_{t-1}} \\ & DW = 0.50 \qquad R^2 = 0.67 \qquad RMSE = 0.064 \end{aligned} \tag{8}$$

The estimates of the parameters in (8) are consistent, but not efficient because, as indicated by the low value of the Durbin-Watson (DW) statistic, the disturbances, u_t, are serially correlated. Box-Jenkins analysis indicated the following third-order auto-correlation, AR(3), process of the disturbance term in (8):

$$u_t = \underset{(13.30)}{1.25u_{t-1}} - \underset{(-6.10)}{0.81u_{t-2}} + \underset{(3.26)}{0.31u_{t-3}} + \epsilon_t \tag{9}$$

[5]We use the CPI, not seasonally adjusted, for Toronto (Statistics Canada, Cat. No. 62-001).

where the t-statistics are, again, shown in brackets and ϵ_t is a white noise process. The AR(3) process in (9) can be represented as:

$$u_t = \frac{\epsilon_t}{(1-\rho_1 L-\rho_2 L^2-\rho_3 L^3)} \qquad \textbf{(10)}$$

where ρ_j, j = 1,2,3, are the unknown parameters of the AR(3) process. Substituting (10) into (7) yields:

$$p_t = \beta_0 + \beta_1 D_t + \beta_2 x_t + \beta_3 T_t + \lambda p_{t-1} + \frac{\epsilon_t(1-\lambda L)}{(1-\rho_1 L-\rho_2 L^2-\rho_3 L^3)} \qquad \textbf{(11)}$$

The disturbance term, ϵ_t, of equation (11) has a MA(1) structure, thus the maximum likelihood method was applied to estimate this relationship. Since the estimates from equations (8) and (9) are consistent, these were used as the initial values for the parameters in estimating equation (11).

The estimates for equation (11) are given in Table 1. The D-W value of 1.828 shows no evidence of serial correlation at the 1 percent level of significance. Consequently, the estimated coefficients in Table 1 are both consistent and efficient. Correction of the AR(3) structure of the residuals brings about an appreciable improvement in the explanation of variation in quota values, as shown by the increase in R^2 from 0.67 to 0.88. Using the estimates of equation (11), we constructed one-step-ahead forecasts for quota values and plotted this series of forecasts against actual Ontario quota values in Figure 1. The model appears to track actual Ontario quota values reasonably well.

Table 1

Results of Dynamic Regression Model of the Determination of Ontario Fluid Milk Quota Values
(August 1984 to July 1993)

Parameters	Estimates	t-statistics
β_0	-3.51	-7.00
β_1	-0.06	-3.65
β_2	0.36	5.08
β_3	0.66	8.01
λ	0.94	48.70
ρ_1	1.20	14.04
ρ_2	-0.79	-5.32
ρ_3	0.16	1.38
$R^2 = 0.88$	Degrees of freedom = 95	
RMSE = 0.036	DW = 1.82	

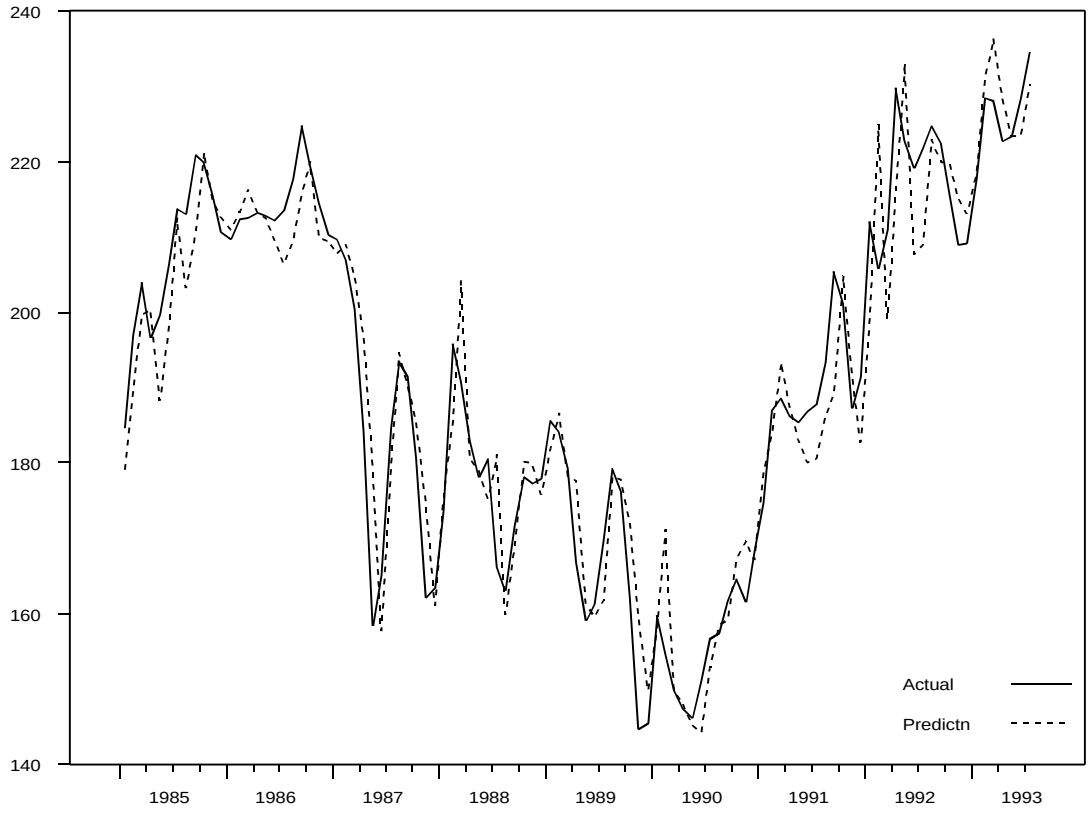
Table 2

Estimation Responses in Quota Value with Respect to One-Percent Changes
in Milk Price and Milk Production Technology

	Milk Prices	Milk Production Technology
Short-run	0.36	0.66
Long-run	6.00	11.00

Calculated from the results reported in Table 1.

Figure 1: Actual and Predicted Quota Values 1985-93



The coefficient on the dummy variable testing for the possibility of pessimism in expectations that may be associated with possible changes in the level of protection afforded the sector due to import controls has a negative sign and is significant at the 1 percent level. It appears that the GATT panel finding that Canada's import quotas for ice-cream and yoghurt were not justified under Article XI of GATT did contribute to pessimism of producers regarding future rents, but this negative impact on quota values was relatively short-lived. The coefficients on gross returns, the technology variable and lagged quota values all exhibit the postulated signs. The estimates are significant at the 1 percent level (applying two-tailed t-tests).

The estimated coefficient of adaptive expectations is 0.94. Thus, dairy farmers revised their expectations in each period by some 6 percent of the discrepancy between the latest observation and the expectation of quota value for that period. The median lag in the full adjustment of quota values, calculated from the coefficient on lagged quota values, is 10.18, indicating that it takes about ten months for 50 percent of the total adjustment in quota values to be completed following a change in milk prices or milk production technology. Some 95 percent of the total adjustment of quota values to a change in either milk prices or milk production technology is achieved in about four years (48.9 months); 99 percent of adjustment in quota values occurs after 75.7 months. Based on the results reported in Table 1, estimates of the short-run and long-run responses of quota values with respect to changes in milk prices and production technology are calculated and presented in Table 2. These results indicate that, other things being equal, a one percent increase in milk prices will lead to a 0.36 percent increase in quota values in the current period and a 6 percent increase in quota values when the adjustment is completed. One percent increase in average herd size would raise quota values by 0.66 percent in the short run and by 11 percent in the long run. It appears that the regulated marketing system for fluid milk has enabled appreciable returns from improvements in milk production technology and administered prices to be appropriated by producers.

Table 3 presents the long run effect of two alternative scenarios of reductions in milk price cuts that involve, respectively, a 15 percent and 36 percent reduction in milk prices phased in over a time-frame of 6 years. We chose to model hypothetical price reductions of this magnitude, since reductions in protection of this order were envisaged as tariff reductions in the Dunkel text of the draft of the Agricultural Agreement tabled by then Director General of

Table 3

Results of an Experiment to Simulate the Impact of Two Different Phased Reductions in Milk Prices on Quota Values

	15% Reduction		36% Reduction	
Time Period	Quota Value	Reduction	Quota Value	Reduction
Based Period:[n]	$ 181.08		$ 181.08	
1995:1	179.45	$1.63	177.17	$ 3.91
1996:1	164.57	16.51	141.88	39.20
1997:1	144.55	36.53	98.32	82.76
1998:1	123.66	57.42	59.03	122.05
1999:1	103.99	77.09	29.21	151.87
2000:1	86.46	94.62	9.49	171.59
2001:1	71.97	109.11	--	--
2002:1	65.08	116.00	--	--
2003:1	61.80	119.28	--	--
2004:1	60.24	120.84	--	--
2005:1	59.49	121.59	--	--

[n] The base-period prices are the average of the first three months of 1994, i.e., 1994:1-3.

GATT, Arthur Dunkel, in December 1991.[6] Using the real quota value in the first quarter of 1994 as a base for the simulation, a 15 percent reduction in milk prices introduced in 6 consecutive years (2.5 percent reduction per annum) would depress the real quota value by $121.59 in the long run, other things being equal. More precisely, if milk prices were cut by 15 percent in six years starting in January 1995, the real quota value would fall from the base value

[6] It should, however, be recognized that the exercise of modelling price reductions of this magnitude considerably overstates the reduction in prices that would be expected to arise from reductions in support or protection by 15% to 36%.

of \$181.08 to \$59.49 by January 2005. Following a 36 percent reduction in milk prices phased in over 6 years (involving a 6 percent reduction in each period), the real quota value would drop to zero by October 2000, ten months after the last of the six consecutive reductions in milk values.[7]

In Figure 2, plots are given of the time path of the adjustment of real quota values in response to a 15 percent reduction in milk prices, phased in at the beginning of six successive years, based on the levels of real quota values in the first quarter of 1994.[8] The lagged response in quota values exhibits an exponential decay.

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[7] The adjustment of quota values to consecutive reductions in milk prices is calculated by:

$$P_\tau = \bar{P}_0 - \Sigma_{s=0}^{5} \bar{P}_s \beta_2 \Sigma_{t=sx12}^{\tau} \lambda^{t-sx12} \dot{X}_s$$

where $\dot{X}_s$ is the percentage change in milk prices introduced at the beginning of year s; β_2 is the short run elasticity of quota values with respect to a change in milk prices; λ is the coefficient of expecation; $\bar{P}_s$ is the real quota value at the beginning of year s when one of the six consecutive annual reductions in milk prices is introduced. $\bar{P}_0$ = \$181.08, the average real quota value of the first quarter of 1994, is used as the initial quota value for this experiment to simulate the cumulative effects of each of two postulated dynamic adjustments. $\bar{P}_s$, s = 1,2,3,4,5, is the quota value at the end of each of the next five 12-monthly periods prior to the introduction of each successive reduction in milk prices in year s. Thus, the base quota price for the second price shock is:

$$\bar{P}_1 = \bar{P}_0(1 - \beta_2 \Sigma_{t=0}^{11} \lambda^t \dot{X}_0)$$

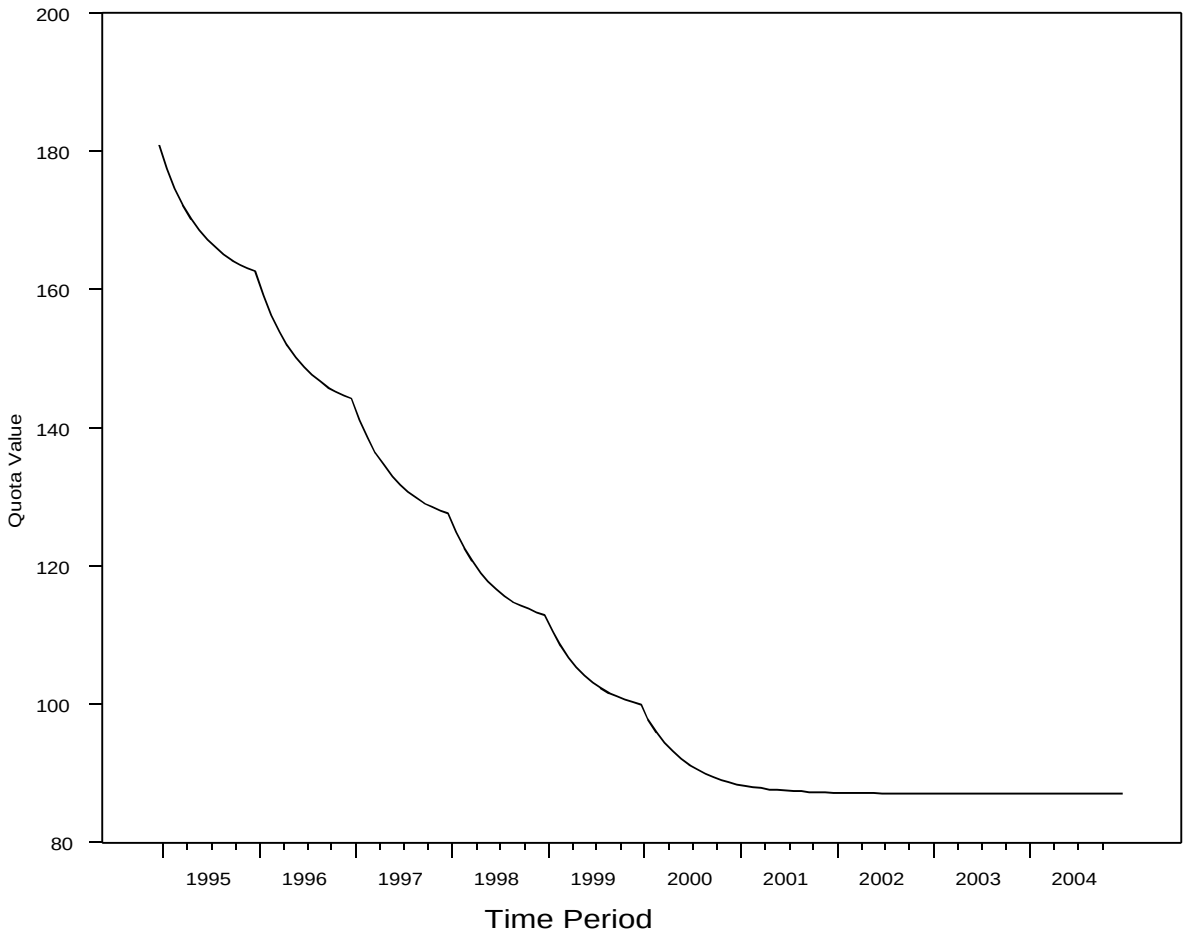
and, for the third shock, the base is:

$$\bar{P}_2 = \bar{P}_0(1 - \beta_2 \Sigma_{t=0}^{23} \lambda^t \dot{X}_0) - \bar{P}_1 \beta_2 \Sigma_{t=12}^{23} \lambda^{t-12} \dot{X}_1$$

and so on.

[8] The cumulative effect of successive smaller reductions of milk prices on quota values, as explained above, results in a less substantial fall in quota values than if the cumulative percentage reduction in milk prices were to be applied as a once and for all reduction.

Figure 2: Impact on Ontario Fluid Milk Quota Values of Phased Reductions in Milk Prices of Fifteen Percent



In the final agreement of the Uruguay round of GATT negotiations, an ostensible cut in import tariffs of 15 percent, the minimum level, was agreed to for Canada's supply-managed commodities, to be phased in over 6 years. However, the posted tariff equivalent rates, scheduled as bound tariffs, are sufficiently high as to prohibit imports (except for specified levels of import access) during the 6 years in question (Veeman 1994). Consequently, reductions in milk prices are not currently envisaged. Even so, the experiment reported above

gives some light on the nature of changes in quota values that might be expected if challenges to the tariffication rates for supply-managed commodities, currently being pursued by the US through the NAFTA panel process, should be successful or if, for other reasons, regulated prices for Ontario milk were to be cut to lower levels, such as the levels that apply in the adjacent market area of the US.

Burt (1986), calculates capitalization rates for US farmland from a similar econometric model, applying a linear homogeneity constraint. We were unable to compute capitalization rates from the estimates of the intercept of the milk quota value model. This is apparently due to the lack of accurate data on net returns to milk quota holding and the need to use milk prices and a technology variable as proxy variables for the net returns from holding milk quotas. Thus estimating equation (11) can be regarded as an approximation rather than as the exact form of the capitalization formula for fluid milk quota values. Specifically, we conjecture that the negative value of the intercept for equation (11) found in this study may reflect a mixture of the capitalization rate, transfer tax, and the effect of milk production costs omitted in the regression. Fuller information on milk production costs is required to separate precisely the values of these effects. Burt (1986) was also unable to calculate capitalization rates for farmland when using unadjusted returns data in analysing land prices. Precise estimation of capitalization rates associated with quotas requires refinement of data on net returns to quota-holding and raises issues of the nature and extent of risks that may be associated with quota-holding, including the risks of policy changes, an issue that is discussed by Barichello (1983), Lermer and Stanbury (1985), Veeman (1987) and Beck et al (1994) but is beyond the scope of the analysis reported in this paper.

Discussion and Conclusions

The results reported here support the economic analysis of supply-management marketing quota as a factor of production in the production process of regulated firms. The application of the capital asset pricing model to analyse the effects of major economic influences provides results that are consistent with the economic theory of profit-motivated firms. As we hypothesized, increases in price levels of the regulated product, milk, tend to lead to increases in quota values. Given levels of output prices, improvements in technology also lead to increases in quota values in a manner that is consistent with the postulates of economic theory regarding the rational use of inputs by profit motivated firms. It appears that quota may be usefully analysed as a production input, and the capital asset pricing model may be appropriate for this purpose. These features reflect characteristics of fluid milk quota which is administered as a divisible capital asset.

The results are of interest in giving some indications of the quantitative relationship associating administered price levels and the levels of quota values for fluid milk. Changes in producer-level prices of milk by one percent can be expected to change quota values by 0.36 percent in the current period and by 6 percent in the longer-term. This relationship was explored further in our experiment to assess the effect of phased reductions of milk prices, introduced in equal increments over a 6-year time horizon, amounting to total reductions of 15 and 36 percent. Reductions of these magnitudes were envisaged in the recent GATT negotiations but will not actually apply due to the prohibitive levels of tariff rates that were negotiated for imports in excess of specified import levels during that round. Since quota values represent a significant

capital asset for Canadian dairy farmers and also constitute a relatively large component of their fixed costs, necessitating appreciable financing costs for entrants, knowledge of the general order of this relationship may be of considerable interest to producers, policy analysts and policy makers.

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