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CENTER DISCUSSION PAPER NO. 454

ANALYZING AN AGRICULTURAL MARKETING QUOTA

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## ANALYZING AN AGRICULTURAL MARKETING QUOTA\*

Richard Barichello

### Introduction

Marketing quotas have emerged during the decade of the seventies as a major instrument of Canadian agricultural policy. This is partly due to the increased formation of farm marketing boards<sup>1</sup> in general, but more importantly, to the increased number of boards which have acquired the power to restrict output or manage aggregate supply. The increased willingness of the government to grant these powers (and their attendant instrument of control, marketing quotas) reflects its desire to pay farmers higher prices yet avoid incurring costly and embarrassing surpluses of farm products. However, one effect of these supply restrictions combined with regulated prices is the difficulty in observing and estimating the actual supply curve. This leads to difficulty in determining the economic effects of the regulation, such as how resource allocation is being altered and how much income is being transferred from consumers to producers.

This problem exists more widely than in the supply managed (i.e., dairy and poultry) sectors of Canadian agriculture. It arises whenever aggregate market supply is restricted by a quota and not determined by individual producer behavior, effectively preventing the industry supply price from being observed at the margin of production. Some examples include the Israeli dairy and poultry industries, the English hop and potato industries and the

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Due to its gradual evolution, this paper has benefitted from the comments of many people, including workshop participants at Maryland, Minnesota, U.B.C. and Yale, but I would particularly like to thank Robert Allen, Jonathan Eaton, Daniel Gordon, John Graham, Herbert Grubel, Michel Patry, Anthony Scott and John Strauss. Responsibility for remaining errors rests, of course, with me. The Social Sciences and Humanities Research Council of Canada provided partial financial support for this research which is gratefully acknowledged.

Australian dairy industry.<sup>2</sup> Although marketing boards are prevalent in some The marketing boards which provide the basis for this analysis can be described as producer cartels where a monopoly solution may be sought and where the proceeds of the monopoly tax goes to holders of the quota (e.g., the producers).

Unlike the import quotas so commonly found in parts of the foreign trade sector these agricultural quotas are held by a large number of firms and they are often traded in markets with observable prices. It is the objective of this paper to show that when this quota market data is combined with institutional details such as pricing and quota allocation rules much can often be disclosed about aggregate supply prices and the economic effects of the regulation.

It should be made clear at the outset, that we are concerned with marketing quotas which are defined in terms of production, and which can usually be purchased or somehow obtained in an incremental fashion. The crux of the matter is that the purchase or sale of this asset is a marginal decision, determined by the usual criteria at the margin of production. This is in contrast to a license restriction, where entry to the industry is conditional upon the acquisition of a license, yet output is not restricted by the license. The distinction is important for the exercise undertaken in this paper, because the quota will attract only marginal rents whereas the license will attract inframarginal rents.

Although it is not new to use quota stock prices to infer output supply prices, the steps incorporated here represent an increase in complexity over the procedure usually followed. The standard treatment in analyzing quota prices is to multiply the stock value by a current nominal interest rate to obtain the annual rent. In fact, the research reported here has been largely

motivated by serious shortcomings of this procedure observed in applying it to the British Columbia dairy industry. For example, the standard treatment provided no explanation for the rapid increase in B.C. milk quota values in the 1975-76 period (see Appendix 1). In several jurisdictions, notably both the B.C. egg and milk industries, it is difficult to rationally explain or comprehend currently high levels of quota values using the standard model. Finally, in talking to individual farmers and agricultural bankers, references to capital gains from the quota and a brief "payback period" are commonly made, yet there is no systematic consideration of these factors in the standard model.

The model reported in this paper represents an attempt to analyze quotas more realistically, drawing on well developed procedures for valuing other financial assets such as common stocks. Although attention is given to the potentially important factor of quota returns additional to current production rents (e.g., capital gains), it is the risk associated with quotas that is particularly important. We suggest that one part of this risk is the possibility that government policy will change, reducing the regulation-created rents of the quota system, and that this is an important component of the unusually large apparent discount rates (earnings/price ratios) which are observed. An application of these procedures is made to the B.C. dairy industry with the objective of more accurately estimating the supply price of milk.

### Analysis

Standard treatments of this quota (Arcus, Grubel and Schwindt, Veeman) usually feature two steps. The industry equilibrium is described by Fig. 1, with industry output restricted from an unregulated  $Q_e$  to the restricted level  $\bar{Q}$ .<sup>3</sup> This creates a wedge between the demand price  $P$  and the supply

price  $C$ , measured by the rent,  $R$ . Secondly, the quota is assumed to take on a value equal to the discounted stream of these rents. When this stream occurs in perpetuity, the price of quota  $P_Q$  is simply equal to  $R/r$  where  $r$  is the rate of interest.

Unfortunately, few investments or capital assets are accurately described so simply and marketing quotas are no exception. In the analysis of

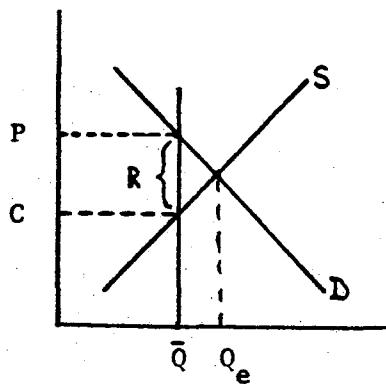


Figure 1

common stock prices, their determinants are specified in a valuation model, (e.g., Elton and Gruber, 1981, p. 397), the most theoretically attractive and widely used of which is the net present value or discounted cash flow model. Accordingly, financial assets such as stocks are generally valued and, with competition, priced as the present value of the stream of net returns accruing to ownership of that asset and expressed in the familiar net present value equation,

$$P_Q = \sum_{i=0}^N \frac{F_i}{(1+r_i)^i}$$

(1)

where  $P_Q$  = price of a unit of asset

$F_i$  = net return or benefit from one unit of the asset in period  $i$

$r_i$  = interest rate in period  $i$

$N$  = expected life of the asset.

Although general, this equation makes onerous informational demands for an asset of any reasonable life. This is true for the stock analyst, the farmer contemplating quota purchase or sale and the economist trying to analyze the industry. Some simplification is necessary, and one possible response is to assume a constant level over time of both the discount rate and the net returns. In terms of the farm investor this is equivalent to using an expected average long run discount rate and net return in his valuation of the quota, a reasonable formulation given the uncertainties facing a prospective quota market participant. The value equation then becomes

$$P_Q = \sum_{i=0}^N \frac{F}{(1+r)^i} \quad (2)$$

This simplification is very helpful for analysis of the asset because now the quota investment can be treated as an annuity. When  $F_i = F$  and  $r_i = r$ , the net present value equation can be solved for one of  $P_Q$ ,  $F$ ,  $r$ , or  $N$  when the other three are known. The farmer in his quota purchase decision essentially solves for  $P_Q$ , given his known or calculated values for the other three, the familiar stock valuation problem. However, the economist wishing to determine the economic effects of this regulation faces a different problem. Because the quota asset often trades as a stock but is not usually rented, the market price of quota ( $P_Q$ ) can be observed and the rental price normally cannot. After the determination of  $N$  and  $r$ , however, one can calculate the net returns,  $F$ , and subsequently the supply price,  $C$ . This describes the general strategy of the paper.

What we obtain from this procedure is an estimate of a point on the industry supply curve. More specifically, it is the supply price of the subset of farmers who are trading quota, the relevant aggregate margin of production. This method does not provide the slope or elasticity of the supply curve.

Because that information must be provided from other methods and data we cannot determine the unregulated industry equilibrium solely from analyzing quota price data. We can also interpret this supply price estimate as being drawn from the long run supply curve. This is suggested by the nature of the quota purchase or sale decision as a capital decision, and this interpretation is strengthened by the five-year prohibition on the resale of quota observed in the British Columbia dairy industry. Finally, although it may be attractive to assume that this supply price embodies the usual profit-maximizing conditions, the only condition we actually assume is that farmers maximize profit with respect to their quota purchase or sale decision, equalizing the demand price for quota across farms (footnotes 9 and 10 elaborate).

Before empirically applying such a simplified present value model as (2) directly to agricultural quotas, two issues remain to be addressed. First, we must determine whether the marginal rents,  $R$  of Figure 1, exhaust the flow returns,  $F$ , which determine the quota stock price. Secondly, following casual observations that these quotas are "risky" assets we must consider whether this risk is appropriately captured in the discount rate and how it can be measured.

#### Returns to the Quota

One feature of agricultural quotas is the likelihood that current production rents do not provide a complete account of the expected annual net returns which determine the stock price. Just as the ownership of a common stock may yield both dividends and capital gains, so may the ownership of a quota. In the former case, when a firm does not distribute all earnings as dividends, future dividends, hence share prices, can be expected to grow at some rate,  $g$ , from the reinvestment of retained earnings. As this becomes expected, capitalization into the stock value occurs.



In the case of agricultural quotas, production rents may also be expected to grow over time, even in real terms. This is due to the likelihood of continued technical change in the production of the commodity combined with the particular pricing methods which have become institutionalized. Pricing is often determined by a cost-based formula which fails to capture fully the technical improvements being adopted at the economic margin of production and which is revised infrequently enough to fail to capture most input substitution. The net result of these formulae is an upward-biased measure and growth rate of costs, hence prices which grow to systematically increase production rents as long as these conditions continue. In markets where they are observed and expected to continue, quotas will continue to increase in value and this expectation of capital gains will be capitalized. One method of incorporating these expectations is to reduce the discount rate by the expected growth rate,  $g$ , modifying the value equation to (3),

$$P_Q = \sum_{i=0}^N \frac{F}{(1+r-g)^i}$$

where  $g$  = the expected rate of growth in the price of quota or the production rent. Only if we ignore the existence of capital gains will this analysis yield the biased results suggested in Schmitz (1983).

Our interpretation of capital gains from quota ownership must be broad enough to encompass more than price appreciation of the asset. It is often necessary to add new quota to the system to accommodate demand growth and this is sometimes accomplished, at least in part, by giving new quantity allocations to existing holders of the quota. Because demand growth precedes this increased supply of quota, dilution of stock value does not occur, and as long as individual holders of the stock are given at least some of the new issue, it can be handled analytically as a capital gain. Of critical importance for the analysis is the usual rule by which new quota is allocated to existing holders.

A proportional allocation, expected to add one percent per annum to a farmer's quantity of quota, is equivalent to an additional expected annual capital gain of one percent, and this consideration can be incorporated in equation (3) by adjusting the value of  $g$ .<sup>4</sup>

This discussion of net returns is complete only if current production rents and capital gains exhaust the benefits of quota ownership. However there would appear to be another benefit included in  $F$  which accrues to purchasers of quota and is due to the tax system. Those who purchase quota may deduct from income an allowance for depreciation of the quota (essentially a capital cost allowance), even though quota does not depreciate in the usual sense and in fact typically appreciates in value. This tax advantage does not last forever, as it is "recaptured" in capital gains taxation upon eventual sale. It is in essence an interest-free loan which grows as depreciation is claimed and continues until the quota is sold.

The present value of this tax advantage per dollar of purchased quota, including both the benefits from tax deductions during quota ownership and the cost of paying back those deductions upon eventual sale (recapture), is given by  $TS$  (tax savings) in equation (4)

$$TS = \frac{f\theta}{f+\rho} \left[ 1 - \frac{1-f}{1+\rho} \right]^n - \frac{\theta}{(1-\rho)^n} [1-(1-f)^n] \quad (4)$$

where:  $f$  = allowed rate of depreciation

$\theta$  = effective marginal tax rate

$\rho$  = nominal discount rate of quota purchaser

$n$  = expected holding period

This present value of the tax advantage from quota ownership represents the extra amount a profit-maximizing purchaser would be willing to pay for each dollar of quota bought. Rather than translate this into an artificially constant annual flow as part of  $F$  (equation 3) it can be used directly to deflate

the observed market price (which already includes TS). Equation (3) can then be written with  $R$ , the production rent, substituted for  $F$  and with the market price,  $P_Q$ , having been appropriately adjusted.

Beneficiaries of supply control regimes often suggest that additional benefits are conferred on quota holders. A number of these benefits may in fact flow from the regulatory regime, and taken collectively, they can form the basis for some value placed by producers on belonging to the regulatory regime or cartel. However, one relevant question is whether these benefits are marginal or inframarginal in nature. The producer purchasing incremental quota, who is already a member of the cartel, enjoying the stability and predictability of price, a certain market for his product, and so forth, will not pay more for those "environmental" benefits which he receives regardless of whether he buys quota or not. The value of belonging to the cartel is the sum of all inframarginal rents enjoyed by the marginal producer relative to the rents he would enjoy in an unregulated regime. This would enter his demand price for a license, as discussed earlier. Alternatively, in a situation with no licensing as such, it would determine how many resources a producer would be willing to spend to lobby the government to preserve the regulatory regime. It would have no effect on his demand for incremental quota, where only marginal costs and benefits apply.<sup>5</sup>

However, this is not to deny that some features of the marketing board regime may have shifted the industry supply curve. It is possible that the board causes producer prices to be more stable and this may have effectively lowered farm costs, shifting the industry supply curve to the right.<sup>6</sup> In this case, these new supply conditions form the basis for farm decision-making and the supply price revealed by analyzing quota prices is along the "new"

supply curve. Being unable with current data to estimate the "old" supply curve we can identify neither the sign nor the size of the net effect of the board. Even if these effects were measured, they should not be added to the quota's net returns because they are already implicit in observed quota prices.

#### The Discount Rate and Quota Risk

Choosing an appropriate interest rate to discount future returns necessarily involves considering the risk associated with the asset. This means determining the level of returns additional to the risk-free return (i.e., the "risk premium") which is necessary to compensate holders of this asset for the risk expected from it. The risk of an asset is usually measured by the probable dispersion (variance) of its future returns and decomposed into systematic (market-related) and unsystematic (firm-specific) portions. With perfect capital markets, the market valuation of this risk depends on the extent of the systematic risk (the asset's "B" value), or on the variance and covariances of its returns with those of alternative assets.

There is no question that the outcomes associated with agricultural quotas are uncertain. Net returns vary, sometimes substantially, for all the reasons one might expect in an agricultural enterprise. In the dairy industry, for example, net returns fluctuate with weather (e.g., crop and milk yield), biological factors (e.g., herd health, reproductive success and milk yield), input and output price changes and newly available inputs (technology). In turn, these sources of variance in expected returns can be classified into systematic and unsystematic risk components, just as can be done with the variance of a stock's returns.

Recent experience in the Canadian dairy industry suggests that at least part of the variance in net returns in that industry is systematic. The

increase in real interest rates in the early 1980's affected this industry like many others: reductions in net cash flow, some bankruptcies and a notable fall in real quota prices (Appendix 1). The ensuing recession in 1982-1983 led to unexpected reductions in scheduled industrial milk price increases. Demand growth for many dairy products also fell over this period, resulting in industrial milk quota reductions at the farm level.

Bearing in mind that a unit of quota is like a share in the stock of the dairy industry, unsystematic risk arises from farm and industry-specific sources. These can include most of the factors listed above, and arguably unsystematic risk is the larger component of the total variance in expected returns. This risk is diversifiable and with well-functioning capital markets and unrestricted quota trade, no risk premium from this source should be demanded by the market, hence included in the discount rate. Lermer and Stanbury (1983) make this argument and conduct their empirical work accordingly.

In practice, this position may be too strong because there appear to be some impediments to complete diversification. First, there are a variety of quota transfer restrictions which vary by jurisdiction and do appear to effectively reduce transactions. This exacerbates the problem of "thin" markets which already affect a number of jurisdictions (e.g., the poultry industry in Western Canada). Second, the size of typical asset holdings in some quota-controlled industries (e.g., the B.C. dairy industry) are well in excess of a million dollars. The absolute size of a diversified asset portfolio may force some farms to remain incompletely diversified unless they issue shares, at least given present capital markets. And widely-held (non-family) share issue is often prevented by board regulations.

In sum, even though there would appear to be less than average systematic risk in holding these quotas, hence a small risk premium, there may be some market premium for bearing unsystematic risk due to incomplete diversification. Although we do not presently have the data to measure it, we conclude that the appropriate discount rate should incorporate some modest premium for this familiar (variance, covariance-based) type of risk.

However, there is a less common feature of these agricultural quotas which indeed contributes much risk and this relates to the regulated structure of the industry. Because the size of the net returns and the existence of the quota itself are conditional upon government-granted powers, regulations and policies of the industry, there is some probability,  $\lambda$ , that the government will change or even eliminate those rules and policies. In the extreme these possible changes will eliminate the total value of the asset and, at the very least, the future returns and value of the asset would be reduced.

This type of risk might be described as "policy risk". Its magnitude is based upon the uncertain predictions of future government policy change or regulatory board decisions, not on the more familiar basis of an historical time series of returns variability. This risk, that the return some period might with probability  $\lambda$  be negative and as large as the asset price itself, affects the expected value of the asset instead of the variance of its future returns, the risk incorporated in the discount rate. As such, it is analogous to the default risk faced by international lenders, notably commercial banks lending to foreign governments as analyzed recently by Eaton and Gersovitz (1981) and Kletzer (1984). Just as a poor country may default on the repayment of its international borrowings with some probability, lowering the expected value of the lender's portfolio, so may a government change its agricultural

policy with some probability, making the quota purchaser's investment worthless in that situation and reducing its expected value in any case.<sup>7</sup>

This situation can be modelled most simply by making this default risk discrete — either the quota regime is scrapped causing the loss of the quota value itself, or it is maintained, with the flow of benefits as described in (3). This adds a default term to our value equation, and with each situation weighted by its respective probability we arrive at (5), the expected value of the quota,

$$P_Q = (1 - \lambda)F \sum_{i=0}^N \frac{1}{(1 + r-g)^i} + \lambda(-P_Q) \sum_{i=0}^N \frac{1}{(1 + r-g)^i} \quad (5)$$

where  $\lambda$  is the probability that the quota scheme will be scrapped, causing rents,  $R$ , to fall to zero.<sup>8</sup>

Nothing has yet been mentioned of the remaining variable in this expected value equation, the time horizon of the investment,  $N$ . How we interpret and treat this variable is not independent of how we handle default risk. In the discussion above, the quota's risk is broken into two components. Systematic risk is incorporated via some risk premium in the discount rate, and default risk is included as a probability  $\lambda$  affecting the quota's expected value. The expected life of the quota was implicitly assumed to be a very large number. For reasons of simplicity and because we have no clear information to the contrary, we proceed assuming an asset life of infinity.

Alternatively, one could express the default risk not by this parameter but by shortening the expected asset life (planning horizon) to some finite number of years. This procedure is artificial in one sense because an increase

in perceived default risk will appear as if the planning horizon was shortened despite no actual change in expected asset life. But it does have the intuitive appeal of corresponding to the notion of a "payback period" and for our purpose of estimating R from values of  $P_Q$  these two alternative depictions of default risk are almost equivalent. In the empirical part of the paper, calculations of this payback period will also be presented.

With an infinite time horizon, equation (5) can be simplified, and collecting terms it becomes (6)

$$P_Q = \frac{(1 - \lambda) F}{r + \lambda - g} \quad (6)$$

Applying this model of quota pricing to determine industry supply price in a competitive environment, we can incorporate the tax benefits of quota ownership as discussed earlier by deflating the observed quota price by the present value of the tax advantage. If we denote this adjusted quota price as  $P^*_Q$ , we can express equation (6) directly in terms of marginal production rents R. The supply price, C, is the output price less the production rent, and R is given in (7) by rearranging (6).

$$R = \left( \frac{r + \lambda - g}{1 - \lambda} \right) P^*_Q \quad (7)$$

If we let  $r^* = \frac{r + \lambda - g}{1 - \lambda}$ , our operational equation  $R = r^* P^*_Q$  is



similar to the standard procedure ( $R = iP_Q$ ) initially criticized. The difference is in the structure and empirical choice involved in the right hand side variables. It would be fortuitous if a nominal market interest rate was the appropriate value for  $r^*$ .

To illustrate the application of these conceptual tools to an empirical situation, we will examine fluid milk quotas in the British Columbia dairy industry in 1980 to determine the supply price of milk at that time. The advantages of this particular empirical application are that the B.C. fluid quota market includes most of the features noted above, we are able to measure the default risk of the quota, conditional upon discount rates chosen, and this market features the highest price of fluid quota in Canada.

#### Empirical Application: The B.C. Milk Industry

Before proceeding with quantifying equation (5), a few details on the institutional structure of the B.C. dairy industry may be in order. As with most dairy industries, there is a two part market for milk, a fluid or fresh milk ("Class I") market and a manufactured or industrial milk market, producing cheese, butter, ice cream and skim milk powder. Virtually all producers ship to both markets and health or quality standards are likewise the same. Farm prices paid for fluid milk are formula determined, and the seven component indices reflect movement in general inflation, wages and salaries, and a selection of milk inputs. The formula is constructed as a ten year moving average and consequently the milk price is reasonably straightforward to predict. Because the fluid price is attractive, access to this market is restricted by fluid milk quotas. Individuals face relatively few barriers to the transfer of quota between farms, subject to certain minimum levels on the size of the transaction and a five year holding period before resale. Consequently, an

active market exists, including a number of quota brokers.

The industrial (manufacturing) milk price is also determined by a formula, this time at the federal level, and although this price is considerably lower than the B.C. fluid price, it is still sufficiently attractive to B.C. milk producers to require additional quota restrictions to keep total B.C. production of industrial milk within the province's allocated quota. This quota, called market sharing quota or MSQ, is distinct from fluid quota (although not unrelated, as will be seen later). These regulations put all of a producer's output under the constraint of a quota although this was not always so. B.C. only entered the national milk supply management scheme, under which authority for MSQ exists, in 1973 and the provincial MSQ allocation became a binding constraint only in 1975. This detail is important, as it later provides us with the means of calculating the discount rate. Unlike fluid quota in B.C. or MSQ in Alberta, Ontario and Quebec, MSQ in B.C. is not traded but allocated administratively on the basis of a variety of criteria.

One of these criteria is relevant to the demand for fluid quota because since 1976 some MSQ has been provided free of charge to certain fluid quota purchasers. To ensure a margin of flexibility to dairymen in meeting their fluid quota, given the inevitable production fluctuations due to weather, herd health, or other biological factors, the Board has usually promised fluid quota purchasers whatever additional MSQ is necessary (if any) to cover milk production of 10 percent above their new fluid quota holding. Like the tax provision noted earlier, this rule provides an additional benefit to fluid quota buyers, increasing the value of F. Also, this benefit will be most valuable to those producers who qualify for the full 10 percent MSQ allocation (and who can be expected to dominate the market). If we assume that MSQ is as valuable as fluid

quota (likely an upward biased estimate of MSQ value because the corresponding milk price is only seventy percent of the fluid milk price), then this benefit is worth one-tenth of the value of fluid quota. If this does overstate the value of the benefit we will understate the production rent and overstate the supply price by an amount less than 10 percent.

Now we turn to determining the values of  $P^*_Q$ ,  $g$ ,  $r$  and  $\lambda$  for equation (7). Both  $P_Q$  and  $g$  can be determined with quota price data generated in the fluid quota market for the Lower Fraser Valley region, the major dairy production region of B.C. As data from this market are the empirical backbone of the paper some discussion of their nature and accuracy may be useful. Subject to minimum transaction size and resale restrictions, fluid quota transfers relatively freely among producers (usually through the intermediary of a broker). The regulatory body, the Milk Board, neither taxes nor otherwise controls the terms of the transaction. The data we use are gross of brokerage fees and collected ultimately from the brokers themselves. Since 1978 the provincial Ministry of Agriculture and Food has collected these data on a monthly basis, published with a series of other input prices, while those for 1971-1977 were collected directly by the author and Grubel and Schwindt (1977). Annual averages and rates of change are found in Appendix 1. The number of traders and transactions indicate that prices are competitively determined, and information about these prices is possessed widely enough to result in a low dispersion of transaction prices each month. 9,10

In conclusion, these data appear to be reasonably clean and appropriate for our purpose. Any periodic noise in monthly figures will be minimized by our use of annual averages. The average quota price observed in 1980 is \$155 per pound of daily production, or \$96.44 per annual hectolitre, corresponding to our variable  $P_Q$ .

This value must now be adjusted to  $P^*Q$  in order to take into account the two benefits which distinguish F from R. The first adjustment is necessary to account for the capitalization of tax benefits accruing to quota purchasers. Empirical estimates of the present value of this tax saving (equation 4) are between 1.75 and 1.78 percent of the purchase price (Barichello and Glenday, 1983). When the stock price is deflated by the mean estimate it becomes \$94.77.

A second adjustment is needed to account for the capitalization of the benefit of free MSQ allocation to quota buyers. Valuing this benefit at 10 percent of the value of fluid quota as argued above, observed quota prices should be deflated by 1.1, yielding an adjusted quota stock price of \$86.15. This price corresponds to  $P^*Q$  of equation (7) and is the average market price purged of both tax and MSQ benefits to reflect only production rents, R.

The value of  $g$ , the expected rate of capital gain, could be determined from the time path of net returns, but because it is unavailable for this period we rely upon the time series of quota prices. However, the striking characteristic of this price series is its erratic nature, especially when seen in real terms. The year to year change in real price has ranged from -17 to +49 percent within the 1971 to 1983 period, all of this in an industry with a stable pricing formula and sustained but gradual improvements in technology. The negative real price changes have been usually associated with rapid increases in an input price, such as grain prices (1973) or interest rates (1981-82), and the most dramatic increases in real price occurred with the initial (1975) imposition of and subsequent (1978, 1983) cutbacks in MSQ.

This price change series does pose a challenge for the formation of expectations of future capital gains. Because we have no observations on the actual expectations process of market participants, we assume it displays the

following characteristics. First, with this history of unanticipated events and large resulting quota price response in both directions, producers are assumed to place a small weight on any one year's experience. This is equivalent to considering a long series of price changes to keep small the impact of any one year's new price change information. Secondly, because recent price changes do little to depreciate the value of older price change information, we assume that all have some relevance and that the weight given to each observation falls modestly from new to older observations. Finally, if some event is considered sufficiently rare or unique, it may receive a particularly low weight in the expectation. It may generally be difficult to define a unique event, but one such example would seem to be clear in this time series.

One method of incorporating these considerations in a systematic and straightforward manner is to use geometrically declining weights for the nine years of available price change data (1972 to 1980), beginning with the most recent (1980) observation. The expected value of  $g$  is then approximated from this series as

$$g = \frac{\sum_{i=1}^9 g_i k^i}{\sum_{i=1}^9 k^i}$$

with  $i = 1$  representing 1980, summing back in time to 1972. To keep the time profile of weights ( $k^i$ ) relatively flat we choose  $k = 0.95$ . When surveying the 1971-1980 period, one event stands out as a unique occurrence for the B.C. milk market, the initial introduction of the industrial milk quota (MSQ). Although this federal program, including quotas, was introduced earlier, MSQ became a binding constraint on B.C. milk producers only during 1975. It forced many producers to reduce output or purchase fluid quota, resulting in a dramatic jump in fluid quota prices which industry participants have subsequently viewed as a one-time event. Therefore, we have reduced the weight applied to this 1975 observation to one-half of what it otherwise would be.

When applied to the data of Appendix I, these procedures give for 1980 a long run expected rate of real capital gain of 8.0 percent. With a price series as variable as this, some of the different possible expectations models can produce quite different values for  $g$ . In fact, with this pattern of prices these differences are likely to be found across individual producers as well. We have opted for a systematic and simple model instead of a more ad hoc procedure which incorporates much additional judgmental information.<sup>11</sup> Nevertheless, the possibility of error here in estimating  $g$  is clear, and sensitivity tests will be undertaken.

Throughout the history of this marketing board regime, there have been increases in aggregate quota, system-wide, in response to demand growth, some of which has been allocated without charge to existing producers. Allocation is proportional to milk production in excess of one's fluid quota, essentially one's industrial milk production. Although new allocations are not made with explicit reference to fluid quota holdings, the close measured relation between fluid quota milk and excess milk production (consistent with excess production being chosen as some fraction of fluid quota production) means that larger fluid quota holdings will typically attract larger new quota allocations. Data from 1974 to 1977 on new quota added to the system, adjusted for allocations to existing producers, and weighted with geometrically declining weights as described above, gives an expected percentage increase in the quantity of fluid quota of 1.25 percent. When added to the expected real price appreciation of 8 percent we arrive at  $g = 0.0925$  for the expected rate of capital gain.

#### Measuring the Discount Rate

There remains the task of determining  $r$  and  $\lambda$ , measured in real terms to be consistent with  $g$ . We are able to do this by considering the period prior to the effective imposition of MSQ, when production at the margin was

uncontrolled and from which we can observe both rents and quota prices. This allows calculation of  $r^*$ , the inverse of the price-earning ratio, but we do not have enough information to identify both  $r$  and  $\lambda$ . As a result, we will assume a value of  $r$  and calculate the implied probability of default. To choose a value of  $r$ , we begin with Jenkin's estimate of the private real cost of capital in Canada, 6 percent, the opportunity return on capital of all risks facing farmers, averaged across sectors and over the mid-1960's to mid-1970's decade.<sup>12</sup> However, on the basis of our earlier discussion of systematic quota risk, the possibility of incompletely diversified unsystematic risk, and the evidence of apparently fluctuating net returns shown in Appendix 1, we choose a value larger than this average, namely 8 percent.

Our observations on  $r^*$ , the earnings-price ratio, are possible due to fortuitous changes in policies and institutional rules during this period. Prior to B.C.'s entry into the federal market sharing program (late 1973), there was no constraint on the production of industrial milk, or more specifically to the dairy producer, no limit on his production in excess of his fluid quota ("excess milk"). With a two price system and a quota on fluid milk, the industry could be described with Figure 2, deleting for now any reference to the demand side.

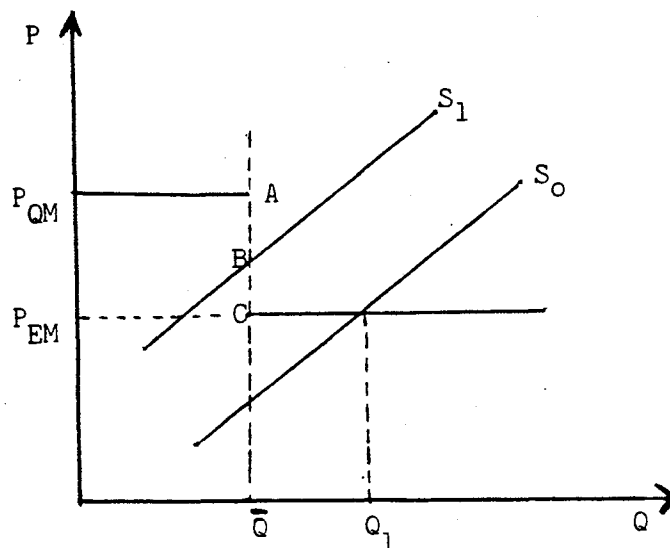


Figure 2

The price of fluid quota milk,  $P_{QM}$ , is exogenously determined by the pricing formula of the Milk Board, the fluid quota level is noted by  $\bar{Q}$ , and all milk produced in excess of  $\bar{Q}$  receives the excess milk price,  $P_{EM}$ , the result of exogenous federal government support prices for industrial milk products. With supply curve  $S_0$ , production occurs at level  $Q_1$ , of which  $\bar{Q}$  is fluid milk and  $(Q_1 - \bar{Q})$  is excess milk. In this situation, the current production rent  $R$  is no longer the unobservable  $P-C$  of Figure 1.  $R$  is still price less marginal cost (supply price) but this is now the observable quota milk - excess milk price differential,  $AC$  in Figure 2.

If, however, the supply curve is described by  $S_1$ ,  $(P_{QM} - P_{EM})$  will overstate the rent  $R$ . Under these circumstances the quota rent will be  $AB < AC$  and we are once again left with an unobservable magnitude for  $R$ . To identify  $R$  we must be able to distinguish empirically those periods when the supply curve is characterized by  $S_0$  and those by  $S_1$ . Over the longer term (say, year to year) if  $S_0$  applies, at output level  $\bar{Q}$  the price of excess milk exceeds its supply price. Production would be expanded and we would expect to find a significant volume of excess milk,  $Q_1 - \bar{Q}$ .

The level of excess production which could be termed "significant" is difficult to establish, if only because the supply curve is likely to be shifting back and forth over time with changes in input prices and climatic factors. In addition there is a complication from fluid quota allocation rules which penalize a producer for producing less milk than his quota allotment for specified periods during two consecutive years. Because the penalty is a loss of fluid quota, stochastic influences on production give producers



an incentive to maintain a certain margin of production above quota requirements. The allocation of MSQ is instructive in determining this margin. To provide this safety in meeting fluid quota requirements, quota purchasers are allocated enough MSQ to cover excess production of 10% above their fluid quota.

Over the 1971 to 1975 period, excess production averaged 29% of the quantity of quota milk produced, ranging by years from 26 to 30 percent. Even if we allow for twice the 10% insurance margin considered appropriate by the MSQ allocation policy, we still find that actual excess production is above this higher margin. Given the stability of milk production, a margin of thirty percent of production as insurance to maintain fluid quota levels is both excessive and highly unlikely. Excess milk prices were high enough relative to the supply curve to encourage a significant production of milk over and above fluid quota levels. Therefore, it seems clear that on average the supply curve from 1971 to 1975 can be depicted by  $S_0$  in Fig. 2.

For shorter periods than a year, before any substantial decrease in production would become widespread, the supply curve could shift to an  $S_1$  position. Hard evidence for this is not available, but any large price increase in one or more important inputs suggests the possibility. Over the 1971-75 period, the large increases in real prices of dairy feed (+48%) and hay (+52%) which occurred in 1973 provide one such example. These numbers, along with casual evidence from the industry of a serious cost-price squeeze, make it seem very likely that the first half of 1973 featured a supply curve in the position of  $S_1$ . Later evidence supports this contention, and therefore we are unable to use the observations for the first two quarters of 1973.

Milk market conditions in B.C. changed substantially during 1975. Despite the entry of B.C. into the MSQ program in October 1973, the provincial industrial milk quota allotment (MSQ) did not represent a binding constraint to the province or individual producers until spring, 1975. At that time the large milk production growth induced by the earlier provincial subsidies (the Farm Income Assurance program discussed above) overcame the previously unimportant MSQ allotment and an increasing number of producers became constrained by this second quota. Any production in excess of this MSQ would incur a penalty, offsetting the excess milk price, and this penalty increased until by 1976, the effective price for over-quota production was almost zero. During 1975, the marginal price facing producers varied by farm depending upon whether the producer was making full use of his MSQ. By the second quarter of 1976, virtually all farmers were so constrained and some measure of equilibrium was reestablished. The industry by then was clearly described by supply curve  $S_1$ , and the rapid growth in fluid quota prices from the second quarter of 1975 to the second quarter of 1976 reflect the adjustment to this new situation. This 1975-76 period is relevant for us because it suggests that supply curve  $S_0$  is descriptive of the B.C. dairy industry only to the first quarter of 1975. Thereafter, from 1976 to date the supply curve is better described by  $S_1$ . MSQ production is effectively inframarginal and its price has no effect on quota values or industry equilibrium.

Because we have both quota prices (adjusted) and production rents for this 1971-1975 period when  $S_0$  was descriptive of the supply curve, we can calculate  $r^*$ . It is worth recalling that this equation for  $r^*$  assumes that subject to a growth rate,  $g$ , expected returns are constant in real terms over

time at the level of current production rents. With some fifteen years of data on these net returns (the milk price differential) this assumption can be examined. First, real fluid milk prices have been kept approximately constant by formula, while real excess milk prices have tended to fall slightly from the late 1950's to the early 1970's. Aside from indicating the growth rate  $g$  of net returns, the data show that there was year to year variability in their level. Almost yearly, the real returns alternated between generally small increases and decreases, mostly the result of discontinuous changes in nominal price levels and variations in inflation. The 1970's data show attenuation of these changes, and provide general support for the assumption above, given our attention to the 1971-1975 period.

But the variability of the data do alert us to the possibility that in some periods, say quarters, current conditions may have been seen to be unusual, such as from an unexpected policy or input cost change. Observations which represent such periods are not likely to form the basis for expected future returns and will be of questionable value to our sample. On this basis, three observations are suspect for our purposes of estimating longer term default probabilities.<sup>13</sup>

To complete our calculation of  $\lambda$  from the equation  $\lambda = (r^* - r + g) / (1 + r^*)$  we first assume that  $r = 0.08$ . To determine expected capital gains,  $g$ , over this early 1970's period we have drawn on the same guiding principles elaborated earlier. However, because we have only two observed quota transactions to illustrate prices prior to 1971, we must turn to the flow returns from the quota, the price difference between fluid quota milk and excess milk. These data are available from the beginning of the scheme, 1956, but early years (1956-58) show erratic movements and are deleted. We are left

with 14 price changes over the 1959-1973 period before new federal and provincial policies altered both prices and regulations in 1974-75. Using geometrically declining weights as before,  $g$  as expected in 1973, midpoint of the 1971-75 period, is 1.8 percent per year. In addition, there were important quantity allocations of new quota. The expected percentage increase in new quota was estimated from annual data since 1967 on aggregate (system-wide) new quota increases, adjusted to percentage annual increases to existing producers and weighted with geometrically declining weights as described before. This value, 1.4 percent per year, is added to the expected price increase of 1.8 percent to arrive at a total expected capital gain of 3.2 percent.

Finally, an adjustment in the price of quota is again necessary to account for the tax benefit (TS of equation 4). This provision was introduced in 1972 and quota prices have been adjusted in subsequent periods in the same manner as described earlier.

Using available quarterly data from the third quarter of 1971 to the first quarter of 1975 we first adjust the quota price for the tax saving (TS), generating  $P_Q$ , calculate  $r^*$  from  $R/P_Q$ , and finally  $\lambda$ , from  $(r^*-r+g)/(1+r^*)$  given  $g = 0.032$  and  $r$  assumed to be 0.08. The results are shown in Table 1.

The mean value of  $r^*$ , excluding the three observations judged to be inapplicable (1973:I, 1973:II, 1974:I)<sup>14</sup> is 0.317. This is a surprisingly large number of discounting the future returns from an investment,<sup>15</sup> and is the evidence alluded to earlier which suggests that the purchase of fluid quota is seen to be a particularly risky investment. Conditional upon our estimated  $g$  (0.032) and assumed  $r$  (0.08) values, the implied risk of default ( $\lambda$ ) over this period averages 0.204 with standard

deviation 0.011. This policy or default risk is equivalent to expecting that all rents from the quota regime will fall to zero with a one in five probability, given no intermediate option of a partial reduction in rents.<sup>16</sup> The size of this expected default probability is not simply an artifact of our values of  $r$  and  $g$ ; in fact,  $\lambda$  is quite robust to changes in these parameters. For example, allowing  $r$  to vary between 0.06 and 0.10 and  $g$  between 0.02 and 0.04 causes  $\lambda$  to fall within the range of 0.180 and 0.225, the former value resulting from the higher discount rate combined with the lower growth rate, and conversely.

An alternative and simpler method of expressing this risk, noted earlier, is in terms of the expected life of the asset. Assuming again that  $r = 0.08$  and  $g = 0.032$ , but solving for  $N$  instead of specifying  $\lambda$  gives an implied time horizon ( $N$ ) of 3.6 years. Farmers holding these values of  $r$  and  $g$  will invest in fluid quota only if they can pay off the investment in at least 3.6 years.

Still, estimates of such large default risk raise the question of the plausibility of the belief that there is a one in five chance that the quota regime will be scrapped. Some program changes are clearly possible. An important source of these rents, the fluid milk pricing formula, has been periodically the subject of political debate, and a series of Agriculture Ministers have publicly decried high and rising quota prices and quota transferability. The dairy subsidy program (FIA) mentioned earlier lasted only five years and paid a significant subsidy in two. Furthermore, arguments at public hearings and in the media for dismantling this milk policy regime are often advanced by consumer interests and economists. Therefore, a perception

of considerable policy risk, manifested in a large discount of future quota returns, would not appear surprising.<sup>17</sup>

As large as this earnings-price ratio ( $r^*$ ) and policy risk apparently are, they are not without corroborating evidence from trade in other government "rights." There is a well developed market for MSQ in Ontario (where MSQ can be traded) with few restrictions on quota transferability. Because MSQ is an annual quota, once a unit of it is used in one year, it cannot be used again until the following year. The quota exchange of the Ontario Milk Marketing Board exploits this distinction and permits trading in two different types of MSQ, "used" and "unused." Using  $R$  again to denote the rents or returns to a unit of quota, unused MSQ will be valued as

$$\sum_{i=0}^N \frac{R_i}{(1+r)^i}$$

whereas used MSQ will be valued as

$$\sum_{i=1}^N \frac{R_i}{(1+r)^i}$$

. The difference in their prices will be

$$\sum_{i=0}^N \frac{R_i}{(1+r)^i} - \sum_{i=1}^N \frac{R_i}{(1+r)^i} = R_0$$

In other words, the difference in price between unused and used MSQ will offer a direct measure of  $R$ , without the complications of having to know expected capital gains, the discount rate or the time horizon.

This MSQ exchange only began operation in March 1980, so to allow transactions to reflect acquaintance with the operation of the market we wish to ignore the data from the first months of the market's operation. No trading in used MSQ occurs during August and September due to the definition of the dairy year. Consequently we choose data from the new dairy year (which begins in August), leaving us four observations (January data is generated by quota

bidding in December) from the 1980 calendar year. The average price difference between unused and used MSQ over this period was 10.25 cents per litre. Given an average MSQ (unused) price over the same period of 35.95 cents per litre, when adjusted by the expected tax saving, the earnings-price ratio ( $r^*$ ) is 29.0 percent. If we assume values of  $r$  and  $g$ , we can determine the implied default risk. We can let  $r = 0.08$  as before, but we have no information on expected capital gains experience, given the newness of the market. If we assume a small real capital gain per year, say  $g = 0.02$ , the resulting  $\lambda$  is 0.18. Alternatively, the implied time horizon using the same  $r$  and  $g$  values, setting  $\lambda = 0$  and solving for  $N$  is 4 years.

Admittedly these data are for a different province, time period and asset, industrial milk quota in 1980 in Ontario instead of fluid milk quota in the 1971-75 period in British Columbia, but the apparent default risks and earnings-price ratios are remarkably similar. These Ontario data, by offering direct information on  $R$  and  $r^*$ , offer some support for our less direct measure of  $r^*$  of B.C., and support clearly the notion that these milk quotas are assets with considerable perceived risk. Casual evidence to support these results, that milk quota in Ontario and B.C. is risky enough to require a planning horizon of about four years is also found in Broadwith & Hughes (1979) and Arcus (1977).

Poultry production in Canada is also regulated by quotas and these markets can provide additional verification of our results. Despite difficulties in making accurate quota price observations due to thin markets and restrictions on quota transfer in some jurisdictions, the quota can be rented in the Ontario broiler and egg markets. This gives us a direct measure of  $r^*$  and subject to the

difficulties of determining expected growth rates in quota prices, we can estimate the default risk for each market, albeit with less confidence than in the case of the dairy markets.

For Ontario egg quotas we have eight years of quota price observations and five years of observations on rental prices. The earnings-price ratio,  $r^*$ , averages 0.18 over the 1978-81 period. Capital gains experience has been more erratic here, and apparently increasing over time, but using  $g = 0.10$  and  $r = 0.08$ , we obtain an estimated  $\lambda$  of 0.17. In the Ontario broiler market we have quota price data from 1976 to 1983, generating an expected annual capital gain of 0.14 by the same methods of calculation as already discussed. For the single year, 1983, we have an earnings-price ratio,  $r^*$ , of 0.1514, resulting in an estimated  $\lambda$  of 0.18. Despite admittedly noisy data and the apparently large influence of capital gains, these markets also show quota purchasers to discount future returns heavily and quota prices embody a perceived default risk of between one in five and one in six.

Finally, there is consistent evidence from an entirely different jurisdiction, the case of North Carolina tobacco allotments. Seagraves (1969) has estimated the rate of return or discount rate (approximately  $r^*$  in our terminology) on these tobacco allotments, and from 1945 to 1962 this discount rate averaged 26 percent. His estimates also revealed an interesting related phenomenon, that the discount rate has generally been falling over time, to average 16 percent in the last ten years of his data. We are unable to test this trend with our limited number of years of B.C. data, but we see that such a trend could arise from a reduced probability of default, increased expectation of capital gains or increased diversification. This result also



suggests some caution in applying a discount rate estimated at one point in time to quota market data some years later.

### Calculation of Supply Price

We are now in a position to solve equation (7) for the annual production rent,  $R$ , in the year 1980 for the B.C. dairy industry. This amounts to calculating  $r^*$  for 1980, and because we know  $P_Q^*$  (= \$86.15 per hectolitre), we can calculate the annual rent  $R$  per hectolitre of milk. Our estimate of  $g$  is 0.0925 and we continue to assume  $r$  to be 0.08 and  $N$  to be infinity. We apply the default probability estimated in the 1971-75 period ( $\lambda = 0.204$ ) to this 1980 market on the assumption that this parameter has not changed over this period. On the basis of these mean values,  $r^* = 0.2406$ , and the annual rent,  $R$ , is calculated to be \$20.73 per annual hectolitre of milk produced (or quota rented). Given that the price of quota milk ( $P_{Qm}$ ) was \$42.16, the aggregate supply price ( $C$ ) is calculated to be \$21.43 per hl. This value gives the striking result that virtually one-half of the price of fluid milk paid to B.C. producers goes toward the cost (rent) of the quota and the remaining one-half pays for the cost of real inputs.

These results, however, are based upon point estimates of parameters measured with possible error. Considering a range of likely  $r$  and  $g$  values for the 1971-75 period,  $\lambda$  was earlier estimated to lie within the range (0.18, 0.225). Again we will consider the value of  $r$  to lie in the range (0.06, 0.10), and to cover a wide range of possible expectations of future real capital gains, we let  $g$  vary between 0.07 and 0.11. This variation in parameters places bounds on  $r^*$  of (0.207, 0.277). In turn, the rent  $R$  will lie between \$17.86 and \$23.90, and the resulting supply price,  $C$ , is between \$18.26 and \$24.30 per hectolitre.

Once again, the Ontario MSQ market data offers corroboration. Recall that the production rent,  $R$ , was measured directly as \$10.25/hl. Given an average industrial milk price of \$32.76, the supply price of milk in Ontario in 1980 was \$22.51/hl. This value is calculated directly, without reference to capital gains issues or estimated discount rates, default risks, and so forth. The similarity of this value of our estimate of the B.C. supply price is encouraging, despite differences in production conditions between the two regions. However, given the range of possible supply prices in B.C. noted above, we have insufficient precision in our mean estimate to conclude that B.C. producers have lower costs at the margin than their Ontario counterparts.

Finally, recently collected average variable cost data for a sample of these B.C. milk producers for the year 1981 provides an additional data source with which to test our results. When we take the largest one-third of sampled farms, on the assumption that these are the firms buying quota, and deflate their costs back to 1980 at the rate of inflation (12.5) percent, we obtain a cost estimate of \$22.16/hl. This estimate represents average variable, not marginal costs, and embodies an assumption of constant costs between 1981 and 1980, but nevertheless is sufficiently close to our estimate to constitute an additional measure of support.

It is useful at this point to contrast these results with the results one would obtain by applying the standard model, where  $R = iP_Q$ . The average (nominal) interest rate on farm debt across Canada was 12 percent in 1980, and the average market price of quota (unadjusted) was \$96.44. The resulting annual

rent to the quota is then \$11.57/hl., approximately one-half of the value obtained with the model suggested in this paper. Similarly, the calculated supply price would then be \$30.60/hl., forty percent above our estimate. Such an estimate suggests not only the implausible result that B.C. milk producers are much less efficient at the margin than their Ontario counterparts, but that marginal costs are so close to the price of MSQ milk that there would be little value to that quota and little demand for it. In fact, there is considerable excess demand for this (untraded) quota and despite sizeable penalties there is production in excess of it.

#### Conclusion

It is the purpose of this paper to give some illustration of the information which can be provided by the market for a government right, in this case, an agricultural marketing quota. Not only can the private value placed on this quota provide a barometer of the general profitability of the industry but it can also disclose specific information about otherwise unobserved industry supply conditions, such as the industry supply price.

In our attempts to estimate this supply price, however, it has become apparent that the analysis of the quota may involve considerable complexity. Multiplying observed quota prices by a market interest rate, as is normally found in the literature, does not appear to do justice to the subtleties of quota ownership, and certainly yields very different results from the analysis we propose. For example the quota is an asset about which there may be a perception of considerable risk, especially the policy or default risk of possible changes in or elimination of the profitable quota regime. It may possess the prospect of earning increasing production rents, hence capital

gains, over time, as well as additional benefits such as tax advantages.

Empirical implementation of this more detailed model required both additional data and institutional detail, particularly in determining the probability of default and earnings-price ratio ("discount rate"). Only through fortuitous policy changes were we able to obtain measures of this risk involved in holding fluid quota in the B.C. milk industry, and that evidence may be unavailable in some jurisdictions.

Nevertheless, it was feasible in the case of the B.C. milk industry to obtain estimates of almost all required parameters and the results are corroborated by a variety of additional evidence. First, our results show that B.C. fluid milk quota is perceived to be a very risky asset, with an earnings-price ratio of 32 percent. By assuming a discount rate of 8 percent embodying a risk premium for systematic risk and the possibility of any underdiversified nonsystematic risk, we estimated a perceived probability of default, that the monopoly rents of the quota system would end, of 20 percent. More direct evidence from the Ontario industrial milk market produces a very similar result (an earnings-price ratio of 29 percent, or a default probability of 18 percent), providing empirical support for both our result and our less direct calculation procedure. Similar results were suggested by data from Ontario poultry markets. The annual rent earned by B.C. fluid quota averages \$21/hl. in 1980, about one-half the price of fluid quota milk, and this contrasts with the result of \$12/hl. obtained with the simple model of quota valuation.

The resulting supply price for milk in B.C. is calculated to be almost \$21.50/hl. in 1980. This is supported by the comparable value of \$22.50/hl.

in Ontario, arrived at without need for data on discount rates, capital gains or other benefits. In addition, average variable cost data from 1981 for the largest third of sampled farms, deflated back to 1980 dollars, gives a value of \$22.16/hl. Given the transfer of production knowledge and genetic material across Canada, the Ontario data is likely to represent a better yardstick of comparison, and they provide support for both the B.C. supply price estimate and the quota valuation model. These numbers contrast sharply with the result obtained from the simple model, where the B.C. supply price is estimated at \$31/hl., a clearly implausible estimate given the excess demand for industrial milk quota.

Although we are encouraged by what empirical support we have for our estimates, it should be obvious that we can claim no precision in the supply price estimation undertaken here. The results are best interpreted as point estimates, and four sources of possible error can be identified. Given the erratic nature of the capital gains series, the estimate of  $g$  is sensitive to the expectations process assumed, hence may introduce error. Second, the estimate of default risk ( $\lambda$ ) used for 1980 was obtained from 1971 - 1975 data and it is possible that it may have changed over the period. Third, the choice of discount rate used in initially estimating  $\lambda$  and subsequently estimating the quota rent may have introduced a small error because the resulting supply price is not independent of the discount rate chosen. In the same vein, the results are slightly affected by the characterization of risk which is chosen. Fourth, the assumption of profit maximization with respect to quota purchase is made throughout the paper and if persistent errors are made over time, our results lose some of their significance. Finally, although we have considered benefits to the quota in addition to the production rent, there may be other factors we have missed.

A range of probable supply price estimates was obtained by varying the parameter values of  $r$ ,  $g$  and  $\lambda$ . Considering the discount rate between 0.06 and 0.10, the rate of expected capital gains between 0.07 and 0.11, and the default risk probability between 0.180 and 0.225,, the resulting supply price ranged from \$18.26/hl. to \$24.30/hl., a fairly narrow range given the wide variation in parameter values. This band could be narrowed by further work in this area, but it still shows the supply price to be well below the simple model estimate of \$31/hl.

What are now needed to test the realism of the procedures followed here (or the efficiency with which the quota market works) are alternative measures of the quota rent or the supply price. There are several possible options here, including the collection of actual cost data, but they represent work for another paper.

Finally, the results themselves suggest several implications. First, the default risk which we have measured for agricultural marketing quotas may be important in a variety of government programs which provide rents to certain groups, from import quotas to farm price supports. One might expect that a high discount of future returns (rents) takes place in arriving at the stock price incorporating these returns, be it an import license or agricultural land. Second, the supply price estimated may be on a new supply curve compared to the unregulated supply curve if the operations of the marketing board have changed real resource costs at the farm level. Third, in contrast to claims that supply management marketing boards are socially efficient because they reduce price risk to farm producers, this work suggests that the boards create an important element of risk as well. Finally, the level of the supply price

is important for determining both income transfers and efficiency effects of the regime. Although these effects are not calculated here, the size of the quota rent makes clear that income transfers in this market are very large.

### Footnotes

1. Marketing boards are statutory institutions, formed in a number of developed and developing countries to intervene in primary product (usually agricultural) markets. Their objectives are typically to "improve" the marketing process, which often means controlling market participants, stabilizing and sometimes increasing producer prices. See Hoos (1979) for international comparisons of these boards.

2. Although marketing boards are prevalent in some developing countries, notably West Africa, this problem does not presently arise there. Marketing boards in those regions act more to impose an export tax, limiting domestic production by reducing the producer price. Only if producer prices were raised above equilibrium levels would quotas become a policy tool in those countries.

3. Although  $Q$  is typically shown to be less than  $Q_e$ , the quota may be imposed at any level of output, greater or less than  $Q_e$ . It effectively constrains output and becomes valuable when its associated output price exceeds the supply price, creating rents at the margin of production.

4. It should be noted that  $g$  can take on negative as well as positive values. Although uncommon, negative price appreciation has been observed in some years and over multi-year periods in some jurisdictions. As well, recent Canadian dairy industry experience with a shrinking industrial milk market has offered examples of quota cutbacks, reducing individual quota holdings across the board.

5. Confusion on this general issue of marginal versus inframarginal returns in analyzing quotas is illustrated in Department of Finance (1981) and (Barichello, 1982).



6. The added cost of planning and adjusting biological production systems to meet known annual or even monthly quotas is one example of the reverse effect, shifting the supply curve to the left. When quota levels are altered, especially with short notice (as can be the case when demand changes unexpectedly), these planning and adjustment costs increase, shifting the supply curve further left. It would be interesting to test the hypothesis that whatever the increase in price stability caused by these marketing board regimes, it is obtained at the expense of increased quantity instability.

7. Kletzer raises another issue that would seem to have application to these quota-controlled markets (or any markets with significant government intervention). Because the lender to a foreign government is likely to have less information than the borrower about the likelihood of default, the lender has an incentive to acquire more information. In quota markets, this translates as the farmer having insufficient information about the likelihood of policy change by the government. It would be profitable for farmers to increase their information by becoming more involved with the government in the relevant policy areas. In fact, one observes in Canada an increased demand for joint policy decision-making between farm groups and the government in those areas where government intervention is greatest. This lobby activity can then be explained as an attempt to decrease the policy or default risk in addition to the more familiar attempt to increase farmers' returns or wealth.

8. Note that this is analogous to pricing the quota as a call option. The quota holder is "in the money" (in options terminology, the future stock price exceeds the exercise price) as long as the quota regime and rents are maintained, but if the quota scheme is scrapped, his quota asset is worthless like a call option when the stock price stays below the exercise price.

Assuming risk-neutrality, the current call price is the expected value of next periods price defined over "pseudo-probabilities", analogous to our  $\lambda$  and  $1 - \lambda$ .

9. In five years of BCMAF collection of individual prices, virtually all months show the range of prices within four percent of the mean value.

10. Because of the competitive market, visible quota prices and low transaction costs, save for the smaller farms for whom the minimum transaction size is a significant proportion of their production, there should be a strong tendency for the stock price of quota to be equated across farms. This is consistent with the low dispersion in reported prices. The tendency toward equalizing marginal costs across firms, while present in the long run, will be weaker in the short run due to possible differences across farms in the other variables of equation (6), notably different expectations of capital gains and perception of the risk.

11. It is encouraging that on the basis of personal experience in this industry I arrived at a similar figure (a more conservative 7 percent) using more arbitrary ad hoc procedures.

12. This is still consistent with earlier work by Jenkins (1972) where the rate of return in agriculture during the 1960's is estimated to be within the range of 5 to 7 percent.

13. This provides an additional argument for deleting the two observations noted earlier, but also draws attention to the first quarter of 1974 when the FIA program was first introduced. Much uncertainty existed about the nature of the program and its effect on fluid quota, resulting in a noticeable increase in the implied discount rate. (See Table 1). This would appear to be a clear case of unusual circumstances leading to an added

discount of current returns and a resulting discount rate estimate of little value to us in measuring longer term default probabilities. Therefore, we do not include the 1974 first quarter observation when calculating the mean value of  $r$ .

14. Including all observations raises the average  $r^*$  to 0.329, but increases the dispersion (measured by standard deviation) by more than 60 percent to 0.030.

15. By contrast, other asset markets disclose implied discount rates at more familiar levels. Berck (1979) found that timber cutting practices of U.S. Pacific Northwest lumber companies implied a real discount rate of 5 percent. In addition, Johnson and Kaserman (1983) explored the private housing market to determine the degree to which energy-saving investments were capitalized into the market price. The range of real discount rates implied were 6.3 to 8.4 percent.

16. Admitting these intermediate options would imply an even larger expected probability that some reduction in rents will occur.

17. Past successes of the dairy lobby would do little to reduce this risk if continual difficulty was seen in mobilizing fellow producers and persuading governments in an increasingly urban environment. This perception appears to be held by many individual dairymen and particularly by those industry leaders who are active in lobby efforts. It is for this reason that we have modelled the annual default probability as being independent of previous years' outcomes.

References

- Arcus, P. L. "The Values of Milk Quotas in British Columbia", Canadian Journal of Agricultural Economics 26 (July 1978): 62-71.
- Barichello, Richard R. "Decision Making Criteria for Purchasing Milk Quota at the Individual Farm Level: A Comment", Canadian Journal of Agricultural Economics 30 (Nov. 1982): 377-82.
- \_\_\_\_\_ and Glenday, Graham, "The Tax Expenditure of Agricultural Marketing Quota Deductibility," mimeo, 1983.
- Berck, Peter, "The Economics of Timber: A Renewable Resource in the Long Run." Bell Journal of Economics 10 (Aug. 1979).
- Broadwith Hughes and Associates, "The Ontario Milk Marketing Board" in Government Regulation, Toronto: Ontario Economic Council, Ontario Queen's Printer 1978.
- Eaton, Jonathan and Gersovitz, Mark. "Debt with Potential Repudiation: Theoretical and Empirical Analysis." Review of Economic Studies 48 (1981): pp. 289-309.
- Elton, E. J. and Gruber, M. J. Modern Portfolio Theory and Investment Analyses, New York: Wiley and Sons 1981.
- Government of Canada, Department of Finance, "An Economic Analysis of the National Dairy Policy" Preliminary technical paper prepared for the Interdepartmental Dairy Policy Review, Economic Development Division, March 11, 1981.
- Grubel, H. G. and Schwindt, R. W. The Real Cost of the B.C. Milk Board, Vancouver: Fraser Institute 1977.

- Hoos, Sidney, ed. Agricultural Marketing Boards: An International Comparison, Cambridge, Mass.: Ballinger Publishing Company, 1979.
- Jenkins, G. P. "Analysis of Rates of Return from Capital in Canada" Ph.D. Thesis, University of Chicago, 1972.
- \_\_\_\_\_, Capital in Canada: Its Social and Private Performance Ottawa: Economic Council of Canada, 1977.
- Johnson, R. C. and Kaserman, D.L., "Housing Market Capitalization of Energy Saving Durable Good Investments." Economic Inquiry, July 1983.
- Kletzer, K. "Asymmetries of Information and LDC Borrowing with Sovereign Risk," Economic Journal, June 1984.
- Lerner, George and Stanbury, W. T. "Measuring the Cost of Redistributing Income by Means of Direct Regulation". Canadian Journal of Economics, forthcoming.
- Malkiel, Burton "Risk and Return: A New Look" NBER Working Paper 700, 1981.
- Schmitz, Andrew. "Supply Management in Canadian Agriculture: An Assessment of the Economic Effects." Canadian Journal of Agricultural Economics 31 (July 1983): 135-152.
- Seagraves, J. A. "Capitalized Values of Tobacco Allotments and the Rate of Allotment Owners". American Journal of Agricultural Economics 51 (May 1969): 320-334.
- Veeman, M.D., "Social Costs of Supply-Restricting Marketing Boards," Canadian Journal of Agricultural Economics 30 (March 1982): 21-36.

## APPENDIX 1

B.C. Fluid Milk Quota Prices and Price Changes, 1971-1983,  
(\$ per daily pound, nominal values)

<u>Year</u>	<u>Quota Price/lb.</u> \$	<u>Nominal Percentage Change from Previous Year</u>	<u>Real Percentage Change from Previous Year</u>
1971	\$35.67		
1972	37.80	+ 6.0	+ 1.0
1973	36.80	- 2.6	-11.7
1974	36.32	- 1.3	-16.6
1975	57.98	+59.6	+48.9
1976	76.57	+32.1	+22.6
1977	93.03	+21.5	+14.4
1978	121.31	+30.4	+23.9
1979	137.57	+13.4	+ 3.1
1980	155.07	+12.7	+ 1.6
1981	150.51	- 2.9	-13.0
1982	155.28	+ 3.2	- 7.5
1983	200	+29	+20

Source: Grubel and Schwindt (1977), B.C. Ministry of Agriculture and Food, Monthly Input Cost Survey, 1979 to 1983, private communication with brokers, GNE implicit price deflator.

TABLE 1

Net Returns, Prices, "Discount Rates" and Implied Default Probabilities ( $\lambda$ )  
for B.C. Fluid Milk Quota

1971 - 1975, R and  $P_Q$  in \$/hl, 1971 dollars.

Quarter	R	$P_Q^*$	$r^*$	$\lambda$	
1971	III	7.05	23.05	0.306	0.197
	IV	6.79	20.96	0.324	0.208
1972	I	6.88	23.42	0.294	0.190
	II	7.13	23.42	0.304	0.197
	III	7.03	21.08	0.334	0.214
	IV	7.43	21.37	0.348	0.222
1973	I	7.97	20.47	0.389	0.246
	II	7.57	20.91	0.362	0.231
	III	6.82	20.68	0.330	0.212
	IV	5.59	18.39	0.304	0.196
1974	I	6.94	18.36	0.378	0.240
	II	6.61	19.45	0.340	0.218
	III	5.20	17.96	0.289	0.187
	IV	5.07	16.16	0.314	0.202
1975	I	5.47	17.35	0.315	0.203